Cost-Effectiveness Analysis of Three HIV Prevention Interventions in Kenya: A Mathematical Modelling Approach

A Thesis for the Degree of Doctor of Philosophy

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Cost-Effectiveness Analysis of Three HIV Prevention Interventions in Kenya:

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BY

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ABSTRACT

Background: In the research for this thesis, the incremental cost per case of HIV averted and the cost per DALY saved were assessed for three HIV prevention interventions from the Strengthening STD/AIDS Control in Kenya Project. These interventions were peer interventions for commercial sex workers (CSWs), occupationally focussed interventions with men, and syndromic management of sexually transmitted infections (STIs). The programmes directly reached 5,000, 3,015 and 6,637 people respectively. *Methods:* The project began with a thorough and systematic review of the literature including reports, budgets, raw data and published documents. Direct observation and a Project staff discussion group also were used in order to seek out the best possible information for the model. Actual programme costs were collected from the provider's perspective. Next, a model was built to simulate the sexual behaviour of people living in the city of Nairobi. The model allowed for estimation of the reduction in cases of HIV that are directly prevented, as well as the prevention of secondary cases. The impact of the project's interventions were simulated and subtracted from the baseline model (the expected outcome without the interventions). From the cumulative HIV incidence, numbers of cases averted, the cost per case of HIV averted and disability adjusted life years saved were calculated. A sensitivity analysis was performed which showed the model and the ranked results to be robust. *Results:* The CSW peer intervention project was found to be the most cost-effective of the three interventions, preventing 983 cases of HIV in one year and costing Can$101.24 (KSh 4,556) per case of HIV averted and $6.25 per DALY saved. The syndromic management of STI project ranked next, showing a reduction in annual cases of HIV of 726 and costing $164.26 (KSh 7,392) for each case averted and $10.14 per DALY saved. Finally, interventions for men in occupations that are at high-risk for HIV reduced the annual HIV incidence by 369 cases and cost $241.84 (KSh 10, 883) per case of HIV averted and $14.93 per DALY saved. *Implication:* These three projects were all found to be highly cost-effective, and should be replicated on a larger scale.

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List of Abbreviations

AEA	Alternative Economic Activity
AIDS	Acquired Immune Deficiency Syndrome
AMREF	African Medical and Research Foundation
ANC	Antenatal Clinic
ART	Antiretroviral Therapy
Can$	Canadian Dollar (year 2000)
CEA	Cost-effectiveness Analysis
CIDA	Canadian International Development Agency
CSM	Condom Social Marketing
CSW	Commercial Sex Work(er)
DALY	Disability Adjusted Life Year
DHS	Demographic Health Survey
FGM	Female Genital Mutilation
FSW	Female Sex Worker
GUD	Genital Ulcer Disease
HAART	Highly Active Antiretroviral Therapy
IEC	Information, Education and Communication
KAP	Knowledge, Attitudes and Practice
KSh	Kenyan Shilling

NACC	National AIDS Control Council
NASCOP	National AIDS/STD Control Programme
NGO	Non Governmental Organization
OFIM	Occupationally Focused Interventions with Men
ORM	Occupationally Risked Men
QALYs	Quality Adjusted Life Years
SM	Syndromic Management
STI(s)	Sexually Transmitted Infection(s)
TOT	Teacher of Trainer
U of M	University of Manitoba
U of N	University of Nairobi
UNAIDS	Joint United Nations Programme on HIV and AIDS
US$	United States Dollar (year 2000)
USAID	United States Agency for International Development
VCT	Voluntary Counselling and Testing
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

By the year 2000, within fifteen years of the detection of the country's first official case of human immunodeficiency virus (HIV), 12% of the adult population of Kenya was believed to be HIV positive (World Health Organization, 2000). Nairobi's HIV prevalence was estimated to be about 17% in the year 2000, stabilizing, or possibly reducing slightly to 16.8% by the beginning of 2001 (Ministry of Health, 2001). This meant that approximately as many people were being infected with HIV in Nairobi as were dying of the disease each year. As of June 2000, it was estimated that HIV was responsible for the deaths of 1.5 million Kenyans, prompting the president of Kenya to declare the country's AIDS epidemic a "National Disaster".

HIV continues to spread throughout the world resulting in disease, human misery, death and devastating social and economic consequences. As a result of high levels of loss, there is a great need to better understand the epidemic. In the absence of a vaccine, behavioural interventions and risk reduction are the only protection against the virus. Oftentimes governments choose to implement programmes based on their popularity, and acceptability with the general public, while avoiding effective programmes that may be controversial (Marseille *et al.*, 2002). In a resource-limited economy, such as that of Kenya, increasing the overall number of intervention strategies may not heighten the total effectiveness of the national prevention programme (Ainsworth & Teokul, 2000). However, by strategically implementing a small number of highly cost-effective strategies on a national scale, the tides of the epidemic could be turned. Yet, there is no clear evidence that indicates which interventions would be most cost-effective within the Kenyan context. Given the limited health care budgets and the seriousness of the epidemic in Kenya, the need to determine which interventions are most cost-effective is of the highest priority.

This thesis is a report of the research that was done to establish cost-effectiveness analysis of three different HIV prevention interventions in Nairobi, Kenya. The interventions included syndromic management (SM) of sexually transmitted infections (STI), commercial sex worker (CSW) peer interventions and occupationally focused interventions with men (OFIM). The project began with an extensive literature review of the known effective HIV prevention interventions. Next, an original model was created to measure the cases of HIV that would be averted if those effective interventions were carried out. While the model used a hypothetical population, the parameters were derived from shared data which was collected from people in the communities that were served by the Project in Nairobi and the neighbouring area of Thika. From this model, cases of HIV averted in each intervention scenario were matched to financial estimations from budgets, staff reports and direct observation of the Project's activities. Cost-effectiveness ratios were determined and compared.

This research was undertaken at the request of the project *Strengthening STD/AIDS Control in Kenya* (known henceforth in this thesis as "the Project") to help them to better understand the effectiveness and cost-effectiveness of the interventions that they deliver. The data from this research project will also be helpful for decision-makers (such as politicians, project leaders and community leaders) who are fighting the spread of HIV in Kenya. It is indeed important for all of those who are establishing Kenya's HIV prevention and care policies to be aware of the impact that their investments have on the overall epidemic. This thesis report also outlines the challenges and benefits of working in HIV prevention in Kenya, HIV prevention interventions as discussed in the literature, and mathematical modelling. It gives an overview of the methods used in completion of this project and the results. A summary of the sensitivity analysis is also included in this thesis report. The Discussion chapter features further examination of the results, the sensitivity analysis and the implications of the findings. The report finishes with chapters on conclusions and recommendations for further study.

Theoretical and Conceptual Framework

Prevention strategies are meant to intervene in sexual transmission of HIV in two ways. Firstly, they are intended to modify sexual behaviour patterns that may increase exposure to an infected partner. These include increasing the age of first sexual contact, decreasing the number of sexual partners, and reducing contact with commercial sex workers and other groups of people who are at high risk for HIV. Secondly, factors that may influence the transmissibility of HIV during intercourse with an infected partner must be examined. These may include increasing condom use, and treating ulcerative and non-ulcerative STIs (UNAIDS, 1999).

A computerised model was used to simulate the sexual behaviour of the city of Nairobi over a one-year period (the year 2000). Information used to build the model came from the most recent, accurate and local information available. At any given time, every member of the community is at a certain risk for HIV. Several interventions have demonstrated effectiveness at reducing that risk. The difference between the expected incidence (base model) and the new incidence due to a prevention programme (intervention models) yields the effectiveness of the project. Therefore effectiveness was modelled by comparing the simulated incidence of HIV with and without the intervention. Cost-effectiveness (CE) ratios were then calculated and compared to determine which interventions averted the greatest number of HIV cases per dollar or Kenya shilling spent in the year 2000.

Background to the Strengthening STD/AIDS Control in Kenya Project

The collaboration to control STIs between the University of Nairobi and the University of Manitoba began in 1980. An outbreak of genital ulcer disease (GUD) in Winnipeg between 1975 and 1977 sparked the need to better understand the disease. The University of Manitoba approached the University of Nairobi to begin an effort in Nairobi to collaborate on a project to identify the most effective control methods for chancroid. At that time, the respective heads of each university's departments of medical microbiology (Dr. H. Nsanze and Dr. A. R. Ronald) came together to research the natural history and control of GUD. Dr. E. N. Ngugi spearheaded a community-based, self-improvement programme with CSWs in the Pumwani district of Nairobi in 1982. This project allowed for the STI research to continue in this highly susceptible population of women, even before HIV became a serious problem in Kenya. In 1983, the World Health Organization (WHO) designated the STI project to be a *WHO Collaborating Center for Sexually Transmitted Diseases*. In 1984 Dr. Frank Plummer, who had been attached to the project since 1981, assumed responsibility for Canadian activities of the STI project

(Ronald *et al.*, 1991). By this time, the Project was positioned to contribute greatly to the understanding of HIV transmission and prevention.

The project has collaborated with many other organisations over the years including the Kenya Medical Research Institute, the U.S. Centers for Disease Control and Prevention, the University of Washington, and the Kenya-Belgium STD Project. Funding has come from the Canadian International Development Agency (CIDA), the Medical Research Council of Canada/Canadian Institutes for Health Research, the European Economic Community, the National Institutes of Health and the Murphy Trust.

Although the project's main interest was initially focused on chancroid and other genital ulcer diseases, over time the project began to branch out into other areas of interest in the epidemiology and control of STIs. Other diseases that the project began to look at were gonococcal infection and *opthalmia neonatorum*. However, it was in 1985 that the project began to recognise the growing incidence of HIV, the disease for which it would become most renowned.

The first sex worker cohort was created in 1985 to study the epidemiology and biology of HIV and STIs, as well as the control of these diseases in the Pumwani slum of Nairobi. The laboratories and management of this project are located at the Department of Medical Microbiology in the University of Nairobi and from a research clinic situated in the heart of the Pumwani slum. Pumwani is a highly impoverished area of Nairobi that has seen the exponential growth of tin-roofed shacks, garbage and crime over the last two decades. There is little formal infrastructure in this area and poor access to services such as health and education. CSWs enrolled in the cohort get free access to HIV and STI education and counselling, condoms, STI diagnosis and management, diagnosis and management of HIV and AIDS related conditions, and access to income-generating projects and savings programs.

As CSWs, these women have a high risk of HIV-1 infection. Although they are provided with education and counselling services, promotion and provision of condoms and STI management services, the annual incidence of HIV-1 infection among initially seronegative women is still extremely high (estimated between 17-25%). The annual incidence has seen a substantial decrease from the yearly incidence of 40% observed in the early years of the project (Plummer, 1999a).

By 1986, the prevalence of human immunodeficiency virus (HIV) in Nairobi had grown to nearly 2% of antenatal women, 20% of men with GUD, and 60% amongst lower socio-economic CSWs. Retrospective analysis of blood samples from 1980 showed that there had been no HIV in the samples collected that year (Piot *et al.*, 1987). As the Project team had already been working in the area with STIs, they were poised to study and control the spread of the new STI in this population, HIV. While there was little evidence at the time linking HIV to other STIs, the connection was soon unveiled. Much was learned about the mechanics of HIV transmission and factors contributing to its spread as a result of work done by the Project team. More will be discussed about the relationship between HIV and STIs later in this thesis report.

In 1990, CIDA funded the project *Strengthening STD/AIDS Control in Kenya* that was initiated jointly by the University of Manitoba (U of M) and the University of Nairobi (U of N). The first phase of this project focused on building sustainable and replicable models to reduce the spread of HIV and STIs in Kenya. The main strategies used to reduce HIV and STIs were the promotion of the syndromic management of STIs and the formation of peer-education and self-help groups with people at high risk for disease. In 1996, CIDA funded Phase II of the *Strengthening STD/AIDS Control Project.* This phase continued to work towards the same goals as Phase I but included research on providing alternative economic activities and evaluating voluntary counselling and testing as HIV prevention strategies. Furthermore, the project was able to reach out to other groups of people at high risk and expand to new areas of the country.

Phase III of the Project will see the organisation evolve from a project into a collaborative HIV Prevention Centre between the U of M and the U of N. This centre will pull together all of the lessons learned from the past two decades of HIV-related research and take a leadership position in the training and supporting of new partners in targeted STI and HIV control. The centre will also evaluate effective ways of scaling up existing cost-effective interventions as well as developing new strategies. It is anticipated that Phase III will identify effective advocacy tools and integrate gender issues into the project research (U of N/U of M, 2000).

Understanding the Challenges of HIV Prevention in Kenya

The nature of the HIV/AIDS epidemic is both complex and dynamic. This complexity has led to a poor understanding of why the disease is so prevalent in some communities and almost non-existent in others. Although it is widely agreed that there are many issues beyond the actual virus that cause the HIV/AIDS pandemic, there has yet to be a cohesive voice on what the contributing factors are. In Kenya, many issues have been identified as contributors to the epidemic. The next section will outline the following contributory factors: biological and physical, social and environmental, and gender inequality. Some of the factors that are known to drive the HIV epidemic are discussed below.

Biological and Physical causes of HIV/AIDS Transmission

HIV is a virus that has to be physically transmitted from person to person. Changes in risk of transmission are associated with physical and biological aspects to sexual behaviour. These elements are discussed below.

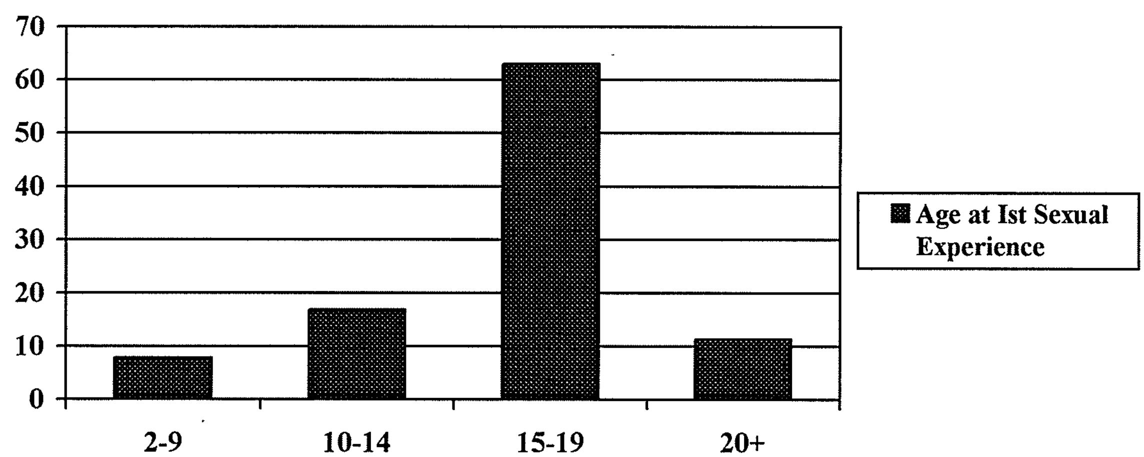
Young Age of Initiation of Sex

A study at a national youth camp in Kenya found that 88.6% of participants had experienced sexual intercourse by the age of 20, with 7.8% having had their first sexual experience between the ages of two and ten (Strengthening STD/HIV Control, 1999). The Kenya Demographic Health Survey (DHS, 1998) reported similar numbers for those under 20, with the average age of first sexual intercourse for men being 17.1 years in urban areas with women reporting a slightly older average age of 17.4. Furthermore, 23.7% of Kenyan women and 25.9% of men reported being sexually active by age 15 (DHS, 1998). These statistics are not outliers within the sub-Saharan African region. A study of 1600 young Zambians found that over 25% of ten-year-olds claimed to have already had sex (UNAIDSd, 2000). In comparison with other areas of the world, the

Kenyan statistic of nearly 90% of teenagers being sexually active is very high. The percentages of sexually active teenagers were reported in the USA, Mongolia, India and the Philippines as follows (respectively): 46.6%, 37%, 10-35% and 24% (Grunbaum *et al.*, 2002, Health and Development Networks, 1999).

The age of first sexual experience affects viral transmissibility in several ways. Firstly, the female genital organs are not fully developed and a women is not sexually mature until she reaches the age of 16-18 (Lee, 1980). By 18, most girls in Kenya have already engaged in sexual activity. Therefore during intercourse with a young girl, tearing and bleeding of the vagina can take place. This causes greater vulnerability to infection and an increased ability to infect. The Figure 1A shows the percentage of reported age groups at first sexual experience in Kenya (DHS, 1998).

Figure 1A: Age at Sexual Initiation, Kenya



Source: DHS, 1998

Young girls are also at an increased risk for cervical ectopy. Cervical ectopy, (known also as cervical eversion) occurs when cells from the cervical canal grow outside the cervix. Cervical ectopy is most common in women who are pregnant, taking birth control pills or in their early teens. There is some evidence from Kenya that this condition may be associated with an increased risk for HIV (Moss *et al.* 1991). However, a subsequent study from the US did not find this association (Mosicicki *et al.*, 2001).

Anal Sex

The highest risk for sexual transmission of HIV occurs during unprotected, receptive anal sex (URA) (Chmiel *et al.*, 1987; Winklestein *et al.*, 1987; Detels *et al.*, 1989; Page-Shafer 1997). A recent study from the US estimated that the risk of acquiring HIV from URA intercourse was 0.82 % per-contact when the partner was known to be HIV positive (Vittinghoff *et al.*, 1999). URA is therefore very risky in comparison with penile-vaginal sex which is estimated to have a transmission probability of 0.1% from women to men and 0.2% from men to women per sexual contact (Anderson & May, 1988).

The virus is able to gain access to the bloodstream efficiently through minute tears in the thin rectal mucosa. The presence of STIs in the anus can increase the risk of becoming infected with HIV. In a Nairobi study, 5.8% of FSW (Strengthening STD/HIV Control, 1997), 1.6% of youths (Strengthening STD/HIV Control, 1999b) and 1.8% of men (Strengthening STD/HIV Control, 1999b) admitted to the practice of anal sex. This is quite low compared to anal sex patterns seen in other populations worldwide (Johnson *et al.*, 2001; Silveira *et al.*, 2002). As a result of the rare practice of anal sex, it is unlikely to be a major contributing factor in the HIV epidemic in Kenya.

Male Circumcision

A number of studies have suggested that uncircumcised men are at higher risk of HIV infection than circumcised men (Simonsen *et al.*, 1988; Cameron *et al.*, 1989; & Moses *et al.*, 1990). A study in Kenya found that uncircumcised men with genital ulcer disease (GUD) had a four-fold risk of being HIV positive over their circumcised counterparts (Tyndall *et al.*, 1996). Further research is needed to understand the causative relationship between circumcision and HIV transmission. In Thika (20 kms north of Nairobi), a study of men in high-risk occupations found that nearly all of the men were circumcised (97.6%) (Strengthening STD/HIV Control, 1999a). However, a

Nairobi study looking at youth found that only 79% of the young men had been circumcised (Strengthening STD/HIV Control, 1999b). This could be a result of the distribution of cultural and ethnic groups in and out of Nairobi. In Kenya, most ethnic groups practice traditional circumcision with the notable exception of the Luos.

Viral Subtype

It can be argued that the virus is being rapidly spread in Kenya due to the type or clade of virus that is predominant in the area. East Africa has predominantly HIV subtype A (Essex, 2000). Research into the relationship of the viral subtype and transmissibility has not yet yielded any evidence of enhanced transmissibility of certain subtypes. Furthermore, subtype C found predominantly in southern Africa appears to be spreading and mutating faster than subtype A.

Presence of STIs

STIs are endemic throughout East Africa causing great morbidity and mortality in their own right. In recent years, the presence of STIs has become even more ominous in that these infections have been shown to increase susceptibility to HIV infection. It is thought that the mechanism through which this works is in the disturbance of mucosal surfaces or by changing the mucosal immunity (Plummer *et al.*, 1991). STIs have furthermore been shown to increase viral shedding in the genital tract, which in turn increases the infectivity of someone who is already HIV positive (Mostad & Kreiss 1996; Cohen *et al.*, 1997; & Ghys *et al.*, 1997). In fact, the infection of STIs such as gonorrhea increase the presence of HIV in semen even when there is no increase in blood plasma viral RNA. A Malawian study showed that HIV-1 shedding was eight times greater in men who were co-infected with both HIV and urethritis than their HIV-positive controls (Cohen *et al.*, 1997). The study furthermore found that after antibiotic treatment for gonorrhea, viral shedding in the semen slowly reduced. Ulcerative STIs are known to increase the viral transmissibility risk by approximately 6.82 times (Deschamps *et al.*, 1996). Non-ulcerative STIs increase HIV transmissibility risk by 2.58. Differences between male and female transmissibility risk were not found to be significant (Deschamps *et al.*, 1996; de Vincenzi, 1994).

Social and Environmental Causes of HIV/AIDS Transmission

Clearly, biological reasons are not the only factors influencing the spread of HIV in Kenya. A number of social and environmental factors exist that impact how the virus is spread and are important to consider in prevention programmes. Some of the social factors that affect HIV spread include stigma, poverty, migrant labour and urbanization. It should be noted that although these factors contribute to the HIV epidemic in Kenya, changing these factors may be difficult and complex in the short term.

Stigma, Fatalism and Lack of Acceptance of HIV/AIDS

The sexual nature of the spread of HIV has made discussing the disease difficult. In Kenya, admitting that a family member has died of AIDS-related causes is a matter of great family shame. The vast majority of people in Kenya who are infected with the virus are unaware of their status. One study found that over half of Kenyans who knew that they were HIV positive had not disclosed their status to their partners because they were afraid of violence or abandonment (UNAIDS/WHO, 2001).

Many people in Kenya believe that HIV is more of a spiritual disease, than a physical one. Due to the long period of time that HIV remains dormant, many people have difficulty connecting the long-past sexual history of an infected person with the current infection. There is a prevailing belief that the virus alone, without the power of witchcraft, would be unable to infect whole families and villages (Caldwell, 2000). In Nigeria, three-quarters of Christian leaders believed that AIDS was a divine punishment (Orubuloye *et al.*, 1993). Given the spiritual connection, many HIV positive Kenyans are seen to be receiving a divine punishment and are discriminated against. Many people choose not to disclose their status or even being tested for fear of losing their jobs, relationships and homes.

There is also a feeling of fatalism and discouragement experienced among many young Kenyans due to lowered life expectancy and employment opportunities. In fact, many people believe the trade off between short-term sexual pleasure and death within five years to be a reasonable exchange. Currently, the average life expectancy of a Kenyan is 48 years (World Bank, 2002). This compares poorly to developed nations such as Canada (life expectancy is 79 years) but compares well against the lowest life expectancies (Sierra Leone is 37 and Malawi and Botswana are 39 years).

The nearly universal spread of HIV/AIDS has left almost every family in Kenya affected by the epidemic. While most Kenyans are aware of the virus, how it is spread and how to prevent it, there is still very little evidence of behaviour change. In fact, the 1998 Kenya DHS reported that 99% of the Kenyan population knew about HIV/AIDS (DHS, 1999). However, even with the widespread knowledge about the virus, only one in five men and 2.4% of women were using condoms consistently in order to avoid the disease.

Despite the high prevalence of the disease in the country, less than 10% of respondents believed themselves to be at great risk of contracting HIV, with one third of the population believing themselves to be at no risk at all. The most frequent response of women who believed themselves to be at high risk was that their spouse had other partners. Men most frequently cited their many sex partners as the reason for their perception of high risk (DHS, 1999). A study in Western Kenya found that of the 35% of men who were in polygamous marriages, nearly half admitted to having another lover outside of these marriages (Lyons, 1999).

Poverty

Poverty is a major problem in Kenya with only 43% of the population being economically active and a per capita annual income of $US 340 (WHO, 2000; MOH, 2001). 62.5% of Kenyans are currently earning less than US $2 per day (World Bank, 2002). Poverty is a special element to consider in the HIV epidemic, as it is a driving force behind many of the other causes of HIV transmission. Poverty creates a vicious cycle. Poor people are at a high risk of becoming infected with HIV and the disease also makes the non-poor vulnerable to poverty. Costs of medical care and funerals, as well as the inability to work have caused many families that were formerly self-sustaining to become impoverished. From a broader economic perspective, HIV also damages economic development due to the loss of skilled labourers. Medical personnel and teachers are also highly susceptible to HIV/AIDS creating a critical void in the countries' social systems.

Due to the impact of HIV/AIDS, the people of Kenya are expected to incur a number of new expenses. The direct costs of losing one family member to HIV are devastating to the average Kenyan household. The expenditure due to medical care, drugs, loss of income and funeral expenses are likely to reduce household income by 54-78% (Bollinger et al, 1999).

If comprehensive care of people with AIDS were to be offered in Kenya, the resources would have to come from sources other than the government health care budget. Presently, the health care budget is insufficient to meet even the most basic needs, such as bandages and sutures. In order to meet some of the health care and HIV control needs, the Government of Kenya has already taken out loans from international organizations. An example of this is the US$ 40 million that the Government of Kenya borrowed from the International Development Agency in 1994 (MOH, 2001). These loans are helpful and valuable if used in effective ways but they also serve to further push the country into debt. As the economy continues to falter under the impact of the virus, people will seek out economic solutions in commercial sex work, and migrant labour in large urban centres. The impact of this shift in occupation and place of residence will likely serve to further fuel the epidemic in Kenya.

Migrant and Transport Labour

Oftentimes men who have little education and few skills try to find work in other cities and even other countries as agricultural, industry, and service labourers. Over 50% of working Kenyans earn their livelihood in agriculture (MOH, 2001). In fact, agriculture is the largest economic sector of Kenya, accounting for 23% of Kenya's gross domestic product, while manufacturing accounts for a further 16% (World Bank, 2002).

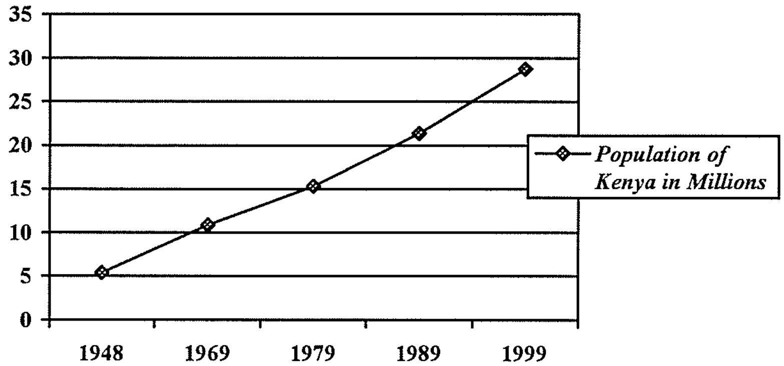
Many of these jobs are seasonal (or even day to day contracts) and many people must constantly relocate in order to work. These people are often young males who leave behind girlfriends and wives to seek better economic opportunities. It has been noted that migrant labourers have higher rates of HIV and STIs than men who do not migrate, when the rates of their home and work communities have been controlled for (Decosas & Adrien, 1997). The reasons for this may include alienation, loneliness, depression, alcohol abuse, and boredom.

Truck drivers and bus drivers are also at risk of acquiring HIV for the reasons mentioned above. This group however, is even more vital to the HIV epidemic as they travel long distances, spreading the disease between commercial sex worker groups, communities, cities and even countries. Military personnel and other uniformed people are also at risk of acquiring HIV because of power imbalances, fatalism, sex with CSWs and rape.

Urbanisation

Over the last ten years the population of the city of Nairobi has grown from 1,324,570 to 2,143,254 (GOK, 2001a). As a percentage of the national population, Nairobi represents 7.47% as opposed to 6.18% ten years ago. The following table shows the increase of the population of Kenya over the last 50 years. In that time, the population is increased from just over five million people to nearly 30 million people (1999 & GOK 2001a).

Figure 1B: Population of Kenya 1969-1999



Sources: DHS, 1999 & GOK 2001a

As people have flocked to the city in search of work and a better life, they have left behind the moral restrictions and cohesive communities of the rural villages. Again, the lack of opportunities, alcohol abuse and loneliness of men come into play. The overcrowded cities force large groups of people to live in small living spaces where there is no privacy or opportunity for long-term sexual relationships. Unemployment, the high costs of transport and the lack of other opportunities force some women into sex work and others into casual sexual relationships with older men. Men may choose not to marry due to the inability to support a family and they may seek commercial sex instead.

While it is apparent that HIV/AIDS is a development issue, it can also be argued that it is a disease of development (Collins & Rau, 2000). A disease of development suggests that it is either the actions carried out in order to develop a community or the developers themselves that alter the ecology and disrupt the natural social relationships that would protect against the spread of disease. As Kenya has developed and industrialised, people have tended to move away from the rural areas to the cities. The normal sexual taboos and the restraint that was encouraged by communities is no longer present. The Western media, music and the perception of Western morals are replacing former tribal cultural norms, for many Kenyans living in urban areas. In Kenya, intentions to modernise and industrialise may actually be adding to the spread of HIV. Of course, one could also argue that if this issue were truly significant, there would be few, if any cases of HIV in the rural areas. This is certainly not the case in Kenya, where there the prevalence of HIV is nearly as high in the rural areas as it is in the major cities (UNAIDS, 2000).

Gender Inequality as a Cause of HIV/AIDS Transmission

Overall in Kenya, HIV infection equally affects men and women. However, women tend to be infected younger than men are infected. In the 15-19 year old age group, women are five times as likely as men to be HIV positive. The rates of infection are three times higher than men in the 20-24 year old age group. Much of this increase in young female prevalence can be explained by CSW, sex with older men, inadequate treatment of STIs in women, and the more efficient transmission from men to women.

Female Sex Work

Where other viable choices for economic survival are limited, commercial sex work flourishes. In sub-Saharan Africa, many women who engage in CSW are from an economically disadvantaged background and have restricted access to resources (Gysels, 2002). In order to provide for themselves and their families, millions of women in developing countries sell sex for money or trade sex for goods or services in kind. A national study reported that 16.5% of Kenyan men who lived in urban areas and 12% of those in rural areas reported having given money, gifts or favours in exchange for sex over the past year (DHS, 1999). It was also found that 12.7% of urban women and 5.1% of rural women had exchanged sex for money, gifts or favours in the last 12 months. While many women do not consider themselves to be CSWs because they only exchange sex on an occasional basis, all women who engage in the trading of sex are at risk for abuse, rape, STIs and HIV. In this thesis research, as with the Project, all women who sell sex or trade sex for goods or services were defined as CSWs.

CSWs can engage in this work for many reasons. A baseline KAP study on CSWs in the Kibera slum of Nairobi found that only 1.3% were married while 9.5% were widowed and 42.1% were divorced or separated. Nearly all of these women were single mothers. Surprisingly only 0.3% of the population surveyed had never had children (Strengthening STD/HIV, 1997). Another baseline KAP study undertaken to understand how alternative economic activities (AEA) might function as an HIV prevention intervention found that 47.3% of the respondents mentioned the lack of alternative employment as the main reason for entering sex work. Income from sex work may be greater than income from other activities for unskilled women in Kenya. Other respondents claimed that they needed to provide for their children (32.1%), or had no other source of income after divorce/separation (5.7%) or widowhood (4.1%) (Strengthening STD/HIV Control, 2001).

Inadequate Treatment of STIs in Women

STIs cause serious disease in both men and women. STIs are also known to increase the transmission of HIV (Anderson & May, 1988; Gray *et al.*, 2000). In Kenya, about 15% of women at antenatal clinics claimed to have had an STI at some time in their lives (Strengthening STI/HIV Control, 2002). However, when women have an STI, there are seldom any physical signs (Strengthening STI/HIV Control, 1999c). This is one of the reasons why men admit to having more frequent episodes of STIs than women (DHS, 1999). Women often present for care during prenatal visits or when their infection is advanced. In fact, it is likely that the 3% of women who tested positive for gonorrhea in the sentinel antenatal clinics over the past ten years would likely not have sought treatment if they had not been diagnosed by the clinic staff (ANC Data, 2001). The fact that the infection goes untreated for so long makes STI treatment more difficult, expensive and complicated. Attending clinics for treatment requires both time and money.

The cost of treatment is also an issue. The average cost of STI treatment to the provider in Kenya is $US 0.66. This works out to be about 50 Kenyan shillings or approximately the average man's daily wages (GOK, 2001). In the year 2000, the drugs to treat STIs were given to clinics free of charge. However, a user fee was issued by the clinics. The consumers paid 20 shillings per treatment, or about $ US 0.29. Even when funds are available, paying for treatment may be difficult. Women in Kenya are not usually the people in the family who decide where the money will be spent. Even when women are the cash earners, 15.9% of them have no say at all in how that money is spent (DHS, 1999).

Young Sex and Early Marriage

A young person may feel peer pressure to initiate sex before they are ready and be powerless against advances from the opposite sex. Sexual decisions made by young people with little experience and high levels of hormones may not be responsible or long-lasting. Thirdly, the younger a person engages in sexual activity, the more opportunity they have to contract the virus over their lifetime. In Kenya, most infections of HIV occur in the mid teens and early twenties (MOH, 2001).

The Kenya Demographic Health Survey (1998) also reports that the age of first marriage in Kenya is quite young. The percentage of women who are currently aged 25-49 who were married by the age of 20 is 57.4%. Only 13.3% of men aged 25-49 were married by the age of 20. While young marriage certainly puts people at risk for HIV as it exposes them to early sex, it may protect them in other ways. In the same national study, women and men who were married reported far less engagement in commercial sex (DHS, 1998).

Wife and Husband Inheritance

In some areas of Kenya, when a man dies, his wife and children becomes his brother's "property". The new husband is often already married and may already have many wives. The cultural practice of wife inheritance has assisted in the provision of widows and their children for many centuries. Now, however, due to the large number of women that are widowed as a result of their husbands dying of HIV/AIDS, the practice has become dangerous. In some families, whole generations have died, leaving only grandparents and grandchildren. As with polygamy, the practice of wife inheritance is practiced less often in Nairobi and is more prevalent in the Western Province near Lake Victoria.

Sexual Abuse

Sexual abuse is a global issue that is experienced by women and children with alarmingly high prevalence. In a national study, 25% of Kenyan females aged 12-24 years claimed to have lost their virginity in a forced sexual encounter (MOH, 2001). This kind of abuse and fear of violence can force women and children into risky sexual situations. Rape and rough sex often result in the tearing of tissues and easier transmission of HIV.

Female Circumcision

Worldwide, there are over 100 million girls and women who have undergone female genital mutilation (FGM) (Brady, 1999). The practice of FGM is considered an important rite of passage in Kenya. Many Kenyans believe that a girl will not be "marriage material" without being circumcised. In 49 out of 64 districts in Kenya, FGM is practiced. Nationally, it is estimated that 38% of girls are circumcised (GOK, 1999). FGM occurs between the ages of five and 18. While Nairobi is not one of the districts where FGM is regularly practiced, many girls are sent to their villages in the rural areas to undergo the circumcision ceremony.

The practice is often unhygienic and can be fatal. Female circumcision may result in the death of young girls due to septicaemia, haemorrhage and shock. It is hypothesised that circumcision spreads HIV in two ways (Brady, 1999). Firstly, often-unclean surgical tools are used during the circumcision. This spreads the virus from person to person during the cutting of a number of girls. Secondly, there is more opportunity for transmission due to the scarring of the genital area. However, much is still left to be learned about this mechanism. Although unlikely, it may even be possible that, like male circumcision, female circumcision could be protective against HIV. More information is needed to understand the possible relationships between female circumcision and HIV.

Understanding the Benefits of Working with HIV Prevention in Nairobi

Nairobi also has many positive attributes that are aiding in the fight against HIV/AIDS. Nairobi is a relatively small city of 2.14 million people (GOK, 2001), with a centralised population living within 550 sq. km. This means that the population is relatively concentrated and can be readily accessed through media. Almost all people within the city have access to radio (over 70%) and there are two major newspapers: *The Nation* and *The East African Standard* that regularly run stories about the HIV/AIDS epidemic (DHS, 1999). In Nairobi Province, 61.8% of women and 66.2% of men read the paper daily. Approximately 36% of people in Nairobi have access to a television on a weekly basis.

HIV/AIDS Prevention Programmes in Kenya

A large number of HIV prevention programmes are currently being carried out in Kenya. As there was a lot of crossover between the goals of the many programmes, a single coordinating organisation was needed to act as the primary collector and distributor of information materials on HIV/AIDS prevention and care. Therefore, the Kenya AIDS Non-Governmental Organization (NGO) Consortium was established. This organisation has over 650 members. The Kenya AIDS NGO Consortium also provides a meeting place for NGOs working with HIV in Kenya and supplies news on upcoming programmes.

The government has recently become more engaged regarding HIV/AIDS Control and declared the epidemic a national disaster in 1999 (MOH, 2001). The Government of Kenya has responded to the HIV crisis by creating two government organisations called the National AIDS Control Council (NACC) and the National AIDS and STD Control Programme (NASCOP). NACC's role is to co-ordinate the national response to the HIV epidemic. This includes organising a nation-wide network of government workers that are able to co-ordinate prevention and care efforts at the district and local level. NASCOP is involved in carrying out prevention programmes such as blood safety, HIV prevention education and community sensitisation.

A number of indigenous churches have begun AIDS ministries and informal grass-roots organisations have also joined the fight against HIV. Perhaps the longest standing HIV prevention organisation in Nairobi is the collaborative effort between the

University of Nairobi and the University of Manitoba's *Strengthening STD/AIDS Control in Kenya Project.*

Nairobi Province is also the province that boasts the highest levels of education. 54.4% of the women and 65.5% of the men have at least secondary levels of education. Only 1.2% of women and 1.8% of men have had no education at all. This compares well with any other province and the overall national results (11.5% of girls and 3.8% boys) (DHS, 1999). Education allows for HIV prevention messages to be delivered at school. Also, an educated adult public can receive information through the written word.

Careful assessment of Nairobi's HIV/AIDS epidemic has been on going for over 10 years. While the first case of HIV was officially diagnosed in the mid-1980s, there is some evidence that the virus may have been introduced into the Kenyan population as early as 1981 (GOK, 2001). It is estimated that about 90% of cases of HIV in Kenya are transmitted through heterosexual intercourse, while a significant proportion is through mother-to-child transmission. Blood transfusions may also contribute significantly to the transmission. The following table shows the results of the sentinel surveillance sites for Nairobi and Thika from 1990 to the year 2000.

Table 1A: ANC Surveillance Site Results 1990-2000

Site	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Nairobi	-	12%	13%	17%	15%	16%	16%	-	-	17%	-
Thika	3%	10%	3%	28%	40%	-	13%	19%	33%	18%	21%

Source: GOK, 2001. Dash (-) implies no data was collected.

The variation in the levels of HIV measured in the ANCs over the years has been a cause of debate. It is thought that the increase in Thika's 1998 prevalence had to do with an initiative to recruit high risk women into antenatal care.

Strengthening STD/AIDS Control in Kenya Interventions

Three interventions were modelled using parameter estimates from Kenya, and when possible Nairobi. The costing data were based on the costs of three programmes within the Strengthening STD/AIDS Control Project. The three interventions of the Project: STI treatment, commercial sex worker interventions, and occupationally focused interventions with men are described below. The descriptions give a history of the projects and describe what was happening in the projects in the year 2000.

STI Treatment

Collaboration between the University of Nairobi and the University of Manitoba for treating STIs has been ongoing since 1980. The Project began training health care workers in the syndromic management of STIs in May 1991. Since then, 779 health care workers have been trained in Nairobi. Retraining of workers occurred in 1996. Another retraining is scheduled for late in 2002. Nine TOTs were also trained in 1994, in an effort to have two TOTs available in each clinic to teach the other health care workers. A great deal of on-site learning and training occurs in order to strengthen STI control. It is the plan of the Project to have the Kenyan Ministry of Health take over total responsibility of training and management of the project, in the interest of sustainability and to assess replicability. A similar project was carried out in Mwanza, Tanzania in the mid-1990s and was shown to reduce HIV prevalence by 40% in the intervention group (Grosskurth *et al.*, 1995).

In Kenya, in the year 2000, the Ministry of Health through NASCOP provided all STI drugs. The original funding for the drug kits came from international donors. Treatment was provided through health centres, clinics and treatment centres specialising in STIs. Given the sensitive nature of STIs, many people were not comfortable accessing formal health care for STI treatment. Instead, those with genital signs and symptoms often sought advice from pharmacists, chemists and other health care workers who were available to the community.

In every country, it is difficult to persuade people to be tested and treated for STIs. As a result, Kenya decided to decentralise the system of diagnosing and treating STIs in order to make the treatment more accessible and acceptable to those who are infected. This meant bringing the ability to diagnose and treat STIs to the community level.

All health care workers in antenatal and outpatient care clinics were trained in syndromic management of STIs. The project trained people from a number of different health-related professions to identify the symptoms of STIs and refer the patients to the city council general clinics. Nurses and doctors can also treat the STIs by this method at outpatient clinics. Sufficient and consistent drug supplies were ensured in order to promote excellent coverage and community trust. Counselling is also an important component of the programme for the prevention of further cases and encouraging patients to refer their sex partners for treatment. Currently, there are five Project clinics in Nairobi where STI treatment is offered. The main strategy is to treat STIs using the Syndromic Management (SM) approach, thereby further reducing the risk of transmitting HIV. Free condoms are also distributed from the STI treatment centres. In the year 2000, the project-assisted sites in Nairobi provided SM of STIs to 6,637 clients and distributed 69,464 condoms.

Commercial Sex Worker Peer Interventions

In 1982, programmes were implemented with women practising commercial sex work in Pumwani. A person in commercial sex work as defined by this project is someone who exchanges sexual activity for money, goods, or services. The Project later expanded into the Kibera slum of Nairobi in the late 1990s to reach out to a younger group of CSWs.

In Nairobi, it is estimated that between 6-12% of the female population are engaged in sex work (ANC data, 2002; DHS, 1998). These women are arguably at the greatest risk for both acquiring and transmitting the virus. Currently, there are no government responses to the problem of HIV and its relationship to prostitution in

Nairobi. The practice of sex work is illegal in Kenya, while being a customer of a CSW is not.

Thus far, 5,000 sex workers have been recruited into the original sites of the programme. Furthermore, 2,000 CSW partners have been recruited. In the year 2000, there were 110 peer leaders and ten trainers of trainers TOTs operating in the Nairobi original sites. In 1997, the project expanded their HIV prevention efforts into the Kibera slum area of Nairobi. Since that time, 1,300 CSWs have been recruited into Kibera peer education self-help groups. For the purposes of this evaluation, only the original Pumwani sites will be included. The decision to include only Pumwani CSWs was reached due to the project's longer history and experience with this group. Some information used to describe the HIV and STI prevalence for sex workers in Nairobi was taken from the Kibera CSW cohort. The goal of using data from this group of women was to give a more accurate and representative picture of the epidemiological situation of CSWs in Nairobi in the year 2000.

Occupationally Focused Interventions with Men

The workplaces in general in Kenya have been slow to react to the epidemic. It was not until late in 2001 that the Kenya HIV/AIDS Business Council was created by the Unilever Company to make a unified effort to prevent HIV. Now, there are nearly 100 members representing over 27,000 people. Another group, the Kenya Association of Manufacturers expects to have HIV prevention programmes initiated in the year 2003. Migrant workers, security forces and transport workers are thought to be at very high risk for infection of HIV. These workers make up a large proportion of the workforce. In fact, agriculture alone makes up over 50% of the Kenyan labour force (MOH, 2001).

While the first phase of the Project dealt with prevention of HIV from the supply side of sex work, it was decided that the second phase of the project should address the demand side. The Project recognised that reducing the number of women working in prostitution, and encouraging safer sex was clearly benefiting those specific women and their clients. However, there are always more young women willing to sell sex (protected or otherwise) in situations where other working opportunities are not available. To further its impact, the Project aimed to reduce the numbers of new partners, and to increase condom use with men at high-risk for HIV. Unlike CSWs, partners of CSWs seldom organise into groups based on their sexual behaviour. Therefore, there was a great need for programmes to address HIV prevention for men where they could be reached - in the workplace.

The Government of Kenya expects that the greatest economic impact that the HIV/AIDS epidemic will have in the country is with the loss of skilled workers (MOH, 2001). Workplace HIV prevalence has been shown to be as high as 30% in areas of Kenya (GOK, 2001). The International Labour Office estimated that by the year 2005, the labour force in Kenya will be reduced by 8.6% and a 20.2% reduction is expected by the year 2020 (ILO, 2000). Another study estimated that the average per capita income will drop by the year 2005 directly as a result of HIV/AIDS (Hancock *et al.*, 1996).

The Occupationally Focused Interventions with Men (OFIM) intervention began in 1999 in Thika (a town 20 km north of Nairobi). The first groups of high-risk men that were recruited into the programme worked as touts, sand harvesters and artisans. Touts are men who collect fares on small buses or vans (called matatus). A baseline survey of 166 men in the informal sector of Thika was carried out in July 1999 (Strengthening STD/AIDS Control, 1999a). Since then, about 3,015 men have been recruited into the programme. In the year 2000, 25 TOTs and 56 peer leaders were trained in the OFIM programme.

CHAPTER TWO: **LITERATURE REVIEW**

The three projects that were evaluated for this thesis project included the following: STI treatment, CSW interventions, and Occupationally Focused Interventions with Men. The literature review below outlines the different interventions that are used to prevent heterosexual, sexual transmission of HIV. The literature search aimed to describe how the relevant HIV prevention interventions work, how they are measured, and what evidence is available to guide in creating perimeters to measure effectiveness.

HIV Prevention Interventions in the Literature

According to UNAIDS (2000a), there are currently nine established strategies that are employed in order to prevent HIV. Of the nine, seven of them are concerned with preventing sexual transmission of HIV. It is estimated that 90% of HIV cases in Kenya are contracted though heterosexual intercourse (NASCOP, 1996). Therefore in this thesis, the author will be examining HIV prevention strategies that could avert cases of HIV within this group. The following HIV prevention interventions were explored: mass media, school education, social marketing of condoms, STI treatment, voluntary counselling and testing, commercial sex worker peer education, and occupationally focused interventions with men.

Sexual transmission of HIV is prevented when either the exposure to possible infected partners is reduced or the transmissibility of HIV during intercourse with an infected partner is decreased. Strategies include increasing the age of first sexual contact, decreasing the number of sexual partners, reducing contact with CSWs and using condoms. Programmes to prevent HIV also have aimed to increase condom use, treat ulcerative and non-ulcerative STIs (UNAIDSa, 1999) and will soon likely encourage male circumcision. Prevention strategies that have been shown to be effective often use a combination of these interventions. When the goal of the overall project is to reduce the HIV prevalence in the community, interventions must be carefully designed to focus prevention efforts on people who are most likely to spread the virus to a number of other people. Therefore, efforts must be made not only to design effective HIV prevention strategies, but also to target the specific population for which they will be most effective. These target groups can be identified through activities such as computerised modelling.

Prior to studying the cost-effectiveness of specific projects, it is necessary to understand how HIV prevention interventions work, how they are measured, and what evidence is available to guide in creating parameters to measure effectiveness. Economic, epidemiological and cultural differences make it difficult to generalize CEA results across large geographical regions. Whenever possible, studies from Africa were used in this paper. However, other relevant studies from the developing world were occasionally included. The literature that was relevant to each intervention method was reviewed for evidence of effectiveness. A review of the literature for the interventions measured for this research project is found below. Information on those HIV prevention interventions that were studied through the literature review but were not evaluated in the project thesis can be found in Appendix A.

Literature Review: Interventions that Were Measured in the CEA

An Introduction to Treatment of Sexually Transmitted Infections (STIs) for HIV Prevention

STIs are a major public health problem in sub-Saharan African countries (UNAIDSb, 2000). There is strong evidence that STIs act as co-factors in increasing susceptibility to HIV transmission (Deschamps *et al.*, 1996; Hayes, Schulz & Plummer, 1995; Rotchford *et al.*, 2000; Otten *et al.*, 1994). HIV infectiousness and susceptibility are enhanced by both ulcerative and non-ulcerative STIs (Fleming & Wasserheit, 1999). The aim of STI control programmes is to reduce the prevalence of curable STIs in the target community, thereby reducing their vulnerability to HIV.

Unprotected sex is a risk factor for all STIs including HIV (UNAIDSa, 2000). Therefore, targeting prevention programmes towards people attending STI clinics will likely reach people who are also at risk for HIV. The activities involved in STI treatment programmes often involve strengthening communication and counselling skills amongst providers. It is hoped that the providers will then be able to counsel, educate and promote condoms to people attending their clinics. Furthermore, those being treated for STIs are also encouraged to abstain from sexual intercourse or use condoms consistently during the period of time when they are being treated. This gives the patients time to get used to obtaining and using condoms.

Syndromic Management (SM) is a relatively inexpensive way of diagnosing and treating STIs. In SM, patients are questioned about symptoms and examined for physical signs of disease. If the signs and symptoms suggest that an infection may be present, then the patient is treated for a spectrum of organisms that may result from that disease profile. The simplicity of this method allows for someone with very little training and in resource-limited settings to provide STI diagnosis and treatment. In the absence of expensive laboratory testing, not only are costs avoided, but also the STI treatment centre can be mobile (UNAIDSb, 2000).

A study in Malawi looked at the cost-effectiveness of treating 144 STI patients with either SM or the current national practice (Costello Daly *et al.*, 1998). This study found that although the syndromic management was slightly more expensive than the national practice, it was more effective at treating the diseases. Much of the costs involved in SM are related to training costs. Clearly in technological and resource-poor settings in East Africa, it is difficult to run laboratories efficiently.

Some STI control programmes use pre-packaged therapy designed for "over-the-counter" use. One project distributed packages containing antibiotics, condoms, partner referral cards and educational information on STIs to be sold (highly subsidized) at pharmacies in Cameroon (Crabbe *et al.*, 1998). One thousand, three hundred and ninety-two packages were sold in ten months with the vast majority of customers claiming to have completed the course of doxycycline (83%), notified all or some partners (76%), and used the condoms (84%). SM has allowed for a wider coverage of STI diagnosis and treatment in areas where laboratories and resources are scarce. However, even with extensive training on the part of the provider, more antibiotics will be available and the potential for resistance due to inappropriate use exists.

Evaluating STI Treatment Programmes

There are a number of possible indicators that could be used to measure the effectiveness of an STI control programme at the national level. These include the appropriate diagnosis and treatment of STIs. Often, providers are assessed for history taking, examination abilities and treatment accuracy. While evaluating a project, a trained assessor could pose as a client at the clinic (UNAIDSb, 2000). This method of sending in "patient assessors" allows the effectiveness of the programme to be evaluated in its natural setting. It is possible to use this method of assessment in SM, as the diagnosis is made on signs and symptoms rather than laboratory tests.

One study in South Africa assessed the adequacy of STI treatment in the private health care sector by interviewing doctors outside of the clinic setting (Connolly *et al.*, 1999). Eleven doctors who used SM to diagnose and prescribe treatment for STIs were recruited to be in the study. Information was gathered from each doctor about how they would treat three hypothetical cases of STI syndromes. Surprisingly, none of the thirty-three prescriptions corresponded exactly to the official regulations, and only three percent were considered adequate. Another study from Nigeria showed inadequate knowledge of the appropriate treatment for STIs among the forty-eight practitioners assessed (Okonofua *et al.*, 1999).

Process indicators such as changes in numbers of patients seen and treated at STI clinics could be measured. "Repeat business" and recurrent STIs may show that the diagnosing of the STIs is inadequate, or that the counselling by the staff is insufficient. Another method of evaluation is to measure the supply of essential drugs available. Important to the success of any STI programme is a reliable stock of drugs available to meet the needs generated by the prevention intervention. The programme may not necessarily need more drugs if SM is initiated. This is due to the fact that while good SM of STIs will result in more cases diagnosed, fewer unnecessary courses of antibiotics are likely to be prescribed.

At a district level, projects have been able to measure the changes to prevalence of HIV following an STI control programme by using a randomized control trial. One study was a SM intervention, the other was a periodic mass treatment programme. Two such studies were found in the literature that described the outcomes of STI control programmes for HIV prevention. These studies will be described below.

The Effectiveness of STI Treatment Programmes

There have been a number of studies that have aimed to assess the effectiveness of STI treatment programmes at reducing HIV transmission. A review of 48 studies looking at the impact of STI treatment on HIV viral load found that successful treatment lowers HIV viral load but not to control levels (Rotchford *et al.*, 2000). Two randomized control trials found in the literature look at outcomes of STI control projects on HIV incidence in the general population. The results from these two trials appear to be conflicting.

Mwanza

The first randomized, community-based study was in a rural area of Tanzania (Kenya's immediate neighbour to the south) called Mwanza. This study established an STI reference clinic, trained staff, ensured a regular supply of essential drugs for STI treatment, organised regular supervisory visits from the African Medical Research Foundation (AMREF), and gave health education about STIs (mainly encouraging treatment). The objective of the project was to create a sustainable and affordable HIV prevention intervention within the east African context (Grosskurth *et al.*, 2000). Both those with symptoms of STIs and their first level of contacts were treated.

Three different areas (islands, roadside, and rural) were matched and randomly assigned to the intervention or comparison arm. The randomly selected cohort included about 1,000 people from twelve different communities. Although minimal change was reported in sexual behaviour, this study reported a reduction in HIV incidence by 40% in the intervention group (Grosskurth *et al.*, 1995). Reductions were seen in the intervention arm, included the lowered prevalence of active syphilis (29% reduction), decreased incidence of active syphilis (38% lower), and the reduction of male urethritis (49% lower, Grosskurth *et al.*, 2000).

Rakai

In the Ugandan district of Rakai, a study was conducted to measure the impact of periodic mass STI treatment. This study used a randomised community design in 56 rural communities. In total, over 14,000 people participated in this study (Grosskurth *et al.*, 2000). This study provided medical treatment for STIs twice, in two ten-month intervals. The treatment was given to all members of the communities available, not just those showing signs and symptoms of STIs. Practitioners used the "directly observed treatment" method to encourage adherence to the treatment regimen. Although this study demonstrated a significant decrease in two potentially important STIs (syphilis and trichomoniasis), it did not show any reduction in HIV incidence (Wawer *et al.*, 1999).

Reasons for the Differences Between the Two Studies

Many reasons are given for the differences in the outcomes between the two trials. A number of explanations for the apparent contrast in the two studies have been discussed in the literature (Grosskurth *et al.*, 2000). Differences in study design, HIV and STI prevalence and the potential for sampling error were all considered as possible explanations.

It has been hypothesised by Hudson (2001), that the reason for Mwanza's success in reducing the expected HIV rates was that part of the SM programme involves recommending abstinence or the consistent use of condoms while the patient is being treated for an STI. However, there was no evidence found for behaviour change in either study. Grosskurth *et al.* (2000) wrote that the two trials measured two completely different interventions, and answered separate hypotheses. He proposed the following explanations for the differences in outcome: the stage of the epidemic, the role of genital herpes, the role of bacterial vaginosis, the importance of symptomatic and symptomless STIs, the reintroduction of STIs, and the differences in the proportion of HIV infection that were attributable to STIs. He also suggested that pure "chance" could not be ruled out. The following table describes some of the differences between the two trials and their populations.

Table 2A: Comparison of the Mwanza and Rakai Trials

	Mwanza (Grosskurth *et al.*, 1995) (Grosskurth *et al.*, 2000)	Rakai (Wawer *et al.*, 1999)
Intervention/ Comparison Populations	4,149/4,400	6,602/6,124
Length of study	24 months	20 months
Age of participants	15-54	15-59
Description of the intervention	STI referral clinic, staff training, regular supply of drugs, supervisory visits to facilities, education about STIs	Two intervals of mass treatment of STIs 10 months apart
HIV Prevalence in community at start	3.8-4.4%	15.9%
Condom use at start	2.3-2.4 (with non-regular partner) 0.0003% (always)	19.3-21.2% (ever)
Lost to follow up	29%	25-26.4%
Syphilis prevalence in community at start	8.2-8.7%	10%
Herpes prevalence in community at start	20% men, 50% women	31% men, 61% women
STIs tested for	Gonorrhoea, thrachomatis, chlamydia, urethritis, syphilis	Gonorrhoea, chlamydia, syphilis, trichomoniasis, bacterial vaginosis

Source: Grosskurth *et al.*, 1995; Grosskurth *et al.*, 2000 and Wawer *et al.*, 1999

Further investigation needs to be done to clearly understand the connection between STI reduction and HIV prevention. An interesting area of further research would be to examine the impact of specific STIs on HIV transmission. For example, the rates of herpes were much higher in the Rakai area. Herpes was found to be a major attributing factor to the spread of HIV in one study in Tanzania (del Mar Pujades-

Rodriguez *et al.*, 2002). This study found that there was a strong association between HSV infection and HIV seroconversion, especially in men ($p<0.001$). Obviously herpes would be unaffected by the antibiotic therapy. The new herpes vaccine (thought to reduce transmission of Herpes by 73% in women- Stephenson, 2000), may be a useful prevention tool in the future.

Certain groups of people in society can be targeted to reduce both STIs and HIV. Studies have shown a decline in HIV incidence when interventions are introduced to reduce the prevalence of STIs in high-risk groups. A number of studies looked at STI treatment targeted towards commercial sex workers (Hanenberg *et al.*, 1994; Laga *et al.*, 1994; Ngugi *et al.*, 1988). Men in high-risk occupations have also been the focus of programmes for STI control to prevent HIV. An observational study for men at high-risk in South Africa was found in the literature (Steen *et al.*, 2000). This study assessed the impact of providing miners and a core group of high-risk women living in areas around the mines with STI treatment services. This included periodic presumptive treatment and education about HIV prevention. Significant rates of decline in STIs were seen in both the miners and the high-risk women.

STIs are not only co-factors of HIV, they could also act as potential risk markers. For that reason, STI patients may act as a potential target group for behavioural interventions (NIMH, 1998). Neither the Rakai nor Mwanza studies attempted to change behaviour. However, this does not mean that behaviour change is not possible with other methods. More research needs to be done to assess how the behaviour change aspects of STI reduction programmes can be improved.

When evaluating HIV prevention programmes, the rise and fall of STI rates can also be used as a proxy measure for impact (UNAIDSb, 2000). In contrast with HIV, bacterial STIs are curable. Therefore, rates of STIs lend themselves to a much more sensitive and recent marker of the success of interventions to prevent unprotected, risky sexual activity.

STIs contribute to the spread of HIV but strategies for controlling them need further study to assess their cost-effectiveness. The Mwanza study suggests favourable cost-effectiveness for improved case-management (US $10 per DALY and $217.62 per

HIV infection prevented). Obviously, a cost-effectiveness analysis could not be carried out on the Rakai project, as it was found to be ineffective.

As with all interventions, there is the possibility of negative impacts occurring with STI control. If practitioners are improperly trained, and drugs are freely given out when they are not warranted, antibiotic resistance may quickly occur. Training all health practitioners in SM can also be resource and time consuming. However, this HIV prevention method results in wider benefits beyond the primary goal. The costs and time required for proper training of providers may well be justified by the extended benefits that result from the programme. These wider benefits may include avoiding the morbidity and mortality from the STIs, avoidance of unwanted pregnancies through increased condom use, improved essential drug supply systems, and more rational prescribing of antibiotics (UNAIDSa, 2000).

An Introduction to Commercial Sex Worker Peer Education

Since the HIV epidemic began, CSWs have been identified as a highly vulnerable population. By definition, they are people who exchange sexual favours for money or goods but they are in no way a homogeneous group. They may work out of hotels, brothels, bars, the streets, or their homes (Aggleton *et al.*, 2000). They may earn large fees for their service, or work as virtual sex slaves. They may be exclusively CSWs or have alternative sources of income. Even adolescent girls can engage in CSW. A study in Kenya described an area near a truck stop on the Trans-African Highway where many of the girls reported that they had exchanged sex for money or gifts (Nzyuko *et al.*, 1997).

Due to the nature of their work, CSWs are at high risk of contracting HIV. The high rate of sexual partner exchange and STI prevalence create an ideal climate for CSWs to become a high-frequency STI transmitter group to their clients and subsequently the population at large. Concurrently poverty, low self-esteem, and lack of education can strip the CSW of choices and options that may otherwise have been available for her to take precautions (Gysels *et al.*, 2002).

Although this group is important to the overall epidemic, they can be a difficult aggregate of the population to identify. In Kenya, prostitution is illegal and many women suffer abuse and robbery at the hands of the police and are forced to offer bribes in order to continue working. In fact, a number of University of Nairobi staff have been arrested simply for being in areas where prostitutes operate. Conventional health professionals may have difficulty working with this population group due to differences in working and sleeping hours, safety issues and lack of understanding. This is where CSW peer interventions are able to fill the gap. CSWs or former CSWs are able to locate their fellow sex workers and recruit them into groups in ways that non-CSWs cannot. In peer support groups, the women can receive support, information and access to condoms and STI treatment from women who know about the situation that they are in (UNAIDSa, 2000). A study from Morocco found that 93% of CSWs surveyed would prefer to access condoms from peer outreach workers than conventional vendors (Aggelton *et al.*, 2000).

Typically what is meant by peer education is the use of members of a group to effect change among members of equal standing in the same group. The goal is to equip peers to motivate members of high-risk groups in modifying their knowledge, attitudes, beliefs and behaviours. Yet, the effect of CSW programmes often go far beyond the impact seen in the intervention group. Oftentimes the impact of these programmes can be seen at the societal level by modifying norms and encouraging action that leads to changes in policies (UNAIDS, 1999).

CSW Peer education programmes overlap with many of the other strategies that are intended to reduce HIV. The strategies involved in a CSW peer education project include some or all of the following elements: HIV prevention education; supply of condoms; STI treatment and counselling; voluntary counselling and testing; information on communication and sexual negotiation, self-esteem and team building; and engaging in less dangerous income generating activities. Campaigns to promote safe practices among CSWs include access to essential care, information and supplies as well as social skills building and support.

The Evaluation of Commercial Sex Worker Peer Education Programmes

Evaluating the impact of CSW peer interventions can be difficult and time-consuming (UNAIDSa, 2000). Peer education programmes can have far-reaching, holistic impacts on the CSWs and the communities that they work and live in. Identifying the CSW population may be problematic, as they tend to be highly transient. However, once the population is defined and an intervention is put into place, a number of ways to evaluate the impact of the programmes have been attempted. The most common way of evaluating HIV prevention interventions using peer education is through Knowledge, Attitude and Practice (KAP) surveys with the target group (UNAIDS, 1999). Improvements in the KAP scores of a population can act as a measure of the success of the programme to modify people's knowledge and intention for behaviour change. Unfortunately, KAP scores do not give tangible information on the actual behaviour change or the resulting decreases in HIV prevalence.

HIV and STI incidence can be measured to evaluate the impact of an intervention. The measurements can be done on the CSW group alone (Aggelton *et al.*, 2000; Laga *et al.*, 1994) or CSWs and the population that they serve (Steen *et al.*, 2000). These measures can be used in conjunction with self-reported condom use, and claims of reductions in partner exchange. Information can also be gathered on process indicators such as the number of outreach contacts, the number of referrals to STI clinics, and the number of condoms distributed (Aggelton *et al.*, 2000). Qualitative studies and quality of life surveys can be conducted to measure the impact of the programme on social measures (self-esteem, support, etc.).

<u>The Effectiveness of Commercial Sex Worker Peer Education Programmes</u>

Peer education is not new. The practice of using members of the same peer groups to educate one another has been used to in public health interventions in many areas. Peers have been elicited to provide education and support on issues of nutrition, family planning, the use of cigarettes and other substances, and in violence prevention (Brieger *et al.*, 2001; Donovan, 2000; Sothern *et al.*, 2002; UNAIDS, 1999). Peer education and prevention interventions for sex workers have been shown to increase condom use, promote the acceptability of safe sexual practice, and reduce HIV and AIDS amongst female sex workers in a variety of settings (Aggelton *et al.*, 2000; Asamoah *et al.*, 1994; Campbell, 2000; Ngugi *et al.*, 1996). One study in Thailand saw an increase in condom use amongst CSWs even when the men were prepared to pay up to three times more for unprotected sex (Visrutaratna *et al.*, 1995). In Cameroon, a peer outreach programme saw an increase in the number of clients using condoms (from 55 to 81%) and consistent condom use by sex workers with clients (from 52 to 75%).

In Kenya and Zimbabwe, while CSW peer education interventions were shown to be effective in project areas (Ngugi *et al.*, 1996), the progress in enlarging the coverage of these programmes has been slow. This is unfortunate, as HIV prevention education for CSWs is badly needed to reduce the overall population HIV prevalence. Perceived cost or lack of political will may be reasons for the CSW programmes not being scaled-up nationally.

Clearly, the information given to the groups must be accurate in order for reduction in HIV to be seen. A study in Bulawayo, Zimbabwe showed that while nearly all CSWs interviewed *claimed* to be doing something to protect themselves against HIV, many cited ineffective methods for protection (Wilson *et al.*, 1990).

Peer-counselling programmes often include income-generating activities as a complementary intervention to increase programme effectiveness. Having other options for income will not eliminate CSW altogether. If this were so, there would be no CSWs in socialized countries where supports for basic needs exist for the unemployed. However, providing people with other sources of income may encourage safer practices. One study in Uganda found that the more financially independent a CSW was, the better she was at both negotiating a good price for sex, and negotiating safer sex (Gysels *et al.*, 2002). It is expected that less reliance on sex work will encourage the women to have fewer sex partners and negotiate for condom use. Alternative economic activities can help the women to rely less on sex work and more on their other skills. Another study in Zimbabwe found that women who had other jobs besides CSW charged higher fees; were less likely to encounter violence from their clients; knew more about HIV; and were more likely to use condoms (Wilson *et al.*, 1990). In other areas, CSWs have added to the fight against HIV/AIDS by engaging in the sale of condoms (Aggelton *et al.*, 2000). This both provides condoms to people at high risk for HIV and also provides the CSWs with alternative income that is hoped to reduce the necessity for them to provide the higher-paid unprotected commercial sex.

One problem that is identified in the literature review is that CSWs often use condoms only with paid partners, and not with men who are "boyfriends". One study looking at condom use in Cameroonian sex workers showed that while 40% were willing to use condoms with their clients, only 16% would use them with their regular partners (Viness *et al.*, 1998). Surprisingly, the CSWs claimed that there was an element of "trust" that exists in regular partnerships that negates the use of condoms. Unfortunately, many women contract HIV and other STIs from their regular partners, despite the fact that they are taking precautions during professional sex. Other times, it is the regular partner who becomes infected.

A common argument against focusing prevention programmes on CSWs is that HIV programmes may stigmatize them. This would be true if media programmes portrayed CSWs as "grim reapers" or sources of death. However, peer education programmes recognize the CSWs as partners. It should also be understood that positive changes in sexual behaviour within these vulnerable groups can have a very significant effect on HIV transmission in the general population.

Peer education programmes with CSWs serve to empower the participants if they are conducted appropriately. This is achieved through the full participation of the people who are affected by HIV, by sparking dialogue that leads to community-driven plans, and initiating a response that is owned by the specific population in question (UNAIDS, 1999). However, these programmes must include protection of the women, accurate HIV prevention information, appropriate literature, alternative choices for income, access to condoms and STI treatment, and the involvement of partners and customers.

In the Project area in Kenya, the CSW intervention has been shown in the past to be very inexpensive. In 1991, a study based on the Pumwani sex worker cohort estimated that a CSW intervention could produce a reduction in HIV incidence for as little as US$ 8-12 per infection averted (Moses *et al.*, 1991). The measurements used in this analysis were not comparable to the CEA that this thesis is reporting on, as the methods and costs used were not similar.

An Introduction to Occupationally Focused Interventions with Men

Occupationally Focused Interventions with Men are those prevention activities that focus on encouraging men in high-risk professions to engage in safer sexual practices, seek treatment for STIs and access to VCT. These professions may include (but are not limited to) the military, long-distance truck drivers, fishermen, agricultural workers, or miners. The programmes may target the men themselves or focus on high-risk women in the area surrounding where they live and work.

OFIM are similar to programmes that target CSWs in that they use a variety of HIV prevention mechanisms. These may include HIV prevention education and counseling, increasing condom use and availability and encouraging STI treatment. Unlike CSWs, a man who engages in high-risk behaviour is not necessarily breaking the law. Men do not necessarily face stigma as a result of this behaviour.

The mobility of the man often dictates his importance to the spread of the virus. Migrant workers, long-distance truck drivers and military personnel are most often the focus of OFIM. These men in mobile, high-risk professions are an important group not only because of the risk that they pose to themselves and their families, but also because of their geographical mobility. The ORM may be the vehicle of spread into rural areas or other places that formally did not have HIV. Reducing HIV in these groups is key to impacting the overall epidemic because they have also served as "vehicles of further spread" to new geographical areas (Pais, 1996).

Occupations that appear to be at highest risk for STIs and HIV are those in which the man is separated from his home and family for long periods of time. However, there are many other dynamics at work in the transmission of HIV that do not allow for identification of high-risk men based solely on occupation. There has been a large variation in the prevalence of HIV in different samples of long distance truck drivers in Africa. The estimated prevalence has ranged from 0% in Eritrea (Ghebrekidan *et al.*, 1998), 18.6% in Burkina Faso (Meda *et al.*, 1998) to 35.2% in Kenya (Carswell, Lloyd & Howells, 1989). Generalizations should also not be made about the relative risk of an occupation based on social status. A study from Zaire found that sero-prevalence of HIV was higher in a bank than a factory (Ryder *et al.*, 1990). Men with higher incomes may be at greater risk because they are better able to afford to pay for sex.

Evaluating Occupationally Focussed Interventions with Men

Evaluating the impact of OFIM can be complicated. As with CSW peer education programmes, OFIM can have an extensive influence on the communities where the men work and live. Identifying the target group of high-risk men may not be easy but there may be support from businesses as they begin to see the economic benefit of preventing HIV cases in their workforce. Alternatively, workplaces may be reluctant to admit that there is a potential problem with HIV at their businesses for insurance reasons, or the fear of losing the value of their stock. Workers may be reluctant to be tested for HIV at work, for fear of losing their jobs.

The most common way of evaluating HIV prevention interventions has been through KAP interviews with the target population (UNAIDS, 1999). KAP studies measure the changes in knowledge and professed or intended behaviour but do not always give an accurate picture of the true effectiveness of the programme. Workers may be suspicious as to the anonymity of the questionnaires and may therefore be tempted to give the most conservative responses. Although KAP studies can represent some measure of the success of the programme, other innovative methods could be used to measure the various activities involved.

HIV incidence can be measured to directly evaluate the effectiveness of an intervention. The measurements can be done on the men (Ghebrekidan *et al.*, 1998) or with high-risk women living in the surrounding areas (Steen *et al.*, 2000). HIV incidence measures can be used in conjunction with incidence of STIs, self-reported condom use, and claims of reductions in partner exchange. Information can also be gathered on process indicators such as the number of educational sessions attended and the number of condoms distributed. Qualitative studies and quality of life surveys can be conducted to measure the impact of the programme on the social measures (Campbell, 2000).

The Effectiveness of Occupationally Focused Interventions with Men

The literature yielded a few studies on OFIM programmes that have shown promising results. OFIM have been shown to increase condom use (Meekers, 2000), decrease the prevalence of STIs (Jackson *et al.*, 1997; Steen *et al.*, 2000) and reduce the incidence of HIV (Celentano *et al.*, 2000; Senkoro *et al.*, 2000) in a limited number of studies. These studies vary greatly in the intensity and method of intervention among high-risk men. The programmes may need to be quite comprehensive in order to be effective. A study in Tanzania found that a moderate level of exposure to HIV education and access to STI treatment was not enough to significantly affect HIV incidence (Senkoro *et al.*, 2000).

One study in Kenya followed a cohort of men working for a trucking company before and after an intervention. The methods used were HIV serological testing, individual counselling, condom promotion, and STI diagnosis and management. Although no change in condom use was observed, there was a significant decrease in sex with high-risk partners after one year of follow up. The difference in high-risk behaviour was accompanied by a significant decrease in incidence of STIs (Jackson *et al.*, 1997). No studies were found in the literature that described the cost-effectiveness of OFIM.

Other CEA Studies in HIV Prevention

A number of published studies have reported CEA of other HIV prevention interventions. Many of these studies involve expensive anti-retroviral drugs (Miners *et al.*, 2000; Valentini, 2001; & Weinstein *et al.*, 2001) that are logistically and economically out of the reach of the average Kenyan. By far the most common CEAs for HIV prevention in Africa are in the area of mother-to-child transmission (Wilkinson *et al.*, 2000; Halpern *et al.*, 2000; Marseille *et al.*, 1999; Marseille, Kahn & Saba, 1998; Newell *et al.*, 1998; Mansergh *et al.*, 1998). Unfortunately, the majority of the population of mothers in Kenya who are likely to be HIV positive do not seek anti-natal care. Many do not even know that they are HIV positive. Only 5% of women in one

Ugandan study claimed to be pursuing VCT because they were pregnant (UNAIDS, 1997), but this scenario may change in the coming years.

Other studies have looked at the CEA of screening blood for safe blood banking (Gallarda & Dragon, 2000; Jacobs & Mercer, 1999). This project was heavily supported by contributions from the international donor community. The clinics were able to provide safe blood at a cost of US$25-40 per unit. Although this cost is reasonable with outside funding, there is no question that this blood transfusion project would not be economically feasible for a low-income African country to achieve with internal funding. A number of studies have looked at the CEA of HIV prevention interventions in the West. These include prophylactic AZT following needle stick injuries and sexual exposure (Pinkerton, Holtgrave & Kahn, 2000; Ramesy & Nettleman, 1992), and HIV antibody screening for immigrants (Zowell *et al.*, 1990).

Further studies have looked at prevention strategies that could possibly be affordable and effective enough for the African setting such as mass media (al Owaish *et al.*, 1999; Lechky, 1997; Lindan *et al.*, 1992; Gregson *et al.*, 1998; Griffith *et al.*, 1995; Sandbaek & Kragstrup, 1998; Thomas, Cahill & Santilli, 1997; Walsh *et al.*, 1997) and school-based education (Aplasca *et al.*, 1995; Klepp *et al.*, 1997; Migliori *et al.*, 1996; Stanton *et al.*, 1998; Sunwood *et al.*, 1995; Teka, 1997). However, these studies did not find strong evidence of a sustained reduction in behaviour change or HIV incidence. Although individual studies have looked at the cost-effectiveness of individual interventions, it is clear that no study has compared the cost-effectiveness among peer interventions with sex workers, occupationally focused interventions with high risk men and SM of STI in the Kenyan context.

Summary of the Literature Review

Although much has been written about HIV and the interventions that are used to prevent it, no studies were found comparing the cost-effectiveness of STI treatment, CSW peer interventions and OFIM in Kenya. The programmes have in fact not been analysed for cost-effectiveness in a comprehensive way anywhere. This thesis is examining a question that has not yet been explored fully in the literature.

All three of the interventions that are measured in this thesis research were shown to be effective in studies found in the literature. Although clearly, there was more written on STI treatment and CSW interventions, OFIM are now beginning to be more widespread in Kenya and elsewhere. There are likely to be more studies published in this area in the near future. Popular interventions that were included in the literature review but are not included in the CEA are described in Appendix A.

CHAPTER THREE: **UNDERSTANDING COST-EFFECTIVENESS ANALYSIS AND MODELLING**

In order to model sexual behaviour with and without the interventions, and to attach a cost-effectiveness estimate to the interventions, it was first necessary to understand what the literature had to reveal about CEA and modelling. The literature was reviewed to assess the most appropriate method of economic analysis, and what modelling software was available. The possible types of economic analysis, the compartments of CEA and models, examples of models and the use of models to influence policy are described below.

Possible Types of Analysis

Economic evaluation evolved out of the principles of welfare economics in order to assist health planners and policy makers with making difficult economic choices (Kumaranayake, 2002). A number of possible methods for economic analysis exist. The four most common methods mentioned in the literature are: Cost Minimization Analysis (CMA), Cost Benefit Analysis (CBA), Cost Utility Analysis (CUA) and Cost-effectiveness Analysis (CEA). CMA could be used if there were two programmes with the exact same outcome. The CMA then would be an analysis of which programme was the least expensive alternative. A cost benefit analysis is an evaluation that reduces the costs and effects to a single currency (usually measured in dollars). There are obvious difficulties with translating the effects of an intervention (disability, death, suffering, etc) into dollar values. However, with CBA, the researcher is then able to compare the impact of the cost to any other expenditure imaginable. Cost utility analysis measures people's preferences for a possible health outcome. Utility is measured in Quality Adjusted Life Years (QALYs) and takes into account the adjustment made to quality of life after a particular treatment is imposed (Drummond *et al.*, 1996).

Cost-effectiveness Analysis

Since the 1970s, decision-makers have used cost-effectiveness analysis to guide them through difficult choices within an environment of scarce resources (Kumaranayake, 2002). CEA was chosen for this project as the likely outcomes of the other methods would not have been appropriate. The objective of this project was to assess the cost per case averted and DALY saved of the three interventions to prevent HIV infection in Kenya. The effectiveness of the programmes was expected to be different, thus eliminating CMA as an option. CBA was not used because the desired outcome for this intervention was cost per case of HIV averted, rather than a currency value representing that outcome. This value would have been very difficult to obtain given the population that was involved in this evaluation. Because a certain amount of resource was available, a set outcome (such as cases of HIV averted) was sought after, and the different interventions were expected to yield different outcomes, CEA was chosen for the study.

CEA is used to assess and summarise the relative value of an intervention. CEA measures both the costs and the consequences of several programmes and compares alternative interventions that are intended to meet the same objective. This impact is assumed to create a desirable result. In CEA, the outcomes of the interventions are evaluated in terms of the relative cost per unit of effectiveness.

In a CEA, the researcher takes the cost of the overall programme from a set perspective (to be described later in this chapter). Next, the researcher establishes the effectiveness of the programme according to expected health impact. The health impact is calculated either directly or taken from published literature. Next, the net cost is divided by the effectiveness, creating a ratio. When ratios have been estimated to describe a number of alternatives, a fair comparison can be made. Lastly, a sensitivity analysis is conducted to test how robust the model is. In the case of this research project, the interventions are all intended to avert new cases of HIV. The disability adjusted life years (DALYs) can be calculated by dividing the cost of each of the programmes by the estimated number of years lost due to death, and the number of years lost to disability. DALYs have already been estimated for people with HIV/AIDS in the published literature (Gilson *et al.*, 1999; Mulder, 1996; and Creese et al, 2002). In order to calculate DALYs for this project, a similar method was used to that in the Mwanza CEA and DALY study (Gilson *et al.*, 1999).

Importance of CEA

Cost-effectiveness measures value for money (Warner & Luce, 1982). CEA addresses the question of whether or not an intervention is the best use of resources. If the resources were there to support all possible interventions, any strategy that could reduce the incidence of HIV in Kenya would be worth carrying out. However, there are both budget constraints and an enormous economic and resource demand from the burden of other diseases in Kenya. There are also further unmet basic needs (such as housing and food security) throughout the continent. Therefore, choosing only highly effective, strategic interventions is a more logical approach.

The ultimate goal of the CEA is to compare the alternative interventions and prioritise resources according to their ability to yield the greatest desired effect (UNAIDS, 1998). The main assumption in CEA methodology is that resources from either the society's or individual's point of view are scarce. It is believed that through cost-effectiveness analysis, evidence-based decisions can be made that are appropriate to the specific community.

Using CEA to measure the merit of prevention interventions is not new (Dodge, 1977; Haring, Turk, & Okey, 1974; Iber, 1981). Resources for health care are always considered scarce. This is particularly true in situations where expensive new therapies become available or where there is a marked increase in the burden of illness in a population (Pinkerton & Holtgrave, 2000). CEA can provide clues to policy makers and clinicians alike about the best use of resources in their particular situation.

A number of choices are now available for decision-makers who are trying to prevent new cases of HIV. Governments, NGOs, and grass-roots organizations need evidence on which to base their decisions. AIDS continues to devastate the Kenyan economy, reversing the decades of effort to improve life expectancy and quality. CEA can be used to give another perspective on the acceptability of an intervention. There is also a great deal of political pressure at present for governments to spend money on care for their orphans as well as treatments for those who are already ill. CEA can be used as a tool to aid in the decisions that make the most sense within the population for an effective national portfolio of prevention and care. Encouraging decision-makers to allocate some of their resources to prevention can be problematic, as it is difficult to prove "What doesn't happen". CEA can be a "spokesperson" for the effectiveness of prevention. By providing evidence that resources can be saved long-term by focusing them on averting new cases of HIV, then many people will also avoid the needless suffering and stress that the AIDS cases would have eventually caused.

Of all of the countries affected by the HIV pandemic, Kenya has been one of the hardest hit. The health care budget is low and resources have been stretched to crisis proportions. Funds spent on an HIV positive person in Kenya are thought to be around US$13.43 per year with only $2.21 of it coming from the national government. The funding has also not been equally distributed, with the majority of the money being spent in urban centres. Between 1996 and 1997, the US$21,483,595 worth of funding for financing HIV/AIDS activities in Kenya came from development agencies (39%), the World Bank (37%), the national government (16%), and the United Nations (7%) (UNAIDS, 1999). There are many government, NGO, and community groups working on strategies to prevent HIV throughout the country. Yet, little is known about the effectiveness of interventions that are intended to slow the spread of the virus.

The Components of CEA

There are a number of practical steps that must be taken in order to perform a CEA. The first step involves defining the problem to study (UNAIDS, 1998). Next, the researcher identifies all of the consequences of adopting the intervention including use of resources, and the effects on health status (Gold *et al.*, 1996). Then the protocol must be developed, the resources acquired, and administrative approval must be obtained. In this project, the problem under study is, "What are the relative costs of preventing one case of HIV using a number of different HIV prevention interventions in Nairobi?" The outcome measures will include both "cases of HIV averted" and "disability adjusted life years (DALYs) saved". It is possible to use other measures. For example, quality adjusted life years (QALYs) could be used as a measure of effectiveness. The tools that are available to measure QALYs are very specific and tend to be used in developed countries. DALYs are simpler and are more often used in developing countries. Again, there is a standardised and published measure for calculating DALYs in sub-Saharan Africa (Gilson *et al.*, 1999; Mulder, 1996; and Creese *et al.*, 2002).

Disability Adjusted Life Years (DALYs)

First introduced by the World Bank's 1993 Development Report, DALYs have quickly become a popular way of measuring the burden of diseases across the world. DALYs are metrics that factor in the time lost to premature death, and the value of life lost to disability as a result of a disease. The goal of DALYs is to measure the total burden of the disease for the purposes of comparison to other disease outcomes. DALYs consider premature death as the life expectancy in the population minus the number of years at death due to the disease. Disability is also measured by estimating the average loss in quality of life per year. In this measurement, zero represents perfect health and one represents death. Therefore, if the population prevalence or incidence is known any health impact can potentially be measured in DALYs. The cost per DALY saved is measured by dividing the cost of running a programme minus the total DALYs saved.

The Value of Calculating DALYs

There are some limitations to using "cases of HIV averted". This measure does not allow you to measure the effectiveness of the interventions against all other health practices. Therefore, a generic measurement tool is required in order to give fair comparisons of the interventions against other non-HIV prevention interventions. The DALY measures all healthy life lost. This includes both the reduction of years of life from premature mortality, and also the worth of life lost due to disability.

DALYs are also included in order to measure the impact of these programmes against preventing another disease such as malaria. DALYs can help health planners see the impact of HIV prevention interventions within the context of the overall health care plan. However, even assigning DALYs to the interventions does not ensure complete comparability to all interventions. For example, DALYs cannot be used to compare the benefit of HIV prevention with the societal outcome of improving roads in Kenya.

The Perspective

In CEA, it is essential to decide before the study begins the viewpoint, or perspective from which the analysis will be taken. A number of possibilities exist including provider, society, government, patient, employer, etc. The choice is important as different outcomes may occur when different costs and benefits are included. The societal perspective is the most thorough, including all perspectives of provider, patient, family etc. However, it is not always possible to attach monetary value to the time and lives of people in Kenya. This does not mean that the other contributions that are made from society are not valued, they simply are not always valued in terms of money. Many people in Kenya operate outside the monetary system, living as subsistence farmers, bartering, or working largely for goods and services in kind.

For the purposes of this CEA in Kenya, the costs were considered from the perspective of the provider. This meant that the costs to the Project and the costs of all donated items were considered. For example, the nurses' salaries at STI clinics are paid for by the MOH but were included in the analysis. Condom costs and STI drugs, while donated, were also included. Stipends paid to participants for travel expenses were included as well. What were not included were some costs that were incurred or gained by individuals. An example of this would be the value of the work time that was sacrificed in order to visit the STI clinic (i.e. a woman may not be able to hoe her garden for that afternoon). Likewise, the resulting increased work time due to better health was not included. Also, if a CSW lost income because of her decision to use condoms, this was not included. Likewise, if she gained income because of her group's decision to all charge a higher fee for sex, this was not included. Basically, the personal costs to the individual, their family, their employer or their community were not considered. Only costs incurred by the provider (whether donated or actual) were included.

Table 3A: Examples of Scenarios Where Costs/Gains are Included or Excluded

Scenario	Cost Incurred/Resource gained	Included in CEA?
As a result of the intervention, STIs are treated and ORM take less time off work	Resource gained to workplace	No
As a result of the intervention, a nurse is hired to treat STIs	Cost incurred to health care system (donated to project)	Yes
As a result of the intervention, CSWs charge more money for sex acts	Resource gained to CSWs	No
As a result of the intervention, women take busses to CSW meetings	Cost of reimbursement incurred by project	Yes

Time Horizon

A difficult element to determine in the model is the point of time at which the measurement begins and will cease. The time horizon of the study may heavily affect the outcome due to the ripple effect in the cases of HIV averted. For example, a programme that affects a small group of highly sexually active people may not appear to be effective over one month, but may be extremely effective over two years.

For the purposes of this study, the year of capture was the year 2000. This was the last year of complete data collection at the time when this thesis study was initiated. The parameters were entered into the model in terms of months, but the cumulative effects of the programmes over the 12-month period (the year 2000) were used for the research results. Clearly, the model could be used to assess the impact over larger or smaller amounts of time which would have the effect of reducing the costs of each intervention averted. In the sensitivity analysis, the time periods of two years, five years and ten years were also assessed.

Modelling

There are several different types of commercially and publicly available models that can be used to estimate the cost-effectiveness of HIV prevention activities. The models differ according to the purpose for which they were created. Some models were designed to measure the impact of specific interventions (e.g. blood screening). Some models require a high level of mathematical and computer knowledge, while others were designed to be used by clinicians in the field. These more general models are available as computer software packages and include the following: AVERT, Blood, SexWork, and igwAIDS. Of these, only AVERT and igwAIDS are designed to consider more than one type of intervention (IAEN, 2000). However, these models do not allow for groups included in these projects to be fairly measured against each other. For example, SexWork could have been used to measure the CSW intervention but not the SM of STI intervention.

In order to measure changes in the HIV incidence rate in the intervention scenarios, the population was broken down into the following compartments: CSWs, occupationally-risked men, moderately risked men, and moderately risked women. The groups were further broken down into HIV positive and negative risk compartments. In order to capture the movement of people between these specific groups, a new model needed to be developed.

For this project, an original model was created using a computer-modelling programme called *Modelmaker*. The model is a stochastic, compartmental model that allows you to regulate specific flows between the compartment groups. Information estimated from the Project and the east African region was factored in to the model in order to simulate the natural history and transmission of HIV. This information includes the following behavioural characteristics: HIV prevalence among sexual partners, mean number of sexual partners, mean number of sexual acts with a given partner, proportion of sexual encounters using condoms, the efficacy of the condoms, prevalence of STIs in the population, the probability of death, and HIV transmissibility. Cumulative probabilities are included for each study population, using the measure of effectiveness found in the literature.

A number of steps can be followed which allow models to be used to simulate the dynamics of the AIDS epidemic (Stover, 1999). There is a large variation in the complexity of different models that are used in HIV prevention, but a number of elements are common to most models. Most models that measure the impact of HIV prevention programmes have at least one hypothetical population, a set of parameters, and levels of risk of HIV in the various compartments of the population. The first step in modelling is to put together the question to be analysed. Next, the modeller must observe the system and understand the parameters that contribute to the possible outcomes. The modeller next identifies the populations of interest and will estimate the parameters based on the predicted risk of the particular subgroup (i.e. CSWs, or long distance truck drivers). Ideally, the risks associated with those groups will be based on recent, accurate measures of HIV in the population in question.

Estimations for parameters and population compartments can be made using information collected from KAP studies, census data, women at antenatal clinics, people presenting for STI treatment, and blood banks. It is important to define the groups that are most at risk within the population, and those that have been targeted for interventions. Estimates are made for the parameters for each sub-population. Then the problem is then described mathematically in a way that accurately describes the system, the parameters, and how they interact. After collecting the data and completing the model, a simulation can be run and the results can be interpreted (Vanchierei, 1996).

The model allows for the simulation of sexual activity, death rates and maturing populations of a specific group of people. In this way, the number of cases of HIV that a specific population would have incurred over a period of time can be estimated. Next, intervention parameters can be added to the models to simulate the outcome under the effects of the programme. The intervention rate is then subtracted form the "no-intervention" or base incident rate in order to estimate the number of cases of HIV averted as a result of the intervention.

Modelling Questions

There are any number of quantitative research questions that could be asked using mathematical modelling. The question of interest in this project is, "How many cases of HIV do the measured interventions avert?" The number of cases of HIV averted will allow us to rank to interventions according to their relative cost-effectiveness. By simulating the sexual behaviour of Kenya in a mathematical model, the parameters can be manipulated to assess the changes to the outcomes under a number of different circumstances.

DALYs saved as a result of the intervention using the process that was published by Gilson *et al.* (1997) were also calculated. DALYs allow one to ask the question, "How many disability adjusted life years were saved as a result of the intervention?" DALYs are calculated to make the interventions comparable to other health outcomes (even those that do not prevent HIV).

The model outputs are dependent on the inputs parameters which are estimated and which might vary according to the population measured. Thus an important question to ask is how an outcome is altered when the population parameters change. This is important to the generalizability of the study, beyond the population that the analysis measured. A tremendous variation in the outcome of the ranked effectiveness and cost-effectiveness will likely be found when the model is run on different populations. The outcome may depend on the STI prevalence, the numbers of CSWs and the average number of sex partners. A sensitivity analysis was performed in this study in order to consider the impact on the cost–effectiveness ratios as the parameters are changed.

The Compartments of Economic Modelling

In nature, many variables are random. Therefore, to accurately describe what occurs in nature, dynamic models are produced. In models that describe public health outcomes, such as HIV cases averted, a dynamic or stochastic modelling method must be used. Stochastic models have both static and dynamic compartments to them. The static structure defines the system (data figures and their possible states) in which the people are interacting. The dynamic structure defines how the systems change over time (flows and interventions). A dynamic model is able to accommodate changes to the risk, as they would likely occur in reality. Having a dynamic model is important when a researcher is attempting to describe the impact of an HIV prevention intervention. In a dynamic model for instance, those in the cohort who become positive during the run of the model will be able to infect others.

Models can also be either "open" or "closed". A closed model means that the model assumes that only the people in the model are capable of infecting or being infected. Obviously, the margin of error involved in having a closed model is dependent upon how much migration occurs in the population of interest. An open model is more challenging to simulate as it is difficult to measure the movement of some groups of people in society. The model in this project is open in that a certain percentage of new "maturing population" is added to the model population every month. The limitation of this parameter is that of course, immigration cannot be accurately measured. In this model, the new people entering the population are all considered to be HIV negative. This means that in the HIV negative male and female categories, new populations are added to represent the percentage of new people in Nairobi who are entering the sexual population every month.

The Parameters of the Model

The parameters include estimates of factors that the modeller deems relevant to an individual's risk of becoming HIV positive. As HIV is a relatively new virus in humans, some susceptibility parameters are likely yet to be discovered. Obviously, the risk of contracting HIV is strongly linked to the prevalence of the virus in the population that the susceptible person is interacting with. Knowing the HIV prevalence in the intervention and partner populations is of utmost importance in the design of the model. The HIV prevalence of both male and female members of the target and partner populations should be known. Next the average number of sexual partners and the number of sexual acts with each individual must be estimated for men and women in both the target and partner populations. The parameters are described in detail in the Methodology chapter of this thesis report. While the parameters chosen are based on the most recent, local data available, it is important to consider the outcome achieved when changes to those parameters occur. This is the reason for the sensitivity analysis.

The method and frequency of sexual activity also affects HIV transmission and must be included in the model. Different methods of sexual activity (oral, vaginal, or anal) carry with it varying levels of risk. Most people in any given society have a few partners, while others (the high-risk core group) have many. The number of partners and the frequency of sexual contact with each partner must be estimated in each of the groups in question. Knowing the estimated number of casual, new, and long-term partnerships that people in each model compartment have, is critical to the model building process. As each person's specific sexual activity is unknown, the average number of partners and contacts with each individual was used to allow for modelling.

Effectiveness Measures

There are a number of different indicators that are used to estimate the impact of an HIV prevention intervention. Researchers have measured process and outcome indicators with varying degrees of success (IAEN, 2000). Process indicators measure project activities and may include education session attendance, condoms distributed, or STI clinic attendance. While measuring process indicators is likely the easiest way to measure impact over time, outcome and impact indicators provide a more direct and accurate picture.

Outcome indicators measure the degree to which a programme has likely affected the population. These indicators may include the reported reduction in the number of partners, the proportion of people reporting consistent condom use, and/or the number of STIs treated. Rather than use models, a researcher could use the actual number of HIV cases reduced if a randomised controlled trial was set up so that one group would receive the intervention and another similar group would not. However, this would be ethically complex, as well as a resource and time-intensive trial to perform.

The effectiveness indicator that a researcher chooses to collect will be guided by the research question, context, culture, type of economy (i.e. agrarian, barter or currency based etc.) and information available. CEA measures both the costs and consequences of several programmes. In a CEA, the outcome of the interventions is evaluated in terms of the relative cost per unit of effectiveness. The ultimate goal of the CEA is to compare the alternative interventions and prioritize resources according to their ability to yield the greatest desired effect (UNAIDS, 1998). Then a health impact is calculated either directly from specific intervention trials in the population of interest or taken from published literature on similar trials.

The Impact of Antiretroviral Therapy

Since highly active antiretroviral therapy (HAART) became available, questions have arisen about the precise impact that the therapy has on the quality and length of life, as well as the effects on viral transmission. While more studies are needed to determine the possible reduction in transmission, it is believed that antiretroviral therapy (ART) affects HIV transmission by reducing viral load (Hosseinipour *et al.*, 2002). The effectiveness of the therapy on both drug-resistant and drug-sensitive strains must be considered. In a model used by Blower *et al.* (2000), three treatment outcomes for ART in San Francisco were considered. The first treatment outcome suggested that someone with HIV would remain as a non-progressor for a specific period of time. Other possible outcomes included experiencing clinical failure and death with and without developing drug resistance. The model predicted that increasing the usage of anti-retroviral drugs would reduce the AIDS death rate and could practically eliminate the incidence.

It is also possible that the introduction of widespread ART use for treatment in a society may have negative effects on the epidemic. It has been shown in the US and Australia that the perception that ART is a cure, may in fact lead to more risky behaviour (Chen *et al.*, 2002; Van Den Ven *et al.*, 2002).

In Kenya, in the year 2000, although the exact number is unknown, very few people had access to ART. A study that assessed the population of Nairobi's private clinics in the year 2001 found that only 1000 clients of the 364,353 (17% of 2,143,254) infected people in Nairobi (0.0027%) were on any ARV therapy. Only 65 of them were on triple drug therapy (Kimani, 2002). Estimates from Uganda place that country's ART coverage at less than 1% of the HIV positive population (WHO, UNAIDS & IAS, 2000). Therefore, this element was not factored into the model. By the end of 2001, however, out of 6,296 HIV infected patients recorded in the survey's urban centres, there were 332 (5.3%) clients who had ever been on ARVs. The proportion of patients on ART has increased in response to the reduction in prices of the drugs by 70-90% (Kimani, 2002). ARVs are still only available to the elite in Kenyan society with the majority (81%) of those on the drugs having had 13 or more years of school.

The Stage of the Epidemic in the Population

Whether the epidemic is isolated to specific core populations or spread out among the general population will affect the effectiveness of an intervention. An intervention that is effective in an area where the epidemic is mature (i.e. Kenya) may not be effective in an area where the epidemic is relatively young (i.e. India). This is important for generalizability of the model results. In the case of this model, the stage of the epidemic is represented by the HIV prevalence in the eight compartment groups. The parameters, which change as an epidemic matures, dictate the outcome of the model. A model representing a country in the early stages of an epidemic would likely have more marked differences between the HIV prevalence in the target groups and the overall population.

Examples of Commercially and Publicly Available HIV Models

AVERT

AVERT was developed by Family Health International in April 1998 (AVERT, 1998). The purpose of *AVERT* is to estimate the impact of HIV prevention programmes on the reduction of cases of HIV/AIDS in a population. This modelling software is able to calculate the reduction in infections over a specified time period (normally one year) using a mathematical formula developed by Weinstein (Weinstein *et al.*, 1989). This model estimates the risk of becoming infected with HIV when an individual (person A) engages in sexual activity. The computer will randomly choose a partner (person B) for person A from the general population. The probability that person B is HIV positive is calculated according to the population risk for HIV. Next, the model multiplies the population probability by the number of susceptible people in the at-risk population. This process is repeated to account for both partner A and partner B populations (e.g. CSWs and men in high-risk occupations). Model estimates are made for hypothetical sexual contact that would take place over a one-year period according to the population rate and frequency of exchange. This software is provided on-line at no charge.

While *AVERT* is a simple, straightforward programme, criticisms have been raised. Firstly, the programme is not stochastic. This means that it is not able to recognize and account for those people who are newly infected during the model time frame as no longer being "susceptibles". Secondly, and perhaps most importantly, *AVERT* is a static model that is unable to measure the secondary infections that would result from those newly infected people.

HIVTools

Charlotte Watts and Liliani Kumaranayake of the London School of Hygiene and Tropical Medicine developed the *HIVTools* model software in 1999 (Kingman, 2000). This modelling package consists of four different models that are specific to the type of intervention being measured. The models in the *HIVTools* package can assess the impact of interventions to reduce HIV in sex workers, youth, injecting drug users, and people receiving blood transfusions (Watts, 1999). As with *AVERT*, the purpose of developing the model was to assess the impact of several different prevention interventions on HIV epidemics. The model includes default parameters so that researchers who are unaware of accurate local estimates can still use the programme. Obviously, these default parameters will carry with them a margin of error. It is unlikely that the default parameters will correspond precisely with reality. This software is provided by UNAIDS free of charge.

There are also limitations to *HIVTools.* Firstly, the model considers each individual intervention as an independent entity. Several interventions and interactions between interventions cannot be measured in one model (Watts, 1999). It is also impossible to capture the impact of age structure on the output. This problem however could be overcome by stratifying the groups according to age but that will require running more models. Lastly, long-term impact cannot be measured.

<u>AIM</u>

The AIDS Impact Model (*AIM*) was designed by John Stover, The Futures Group and Family Health International. *AIM* was created to assist the POLICY project in providing useful information for policy and planning purposes (Stover, 1997). *AIM* can be used to estimate the yearly HIV prevalence in a population or make future projections of HIV prevalence. Again, the model includes default parameters so that researchers who are unaware of accurate local estimates can still use the programme. The model can also provide information on health impact and macro-economical impacts of the epidemic. This model feeds into another model that was developed by John Stover called *GOALS* which was created in 2001. This model estimates the national spending on any given intervention and the expected impact on the overall epidemic. The *GOALS* model also yields an estimate of the national reduction of HIV over specific period of time and the resulting cost per case of HIV averted.

<u>ModelMaker</u>

ModelMaker 4 software was used to develop the model for this research project. Cherwell Scientific developed this software in Oxford, England in the year 2000. This is a versatile modelling programme that has been used to estimate outcomes in many sciences including sociology, epidemiology, and community health. *ModelMaker* is considered a dynamic model programme because the variables can be programmed to change over time. *ModelMaker4* uses a *Windows* format and is considered to be a compartmental model. This means that members of the hypothetical population are initially assigned to a compartment. Then, due to the dynamic nature of the model, an

individual can then move to another compartment (i.e. become HIV positive due to contact, or become low risk due to an intervention) during the model run.

In order for the modeller to visualize the relationships between the parameters and the outcomes, the outputs are presented conceptually, in diagram format. *ModelMaker* uses the process called, "Monte Carlo Simulation" which accounts for random events (Vanchieri, 1996). In modelling, such random events are also refereed to as stochastic.

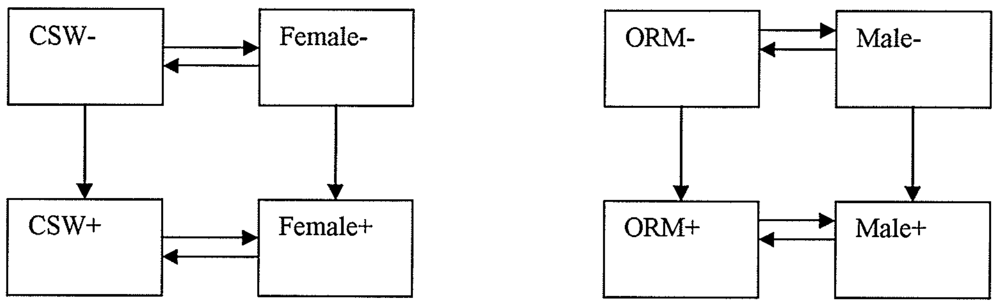
There are also limitations to using the *ModelMaker* computer programme. *ModelMaker* is known to be extremely "data hungry". This means that the programme requires a great deal of demographic and behavioural input in order to model the specific scenario. *ModelMaker* is designed to model many different sciences and is not specific to interventions for HIV/AIDS. A number of modifications are required to adapt the generic model to fit the HIV prevention scenario. *ModelMaker 4* is quite expensive at US$320 and the programme is also devoid of interesting graphics or design.

Why ModelMaker was Chosen to Create the Original Model for his Project

ModelMaker software was chosen to create an original model for this project as no other existing model had been created to answer the specific question that was being asked. The researcher has developed a model using the *ModelMaker* software that uses the populations that are involved in the interventions as the compartment populations. This model also allows populations to move from one compartment to another carrying the HIV and STD risk of the new compartment. In this model, the population increased every month as new people entered the sexually active population of Nairobi. People in this model also move into death compartments according to their risk. By creating a new model, the researcher was able to mimic more closely the population dynamics and sexual behaviour of the populations under study. The individual project reduction in cumulative incidence could be measured as well as the movement between risk groups in the sub-populations of interest to the Project.

Figure 3A illustrates the compartments and the movement of people from one compartment to another.

Figure 3A: The Model Created with *ModelMaker* Software: Movement Between the Groups



Female = non-CSW woman
ORM= Occupationally Risked Man
Male = Non-ORM man

- = HIV negative
+ = HIV Positive

Use of Models to Influence Policy

Policy makers who are involved in HIV prevention at the international, national, and local levels have to make difficult choices when deciding which programmes to implement in their populations. The rationale behind those decisions can come from many sources (experimentation, public opinion, donation of resources etc.). Modelling is an additional inexpensive, quantitative tool that can be used to assist in decision-making and guide further research.

The ultimate goal of people who are fighting to prevent the spread of HIV/AIDS is to bring the basic reproductive number (the average number of people than HIV positive person will infect) to below one. If this occurs, the epidemic will not be sustained. In order to reduce the reproductive rate to below one, either a highly effective single intervention or (more likely) a combination of programmes is needed. Modelling can also help policy-makers to identify core populations that should be targeted in order to affect the greatest influence on the overall epidemic. If modelling can further be used to demonstrate a cost-savings to policy-makers through a CEA, then they may become more motivated to focus resources on prevention programmes. The link between policy and implementation is not always made however. Policy makers have often rejected modelling outcomes until they are confirmed by experimental or observational trials. As yet, no national or international body uses routine mathematical modelling to guide their HIV prevention strategies (Stover, 1999).

Governments, NGOs, and grass-roots organizations need evidence on which to base their decisions. HIV/AIDS continues to devastate the lives of many people in developing countries, reversing years of gains won in the development and public health fields. Governments which are often resource-poor, are looking for ways to fight the spread of this disease in the most efficient way. There is a great deal of political pressure at present for governments to spend money on a number of interventions that may or may not be effective. Modelling is one tool that can assist policy makers in making thoughtful, evidence-based decisions that make sense within the context of the community concerned.

CHAPTER FOUR: **METHODOLOGY**

This project is a cost-effectiveness analysis with the goal of estimating the relative cost per infection averted in HIV prevention interventions in Kenya. The investigator gathered annual cost data and from a review of project budgets, site visits, a focus group and interviews with key informants. Behavioural parameters were estimated from information gathered from government estimates, site visits, a literature review, interviews with key informants and a focus group. Computer mathematical modelling was used to estimate the cases of HIV that were averted over one year. Costs were matched to the specific model outcomes. Cost-effectiveness ratios were then calculated and relative cost-effectiveness was compared. DALYs saved were calculated from the total number of cases of HIV averted. Lastly, a sensitivity analysis was performed to observe the model outcomes under a variety of different circumstances.

Determination of Costs

The overall costs (monetary and donated) of the programmes for each intervention were measured using budgets (obtained both in Canada and Kenya) and direct observation of the resources used. Interviews with project staff, clinic staff and volunteers were conducted in order to gather estimates on donated resources and actual supplies that are needed to run the intervention programmes. Observation of the intervention areas and staff allowed the researcher to understand the system and measure the resources used. The researcher met with groups at all of the intervention sites to observe how the meetings are conducted. Focus groups held with Project staff were helpful in verifying how closely this data reflected the project data in reality.

Determination of Effectiveness

The researcher used the results of published studies from the east African region in order to assess the reduction in STIs, the increase in use of condoms and the change in number of sexual partners associated with the interventions. Not all interventions demonstrated a change in all of these areas. Those changes were then entered into the

Project population of an intervention-specific model. This means that in the CSW model, only the 5,000 CSWs involved in the intervention had changed their condom use to 80%, increased condom effectiveness, and reduced their STI prevalence. The effectiveness of a project was calculated in terms of difference between the intervention model and the base model (the model with no intervention).

Creating and Feeding the Model

All of the data that was used in the CEA was based on the best cost estimates of the interventions and the disease risk and parameters of the Project target populations in Nairobi and the surrounding region. Existing prevalence and incidence data, KAP studies, and published studies from randomized control trials and rigorous cohort trials in the region were used to estimate the model population, compartments and parameters. This information includes the following behavioural characteristics: HIV prevalence among sexual partners, mean number of sexual partners, mean number of sexual acts with a given partner, proportion of sexual encounters using condoms, the efficacy of the condoms, prevalence of STIs in the population, and HIV transmissibility. This information was factored into the model to simulate the natural history and population transmission of HIV.

The Methods Used to Formulate the Model

The model was built using *Modelmaker* from Cherwell Scientific (Oxford, England). The researcher created the original model to simulate the population of Nairobi. The model starts out with a number of simulated people in each compartment. In this case, they are separated according to risk group, sex, and HIV status. The people are assigned to each compartment according to data on the number of people in each category in Nairobi. The model also has "flows" which move people from one compartment to another. The flows are regulated by parameters that are based on population and behavioural data. The flows can either move the people into different risk categories, or move them from being HIV negative to HIV positive. New people are also added to the population by increasing the uninfected men and women slightly every month. This is to account for those people in Nairobi who become sexually active. The model measures the progress of the movement of people into compartments that are designed to demonstrate cumulative incidence, prevalence, monthly incidence and deaths. The researcher can then map the prevalence, incidence and deaths over a period of time, in this case, one-year.

Modelling the Effectiveness of the Interventions

The model was used to measure project effectiveness. A base model was created to assess the progression of HIV in Nairobi in the absence of three Project interventions. This effectively acted as a "before" snapshot. In the base model, the parameters were derived from data from new project sites or baseline surveys. In the model, people who became HIV positive can go on to "infect" others in the population according to their risk.

Next, models were prepared using the changed behaviours after the interventions were initiated. Model outputs were then compared. The difference in HIV incidence between the base model and the intervention model in the year 2000, is the number of cases averted. The cases averted that are measured represent both primary HIV prevention and secondary HIV prevention over the course of the year. Primary HIV cases are those that are averted in the target group. Secondary HIV cases averted are those in the sexual contacts of the target group. The cost of the intervention was then attached to the number of cases averted to show the cost per case averted in dollars and shillings.

The cost-effectiveness ratios were then compared to each other in the form of ratios. The ratios were ranked in order of their cost per case of HIV averted. Next, a sensitivity analysis was performed to measure the impact of changing one of the parameters at a time. The sensitivity analysis then compared the ranking of the interventions to see if any one change altered the outcome. This was done to test the robustness of the model under a variety of circumstances.

DALYs saved were also calculated using the process outlined in the literature by Gilson *et al.*, 1997. The process entailed calculating the years of life lost to death, and the estimated decrease in the value of the years of life lost to disability after infection.

The number was then discounted to account for the likely decreased value of the future years of life. Then, this number was multiplied by the number of cases averted to measure the disability adjusted years saved as a result of each intervention. This number was then used to divide by the overall cost of each programme to work out the cost per DALY saved.

The Sensitivity Analysis

Use of the outcomes beyond the study population has a higher risk of error as the differences between populations, different stages of the epidemic, with varying efficacy of condoms, and the characteristics of the provider etc. may alter the ranking of the cost-effectiveness ratios. To enhance the scope of this analysis to include other populations in the region and to test the robustness of the ranked ratios, a sensitivity analysis was performed.

The sensitivity analysis was conducted by changing elements of the models and comparing the outcomes to the original model outcomes. The elements changed were chosen to represent cases where there was question about the estimate or where two or more studies were found with different results to describe a parameter. An example of this is in the HIV prevalence of occupationally-risked men. In this scenario, there were several studies finding results from 17-35% HIV positive. The range of possibility in this parameter were tested within the parameter to assess the impact that changing this parameter would have on the relative CE ratios.

Population

While the population that the researcher used to model the data on is hypothetical, the rate of partner exchange, condom use and other behavioural and population parameters are based on the characteristics of the people who are involved in the interventions. According to the 1999 National Census 2,143,254 lived in Nairobi during that year (GOK, 2001). The model population is based on the sexually active proportion of those people (this includes those who answered that they had had sex during the past month in the DHS, 1998). The population was then divided into model compartments according to the best estimates from the literature and GOK data on sex and risk status.

The population is separated into the following eight compartments (each sub-population has people who are HIV positive and HIV negative): CSWs, occupationally-risked men, other men and other women. Obviously, compartments could have been grouped by religion, income, age or levels of education as well. Compartments for HIV positive people could have conceivably been further broken down into groups according to their viral loads. However, there are no reliable estimates for these factors and it would add greatly to the models complexity and potential for error. The model compartments represent the groups of interest to the Project and reflects the information that has been gathered routinely.

Interventions Evaluated

The three interventions (STI treatment, CSW interventions and OFIM) were chosen for two reasons. Firstly, there is evidence from the literature to describe their effectiveness. Secondly, they are mature interventions from the Project that are available to be evaluated. Finally, the Project is in the process of scaling up a number of their programmes and there is interest in a number of different methods of assessing the possible outcomes of HIV prevention programmes in their populations.

All costs that are incurred by the Project for each of the interventions were measured. The researcher chose to collect the data according to the provider's perspective. The Project manages all the interventions that the parameters were based on. Estimating costs from one organisation is necessary in order to account for many of the differences in practice and spending that may occur between organisations. One of the strengths of this research is that the three programmes are part of the same project and overseen by the same management team. It was decided that expatriate management costs would be included in the project costs. Of course, it should be noted that the costs are likely to be much less if the projects were to be replicated by local groups.

Analysis

This study yielded three cost-effectiveness ratios. The ratios were measured as the cost per case of HIV averted. The differences between the ratios were compared. A sensitivity analysis was conducted to test the robustness of the ratio ranking. Models are based on a number of assumptions. A sensitivity analysis assessed the possible deviations that may have occurred between the model and reality.

Ethics

This research project was carried out in an ethical manner. The researcher was invited to conduct the research by both the Kenyan and Canadian directors of the project. Ethics approval was obtained through the University of Manitoba and the University of Nairobi/Kenyatta National Hospital. Informed consent was requested and signed consent forms were acquired from by staff members involved in the focus group. The Project managers and staff were eager to assess the effectiveness of the programmes that have been on going for years. The funding partners and the recipients have also expressed interest in hearing the results of this CEA. The research is useful to the recipients in both evaluating the effectiveness and costs of the current project, but also in fulfilling requirements laid out by their funding bodies.

The CEA research was conducted in such a way as to not disrupt the flow of the project and the relationship of the staff with those with whom they work. There was no change to the programme as a result of the study. This study did not directly involve human subjects and no non-staff person was asked to contribute opinions or information to the project. The model population that was generated by the computer is hypothetical but the costs and effectiveness of the model are built on data acquired from the Project recipients.

Site Visits to Intervention Areas

Visits to all of the intervention sites were made to assess the activities and the resources used in each of the interventions. The researcher did not interfere in the meeting schedule or meet with clients personally but rather observed the operations of the interventions. Staff were interviewed to assess what happens at the regular meetings and to find out what resources are used. The following checklist was used in the field visit.

Observation Checklist

1. In what setting are the meetings held?
2. What resources are being used?
3. Are donated items being used at the project sites?
4. What are they? Where do they come from?
5. Are they always available? (Were they in 2000?)
6. Are gratuities offered to anyone?

To Ask Staff

1. What normally happens in your programme?
2. How many clients did you see today?
3. How much time do you spend with each client?
4. What resources are you using?

Project and clinic staff were also asked to walk the researcher through a "normal" interaction with a client. The staff members described how a client would access the service, what would happen at the project site, and what resources were used. The researcher was shown the equipment and supplies at each site. Details of the visits to the intervention areas can be found in Appendix B.

Site Visits and Interviews with Key Informants in Nairobi

Site visits to a number of organisations were carried out to gather information, and to verify the information collected. NGOs, other researchers, and community groups were visited and interviewed. The goal was to collect a lot of information on Nairobi populations, in order to make the model as close to reality as possible. Government modellers were asked to look at the model and comment on parameters. During the visits no other CEA on CSW, ORM peer interventions, or syndromic management of STIs was found to be taking place. A table listing the organisations visited and notes on the outcomes of the meetings can be found in Appendix C.

Focus Group Feedback on Model Parameter Estimates

After the development of initial estimates for various model parameters, a focus group was held at the University of Nairobi, in the Medical-Microbiology Annex. The meeting took place from 9 until 11:30 am on April 3, 2002. The meeting place was quiet and secluded. Five staff members who work directly with the project target population were present, as was the researcher. The staff members were in the prime position to know about the parameters as they had worked directly with the target populations (STD patients, CSWs and ORMs) for many years and were also involved in a number of studies. The staff also understood what data was available nationally. All participants were again briefed on the purpose of the meeting and signed consent forms. All members were aware that their participation was voluntary. Estimates of model parameters were produced in a matrix, and presented to the group for discussion one by one. The information included a list of the model parameters and the source of the estimates. The participants were asked to comment on the parameter input and to add any other source that they were aware of. A table listing the parameters, the model inputs, the source and the discussion group's response can be found in Appendix D.

After much discussion, the group agreed on all of the cost parameters. The discussion centered on the different kinds of equipment, meeting areas and sources. It was an excellent and informative meeting. The participants felt that they learned more about the researcher's project and their own projects. The researcher received verification on a number of parameters and sources of further information.

Key Informant Interviews

To follow-up on the discussion group, the researcher sought out a number of people who were suggested. The researcher visited Mr. Mbugua, Mary Kinoti, Allen Ragi, members of AMREF, Dr. Kimani and Prof. Mumo, the staff of FHI and Dr. Bukusi, as per the suggestions of the group. The results of those interviews are outlined in Appendix E.

CHAPTER FIVE: **THE MODEL**

The equation that calculates probability of HIV transmission from one group to another is made up of the HIV prevalence of the partners, the prevalence of STIs, condom use, condom efficacy, sex acts and number of different partners (Weinstein *et al.*, 1989). The population parameters in this model are based on the data collection in Nairobi and nearby Thika. This model is considered an open model, as it does take into account the people who mature and enter the sexually active population over time. However, the model does not include people who come into the city from other areas and engage in sexual behaviour. This would certainly have implications for HIV transmission rates for Nairobi if there were a large number of HIV positive people from outside the city engaging sexually with people from Nairobi. An example of this would be a large influx of soldiers from a neighboring country. However, there is no information to support that a large influx of new people engaging in risky sex occurred in the year 2000.

In this model, the hypothetical community members can move from one compartment to another in accordance with the risk of the flow. For example, according to the flow equation, some of the hypothetical community members in the CSW compartment would no longer practice sex work and would therefore move into the "female" (lower risk) compartment. The movement in the model would be randomly assigned and the former CSW would then have the same risk level of transmission as the other "females" in the compartment.

The parameters, number of people per compartment and flow were estimated using the national statistics, surveillance data and KAP studies. The data assumes an epidemic that is driven by heterosexual sex (MOH, 2001). Two of the KAP studies (Strengthening STD HIV Control, 1999a; Strengthening STD HIV Control, 1999b) showed that there was some sex between men (4.2% ever, none in last three months). They also revealed some anal heterosexual sex (1.6 - 1.8% ever practiced). However, these sexual encounters were not measured in the model as the numbers over a one-month period would be zero.

The model uses data primarily from the year 2000. This time is obviously retrospective to the study and therefore the data is available to estimate the parameters.

This year was chosen because it was the most recent year from which the data was collected and collated at the time of the thesis project data collection.

There are four separate models used to describe the different outcomes according to the interventions that are initiated. The base model represents no intervention, while each separate intervention is also represented by their corresponding models (STI treatment, CSW interventions and OFIM interventions). In each scenario, the one-year cumulative incidence is compared to estimate the number of cases of HIV averted.

Obviously, there are other interventions that could be modeled such as voluntary counselling and testing, HAART, or circumcision. However, only the interventions for which there was data from mature programmes of the Project could reasonably be measured in this CEA study. Further study may be done in the future to include those interventions that were beyond the scope of this research.

Compartments of the Model

The model consists of nine different compartments. The compartments of the model include the population, the compartments, the flows, the parameters and the variables. Each of the separate compartments is based upon the best estimates of data from populations in Kenya (for the region), or the nearest date to the year 2000 that was available.

The Population

The population that the model was estimated on was the numerical population of Nairobi (about 2.14 million people according to the 1999 census data which was published by the GOK, 2001). For the purposes of the model, only the sexually active people will be considered. The sexually active population for this project is defined as those people who answered in the affirmative to the DHS (1999) question, "Have you had sex in the last four months?"

There are eight population compartments in the model, each of them representing different risk groups in the Kenyan population. Women represent 50.52% of the population (GOK, 2001). The compartments are divided by sex and risk category. The higher risk categories are labeled "CSW" and "Occupationally Risked Men". The women were split into CSWs and females ("females" indicates other women who are not involved in the exchange of sex for money, goods or services). The men were split into Moderately Risked Men and Occupationally Risked Men rather than males and clients. This was due to the relatively large percentage of men who were sexually involved with both CSWs and other females in both male risk categories. The proportion of risk category is based on estimates from antenatal clinic data and the Kenya Economic Survey (GOK, 2000).

The sexually active population of Nairobi differs amongst age groups. The highest overall percentage of females involved in sexual activities is seen in the 30-34 year old age group.

In order to find the sexually active population for the model, the overall numbers in the age group (by sex) were divided by the percent that claimed to be sexually active in each age category (DHS, 1999). Below is a table listing the total number of females that are sexually active in each group.

Table 5A: Population of Sexually Active Women in the Past Month in Nairobi

Sex	Age Group	% Sexually Active in last month, Urban Kenya	Number in Age Group in Nairobi	Total Number Sexually Active
Female	10-14	15	128985	19348
	15-19	19.4	135489	26420
	20-24	52.3	152831	79930
	25-29	66.5	131153	87217
	30-34	67.4	80209	54061
	35-39	65.9	78042	51508
	40-44	62.4	45524	28407
	45-49	53.3	35769	19065
	50-54	50	30350	15175
	55+	40	30350	12140
Total Female				**393,271**

Source: GOK, 2000 and the Kenya Demographic Health Survey, 1999

In the male groups, the total number of sexually active people was also calculated. The following table outlines the data that were used to estimate the total number of men that are sexually active in Nairobi.

Table 5B: Population Sexually Active Men in the Past Month in Nairobi

Sex	Age Group	% Sexually Active in last month, Urban Kenya	Number in Age Group in Nairobi	Total Number Sexually Active
Male	10-14	20	96299	19260
	15-19	24.5	96299	23593
	20-24	48	107940	51811
	25-29	66.2	133337	88269
	30-34	72	100532	72383
	35-39	74.6	83600	62366
	40-44	71.5	56086	40102
	45-49	70.8	40213	28471
	50-54	64.5	32805	21159
	55+	54.5	43387	23646
Total Male				**431,060**

Source: GOK, 2000 and the Kenya Demographic Health Survey, 1998

These categories of sexually active people were then further broken down into the risk categories of CSWs and ORMs as well as men and women who were not in those categories. The table below describes the breakdown of the population that was used in the model.

In order to build the compartments into the model, the categories had to further be broken down by the HIV status in the populations. The following table outlines the breakdown of the population groups according to their behavioural risk and their HIV prevalence. The data came from reports in the Demographic Health Survey (1999) and Government of Kenya documents (GOK, 2000).

Table 5C: Population of Nairobi (Sexually Active Population of Nairobi)

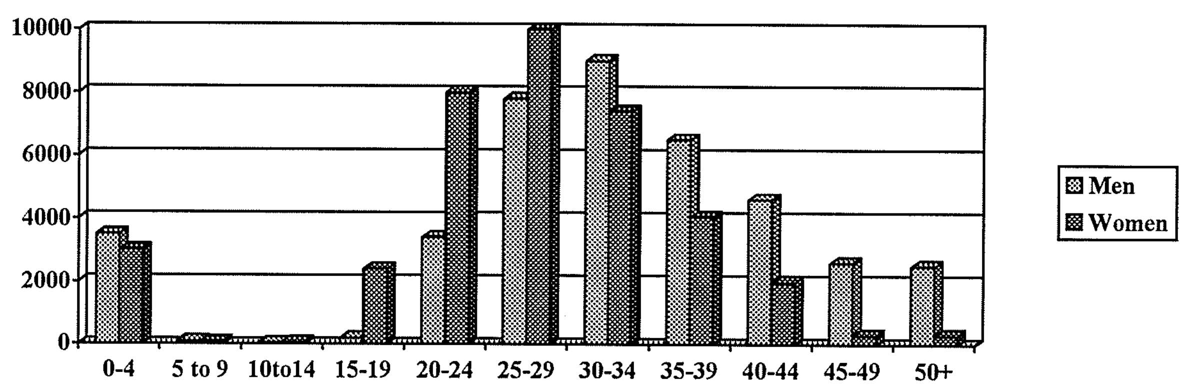
Population Compartment	Number
Total sexually active population	835,598
Total women sexually active in the last 1 month	393,271
Total men sexually active in the last 1 month	431,060
CSWs	31,462
Non-CSWs	361,809
ORM	73,280
Non-ORM (MRM)	357,780

Source: GOK, 2000 and the Kenya Demographic Health Survey, 1998

Percentage of Male and Females that are HIV positive

Using the national data on sex and age distribution of reported HIV cases, the researcher was able to determine that overall, there are as many men infected with HIV as women. However, women are infected at a younger age than men. It is believed that this is due to a large number of young women having sex with older (and already infected) men. These young women have an increased susceptibility to HIV that is both related to behavioural and biological factors (as described earlier). Figure 5A outlines the gender differences in reported cases of HIV in Kenya.

Figure 5A: Percentage of Male and Female Reported Cases of HIV, Kenya (1986-2000)



Source: AIDS in Kenya- MOH, 2001

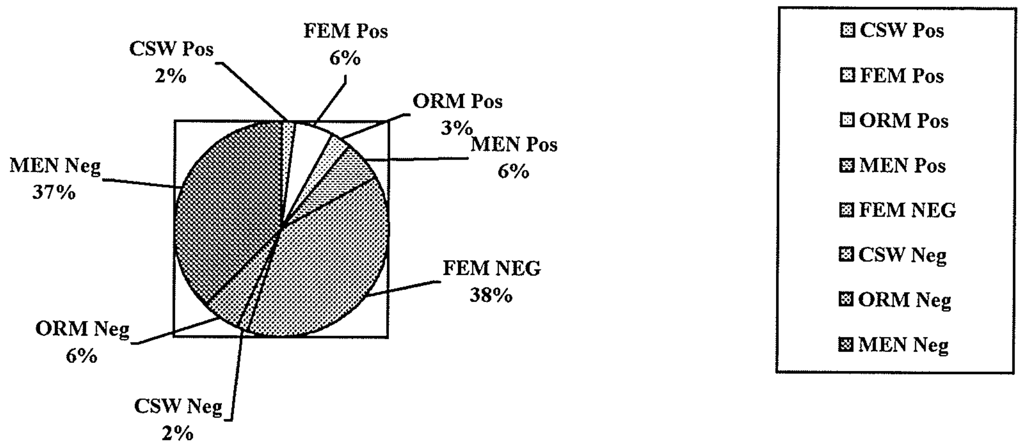
To create the final compartments, the risk categories were then broken down into groups by risk and HIV status. Below is a table showing the number of people and the percentage of the larger category for each final population compartment.

Table 5D: Population Compartments by Risk Behavioural Group and HIV Status

Population Compartment	Number	Percentage
CSW HIV positive	9,439	30% of CSWs (UNAIDS/WHO, 2000)
CSW HIV negative	22,023	70% of CSWs
Female HIV positive	50,653	14% of women (GOK, 2000),
Female HIV negative	311,156	86% of women
ORM HIV positive	14,656	20% of ORM (Mbugua, 1995)
ORM HIV negative	58,624	65% of ORM
MRM HIV positive	50,089	14.4% of men (GOK, 2000),
MRM HIV negative	307,691	85.6% of men
Total	835,598	100%

The pie chart below shows the percentage of the overall sexually active population represented by each compartment in the model.

Figure 5B: Population Compartments



Source: DHS, 1999; GOK, 2000

The other three compartments (those that are not based on sex or risk categories) are the "AIDS death", "CSW AIDS deaths" and "Other deaths" categories. The death rate from HIV was found to be equal to 0.009 (0.9%) per month in a recent study from Uganda (Morgan *et al.*, 2002). Only those in the model population that are HIV positive will move into this category according to their risk. The death rate from other causes was estimated to be 0.0012 (0.12%) per month for all age categories combined (CIA Factbook, 2001). Population from all model compartments can move into this death category. The HIV death rate for CSWs was calculated to be 0.019 (1.9%) per month. This parameter was based on data that found that the median time to death after HIV infection in CSWs was 54 months (Anzala *et al.*, 1995). The different sex and risk groups were then divided by HIV status. The different prevalence rates are estimates from the data collected in the year 2000 or closest estimates.

CSW Negative

The number in the CSW Negative compartment represents the percentage of sexually active women who exchange sex for money, goods or services who are also HIV negative. CSWs engage in sexual interaction both with the general population of males and with ORMs. The parameter estimate was acquired from a report citing that the baseline HIV prevalence in one area of Nairobi was only 27%. Another study in the Pumwani slum of Nairobi was 45% (UNAIDS/WHO, 2000). It was decided that the most prudent number would be 30%, and that higher percentages of HIV infection could be accounted for in the sensitivity analysis. Therefore, the percentage of those that are HIV negative is estimated to be 70%. Some of these women will be randomly chosen to flow into the CSW positive compartment according to the risk of the group (Kibera Project Data, Unpublished).

CSW Positive

The CSW Positive compartment corresponds to the sexually active women who exchange sex for money, goods or services that have contracted HIV. In this model, these women are continuing to interact at the same rate of sexual activity as their HIV negative colleagues. They are able to flow into the other female positive category to represent those women who no longer engage in sex work. Obviously, once they are HIV positive, they cannot flow back into the CSW negative category. Some of these women will flow into the HIV death compartment according to the death rate (1.9% per month). The percentage of women that are HIV positive in this cohort without intervention is 30% (UNAIDS/WHO, 2000).

Female Negative

This compartment box represents women who are HIV negative and are also not presently engaged in commercial sex work. These women have sexual relations both with the general population of males and with ORMs. The percentage of women that were not involved in sex work was derived from the antenatal clinic surveillance data and the Kenya DHS (DHS, 1998). Some of these women will flow into the CSW negative category according to their risk of entering into sex work, or the female positive category according to their risk for HIV. The rate of HIV in the overall Kenyan antenatal clinics was less than the Nairobi average (14% versus 17%) (GOK, 2000a) in the year 2000. The population HIV positive was estimated to be 14%. Therefore, the proportion of women in Nairobi who were HIV negative was set at 86%.

Female Positive

This compartment is used to account for the female population who do not engage in sex work and are HIV positive. The data used to estimate the proportion of women in this group came from antenatal surveillance and the WHO prevalence data for Kenya (2000). These women are able to flow into the CSW positive category to represent those women who engage in sex work. Again, once they are HIV positive, they cannot flow back into the CSW negative category but they may flow into the HIV death compartment according to the death rate. In Nairobi, the rates of HIV for non-CSW women were estimated to be 14% in the year 2000.

Occupationally Risked Men Negative

Men in the ORM Negative compartment are those men who are involved in occupations for which they are at a higher risk of HIV than the general population of men. These men interact both with the general population of females and with CSWs. Men who are considered high risk in the literature are men in the military, truck drivers and miners (London *et al.*, 1997; Meekers 2000; Nzyuko, 1997). Obviously, there is a great deal of individual variation in the sexual behaviour of men in different high-risk occupations, however the evidence appears to point to the fact that men in professions such as these are at higher risk than the general population. Some of the ORM parameters were drawn from included data from the Thika touts, sand harvesters and Jua Kali artisans (Strengthening STD/HIV Control in Kenya, 1999a). Data on truck drivers was used to estimate this parameter.

According to Mbugua *et al.* (1995), the proportion of truck drivers in Kenya that were HIV positive in 1992 was 20%. Another study from 1991 found that 18% of

Mombassa truck drivers were HIV positive (Bwayo *et al.*, 1991). By 1994, estimates had reached 35% in east African truck drivers (Laukamm-Josten *et al.*, 2000). Again, being conservative, it was decided that the estimate taken for the HIV positive compartment would be 20%, and the HIV negative compartment would be 80%.

Occupationally Risked Men Positive

This compartment is used to represent those men that are in high-risk professions and are also HIV positive. These men are both engaged in sexual relationships with CSWs and females who are not CSWs. Therefore the risk flows include interaction between the Occupationally Risked Men and both of these compartments. The proportion of men in occupations at high risk for HIV/AIDS was estimated based on the Economic Survey (GOK, 2000) and work done on the FHI/AMREF East Africa AIDS and Truck Drivers Study (Laukamm-Josten *et al.*, 2000). The proportion of these men that are HIV positive is estimated to be 20%. ORM positive men may flow into the MRM positive compartment or the HIV death compartment according to their risk.

Male Negative

This group is representative of the men in the model's hypothetical community who are not in occupations that are at high-risk for contracting HIV. These men interact sexually with both the general population of females and with CSWs. Their interaction with women is less frequent than with the ORM. Therefore, their risk of acquiring HIV is lower. The data used to estimate the compartments surrounding the men in this group was the National Youth Service Camp (Strengthening STD/HIV Control in Kenya, 1999b). This study looked at people between the ages of 19 and 45 with a target group between 21 and 25. Most of the population of this study (over 75%) was male. The male data was used to estimate the general population parameters for this compartment. Men in this compartment can move into the positive male category or the ORM negative category as a result of their risk. The rates of HIV are equal in Kenya between men and women (GOK, 2000a). In Nairobi, the rates of HIV were 17% in the year 2000. When the ORMs are taken out of the equation the number is somewhat lower than the city's average. For the purposes of the model, the non-ORM men HIV prevalence rate was estimated to be 14.4%. The HIV negative population of men would therefore be 85.6%.

Male Positive

Men in the hypothetical population who are not in occupations that are considered high risk but who are HIV positive were included in this compartment. These men interact with both females from the general public and CSWs. The men in this group are also able to move into the ORM positive compartment according to their risk that is represented by the flow "go high pos" and the parameter "MRMposToORMpos". The rates of HIV are equal in Kenya between men and women (GOK, 2000a). In Nairobi, the rates of HIV were 17% in the year 2000, with the non-ORM average estimated to be 14.4%.

HIV/AIDS Deaths

The compartment HIV/AIDS Deaths represents those deaths that are likely to occur due to HIV/AIDS over the one-year period. No other deaths, besides those attributed to the breakdown of the immune system due to HIV are considered in this compartment. All of the compartments that represent populations that are HIV positive flow into this compartment at an equal rate. The rate for HIV deaths was taken from information gathered in Haiti. It was found in Haiti that median time to death was 7.4 years, or 88.8 months (Deschamps *et al.*, 1996). Therefore to get the monthly rate, 88.8 was divided by one yielding 0.011.

Another study from Uganda (Morgan *et al.*, 2002) found that the median time from infection to death was 9.8 years. This means that the time from infection to death was 117.6 months. On average, the monthly risk of death for a person with HIV is one divided by 117.6 or 0.009. Therefore, as the newer Uganda study is more geographically and environmentally appropriate, the Morgan result will be used in the model as the parameter for time to flow HIV positive non-CSWs into the HIVdeath category.

CSW HIV/AIDS Deaths

In Kenya, HIV-infected CSWs appear to have a faster time to AIDS and death than others. This is thought to be due to lifestyle issues, nutrition and the exposure to other diseases after HIV infection. The average length of life for an HIV positive CSW in Kenya is 54 months (Anzala *et al.*, 1995). One, divided by this number gave us the monthly death rate. In this case, the monthly death rate is 0.019.

Other Deaths

The Other Deaths compartment represents those deaths that are not related to HIV/AIDS. The flow of the population into this category is determined by a parameter that is based on the Kenyan death rate. The death rate for Kenya in 2001 was estimated to be 14.35 per 1,000 people per year (CIA Fact Book Kenya, 2001). This yearly rate, divided by the number of months, yields a monthly death rate of (14.35/1000)/12 = 0.001. This rate was used to estimate the non-AIDS death rate in Nairobi. While this data does not break down the AIDS deaths and non-AIDS deaths, when the model is allowed to run over ten years, this rate results in the population maintaining at the current and expected trend. It is expected that a number of deaths, particularly those from HIV/AIDS related causes go unreported.

General Parameters

There are also parameters in the model that estimate the flow from one compartment to another. In this model, the parameters are broken down into the data that occur over a month. This model is run over a 12-month period. All of the parameters are estimates based on the best and most current data that was available.

Time

The variable for time is represented by the letter "t". This model is run over a 12-month period with the interventions occurring in the first month of the model run. This time period can be increased to look at future outcomes, if the parameters were to stay the same. For the purposes of testing the stability of the model, the model was also run over a five and ten-year period. The parameters remained stable and the HIV prevalence increased to 21.8% by 2010 without interventions.

Maturing Population Males

This parameter allows new young men to mature and enter the sexually active population of Nairobi. Men represent 49.48% of the population (GOK, 2001), equalling 1,080,272. 15.8% of the male population is between the ages of 10 and 14 (170,682). There is a 13% growth in sexual activity in the past month between the 10-14 year old age group and the 15-19 year old age group (DHS, 1999). If the 13% was divided by the four years covered in the age group, there would be about a 0.3% increase each month. There is also likely to be a steady percentage of young men moving into Nairobi from other areas. Therefore, the model includes an increase in the population by 0.5% every month. This means that there are 1,538 newly sexually active men in Nairobi per month. This rate of maturation results in the population of men to increasing at an even and plausible rate when the model is allowed to run over ten years.

Maturing Population Females

This parameter allows new young women to mature and enter the sexually active population of Nairobi. Women represent 50.52% of the population (GOK, 2001), equaling 1,081,128. 15.8% of the female population is between the ages of 10 and 14 (170,818). Of these, 22% have ever been sexually active 37,580. The sexually active population of women increases by 27% over the next age group (DHS, 1999). Therefore, the model estimates an increase of 0.6% per month (or 1,878 new sexually active women). This rate of maturation results in the population of women growing at an even and plausible rate when the model is allowed to run over ten years.

Condom Effectiveness

The effectiveness of condoms is measured by both the ability of the condom to act as a barrier to the virus and their proper use. The parameter was estimated from data from FHI's study of condom distribution in Kenya (FHI, 1998) as well as the NIH's scientific evidence of condom effectiveness (NIH, 2000) and a meta-analysis of 25 studies of sero-discordant couples (Davis & Weller, 1999).

In a number of trials, condom failure due to breakage and slippage were measured. The breakage rates varied greatly from 0.5% to 6.7% and the slippage rates were between 0.1% and 16.6% (Davis & Weller, 1999). In a Kenyan study, 23.6% of CSWs claimed to have had at least one condom break during sexual intercourse over the last month (Strengthening STD/AIDS Control, 1997).

Condoms provide an 85% reduction in HIV transmission when compared in "always" versus "never" users (NIH, 2000). A study in Western Kenya found that the odds of being HIV negative were almost three times greater in those who used condoms versus those that never used condoms (Hargreaves *et al.*, 2002). Obviously, condoms need to be used properly in order to be effective. In Kenya, the majority of students do not complete secondary school (DHS, 1999) and not all schools have sexual education classes that teach about condoms. Much of what is learned in Kenya about condoms may be inaccurate or poorly understood. Most CSWs in a survey in Kibera, Kenya responded that they learned about condoms from the radio (Strengthening STD/AIDS Control, 1997). The same study found that 86% of the respondents claimed to use petroleum jelly (a non-water soluble product) as a lubricant. Without proper demonstration of use, education, and appropriate lubrication some extra breakage and slippage is likely to occur. Therefore an effectiveness level of 75% was used in the model to represent condom effectiveness in the pre-intervention group.

Condom Use CSWs

This parameter represents the baseline CSW condom use. The data were based on data from the CIDA Kibera baseline KAP study. Kibera is a slum area of Nairobi that had not previously had peer interventions for CSWs. The data were broken down into the condom use categories of "always, sometimes and never". The results were as follows - always: 10.8, sometimes: 23.9, and never: 65.3. The category "sometimes" was estimated at 50% of the time and the always was taken for 100%. Therefore, it was estimated that before the intervention, condom use among CSWs was half 23.9 plus 10.8

= 22.75. Therefore, 22.75% of the CSW population's sexual activity was considered to be covered by condom use at baseline.

Condom Use Non-CSW Females

The baseline use of condoms among women in the general population was based on data from the antenatal clinic surveillance data (Strengthening STD/HIV Control in Kenya, 2000) and the Kenya Demographic Health Survey (DHS, 1999). Data from ANC surveillance stated that 929 non-CSWs responded that they had used condoms out of 8,979. The table below outlines these findings.

Table 5E: Condom Use by CSW/Non-CSW

	Condom Use No	Condom Use Yes	Total
Non-CSW	8049	929	8979
CSW	525	57	582
Total	8574	986	9561

Source: Strengthening STD/HIV Control in Kenya, 2002

However, when respondents in the Kenya Demographic Health Survey were asked about condom use *during last sexual intercourse*, 5.5% of women claimed that they had used a condom. Further conversations with the University of Nairobi's Dr. Elizabeth Bukusi confirmed that less than 10% of women visiting her clinic claimed to use condoms on a regular basis (personal communication, May 2002). Therefore, the population condom use for women in Nairobi is estimated at 7% and the parameter is estimated to be 0.93.

Condom Use Population Men

Men in the general population tended to be more likely than non-CSW women to use condoms. The Kenya Demographic Health Survey (1999) reported that 21% of men had used a condom during their last sexual intercourse. Therefore, the parameter is estimated to be 0.79, meaning that 21% of sex acts are covered by condoms.

Condom Use ORM

ORM have varying rates of condom use, depending upon profession. In the FHI/AMREF truck drivers study, the baseline condom use for having used condoms during all of the last five sexual encounters was 19.8% (Laukamm-Josten *et al.*, 2000). The CIDA Thika men's study (which asked touts, sand harvesters and artisans about their sexual behaviour) found that 56% of the men in Thika study had ever used condoms, with almost 10% always using condoms with CSWs. Therefore, the parameter is estimated to be 0.9, meaning that 10% of sex acts are covered by condoms.

Contact per CSW

The number of sexual contacts with each different client per month was based on data from the CIDA Kibera baseline KAP study and the focus group with Project staff. Looking at both the daily and weekly contacts, it was estimated the monthly contact per different partner would be five.

Contact per Occupationally Risked Man

In the Thika baseline data, ORM described their contacts with CSWs, casual partners and regular partners. The data also showed that most of these men were married and many had girlfriends. Men have fewer contacts with their regular partners when they are travelling, or spending nights with casual partners. As this parameter represents non-paid contacts with wives and girlfriends, it is estimated that the number is slightly less than the regular partner number (12), but higher than the contact with CSWs (five). The model was run over ten years to ascertain at what level of contacts the infection rate would stay at the current level. The rate of eight contacts maintained the plausible trend. Therefore, number is estimated to be eight.

Monthly Sexual Contact per Person in the General Population

This parameter represents the estimated number of times per month that couples have sex in the general population. This parameter is based on the expert opinion of five doctors in Nairobi that work in gynaecology or STI treatment. The team estimated that the sexual contact of an average regular partner is two to three times a week. Similar numbers were found from another study in the east African region (Gray *et al.*, 2000). In this study, the mean frequency of intercourse declined with age and HIV-1 viral load. The group of doctors interviewed by Dr. Joshua Kimani felt that the number was 3-4 times per week. The two to four times per week estimation is consistent with the model's ten-year forecast. This means that when the model is run over ten years, and the sexual contact per month is set to 12, the HIV prevalence in the population maintains at the expected growth rate. Therefore, the estimate of 12 contacts per month was chosen.

The Monthly Number of Different Non-ORM Partners per CSW

In the CIDA Kibera baseline survey, 1.3% of participants were married. 75.1% of CSWs in Western Province of Kenya had at least one non-paying sexual partner with 34% having one, 23.4% having two, 11.4% having three and 6.8% having more than three. In a national survey (ICROSS, 2002), the CSWs reported that over half lived with boyfriends or husbands. While some of these men are regular, about as many are not ORM and yet visit CSWs. Therefore, it was estimated that each CSW has three partners that are not ORM per month. Some of these are paying clients and some are boyfriends or husbands.

The Monthly Number of Different ORM per CSW

The number of different partners per month for the CSW population was estimated using the CIDA Kibera baseline KAP study. The study had two interesting statistics. Firstly, they measured the reported number of different partners per day. The median number for CSWs was 3-4. Next, the weekly number of different partners was 10-14. If they were all different partners, the median number would likely be closer to 21-28. Therefore, it is assumed that many of the contacts are repeat customers. The monthly number was estimated to be 14 based on the higher end of the weekly number of different partners.

The Monthly Number of Different Non-ORM Partners per Woman Who is Not a CSW

The estimation for this parameter is based on data from the National Youth Study. 13% of females over 15 years old have >1 partner per year (WHO, 2000). Some of those women have more than two partners. Therefore, it is estimated that the monthly number would be 1.5 partners.

The Monthly Number of Different ORM Partners per Woman Who is Not a CSW

Women who are not CSWs are also having sex with men in high-risk professions. Although there is no study available that looks at the proportion of women that are involved with ORM, it can be estimated that less than half of women who are not CSWs would have ORM partners every month.

Multiplier for Genital Discharge

The extent to which STIs are involved in HIV transmission is not well understood. However, several studies have attempted to illustrate the relationship. STIs causing genital discharge increase HIV transmissibility risk by 2.58 (Deschamps *et al.*, 1996). As most of the STI diagnosis in Kenya is made by symptom, the presence of discharge is used to describe the presence of these STIs. Differences between male and female transmissibility risk of HIV were not found to be significant with either ulcerative or non-ulcerative STIs (Deschamps *et al.*, 1996; de Vincenzi, 1994).

Multiplier for Syphilis Sero-positivity

Syphilis was also found by Deschamps *et al.* (1996) to increase HIV transmission. The study found that the presence of syphilis in the HIV negative partner to increase his or her chances of becoming infected with HIV by approximately three times.

STI Multiplier for Genital Ulcer Disease

Genital ulcer disease is diagnosed by the presence of a clinical ulcer. As with non-ulcerative STIs, ulcerative STIs act as cofactors for HIV transmission. Ulcerative STIs are known to increase the viral transmissibility risk by approximately 6.82 times (Deschamps *et al.*, 1996).

Genital Discharge Rate for CSWs

This parameter was estimated from the Kibera CSW study. This study revealed that 22% of CSWs had at least one STI. The CSWs from the older sites were estimated to have at least as many STIs as their younger counterparts. Therefore, the rate used as the model estimate was 22%.

Syphilis Sero-positivity Rate for CSWs

The CSW sero-positivity for syphilis parameter is based on the Kibera baseline data from the Fonck *et al.* (2000) study. The data showed that 6% of the women measured were sero-positive for syphilis.

Genital Ulcer Rate for CSWs

The Kibera baseline data (Fonck et al, 2000), showed that about 2% of the women had ulcerative STIs at first examination. Therefore, the rate of 2% was taken to represent the ulcerative STI rates of CSWs.

Genital Discharge Rate for Women Who are Not CSWs

This parameter was estimated from the Rakai, Uganda study data. Paxton *et al.* (1998) found that 7.2% of women had abnormal vaginal discharge. Therefore the parameter is estimated at 7.2% for all non-ulcerative STIs.

Syphilis Sero-positivity Rate for Women who are Not CSWs

This parameter is based on data from two Kenyan studies. One study by Temmerman *et al.* (2000) was looking at results from a family planning clinic study in Nairobi. The second study by Valadez et al (1998) was looking at rural Kenyan populations. Both studies found the rate of sero-positive syphilis to be about 2%.

Genital Ulcer Rate for Women Who are Not CSWs

This parameter is estimated based on data from the antenatal surveillance data (1991-2001). The data found that 96/10,207 women who denied having been involved in commercial sex work, had a visible ulcer on examination. Therefore the parameter chosen is 1%.

Genital Discharge Rate for ORM

This compartment is used to represent those men that work in professions that are known to carry a high-risk for HIV. A lot of data is available from many sources that describe the non-ulcerative STD presentation among high-risk occupational groups in Kenya. The Thika baseline survey that looked at touts, sand harvesters and artisans revealed that 5.5% of ORM reported to have suffered from an STI in the last month. NASCOP reports that by 1997, rates of non-ulcerative STIs in Kenyan truck drivers had increased to 32% (FHI, 1998). The East African Truck drivers study (Laukamm-Josten *et al.*, 2000) reported that 40% of ORM had an STD. In this parameter genital discharge is being measuring specifically. A study by Ng'weshemi *et al.* (1996) reported that 9% of men in Nairobi admitted to having genital discharge. Therefore, it is estimated that 9% of ORM had a genital discharge in the year 2000.

Syphilis Sero-positivity Rate for ORM

The estimate for this compartment was based on a study of Kenyan truck drivers (Jackson, 1997). This study revealed that of the men measured, about 4% were sero-positive for syphilis.

Ulcerative STI Rate for ORM

This compartment is used to represent those men that work in professions that are known to carry a high-risk for HIV. This parameter was estimated from a Kenyan study that found that ORM had an ulcer rate of 4.5% (Ng'weshemi *et al.*, 1996). Therefore, our estimate for men in the ORM population, in the year 2000, is 4.5%.

Genital Discharge Rate for Men Who are Not ORM

The rate of genital discharge was used to estimate the non-ulcerative STD prevalence of men in lower risked occupations (or no occupation) in Kenya. There was no reliable study found in Kenya to estimate the three STI risk groups, so a study from neighbouring Uganda was used as a proxy estimate (Wawer *et al.*, 1999). The study from Rakai, Uganda found that 6.5% of men had genital discharge.

Syphilis Sero-positivity Rate for Men who are Not ORM

For this category, again no reliable study was found from Kenya to estimate the syphilis rates for men who are not ORM. The rate from the Rakai estimates was considered however, it was found to be greater than the ORM category finding (Wawer *et al.*, 1999). Also in neighbouring Tanzania, the baseline study showed that about 10% of men had syphilis. Consequently, it was decided that both the ORM and non-ORM men compartments would be the same. Therefore, this group of men was estimated to have a 4% rate of sero-positivity for syphilis.

Genital Ulcer Rate for Men Who are Not ORM

This parameter was based upon data from Raiki Uganda (Wawer *et al.*, 1999). In this study, about 2.6% of the male respondents were found to have an ulcerative STI.

HIV Transmission

Two major studies were identified in the literature that assessed the transmission of HIV. The first study looked at HIV transmission by gender (Anderson & May, 1988). This study found that the transmission from male to female was twice that of female to male (0.02 versus 0.01). Another study from Uganda looked at 174 monogamous couples, in which one partner was HIV-1 positive. The researchers found that the range for the rate of transmission was overall similar to the earlier findings (Gray *et al.*, 2000). The transmission probability ranged, depending upon viral load, between 0.01% to 0.23% per act. Transmission probability was 0.41% with genital ulceration and on average 0.11 without (p=0.02). Interestingly, in the Gray study, once viral loads and STI prevalence were taken into consideration, the sex of the infected partner was not significant to the transmission of the virus. As this model is based on sex and not viral loads, and the Anderson and May results lie within the range of the Gray results, the transmission rates used will be the mean transmission rates from Anderson and May. The effect of STIs on HIV transmission rate is accounted for in the STI parameters.

HIV Transmission from Female to Male

The transmission of HIV from female to male through vaginal sex is estimated to be 0.01%. This is based on research carried out by Anderson and May (1988). Therefore, the parameter value is 0.001.

HIV Transmission from Male to Female

Again based on Anderson and May (1988), the transmission of HIV from male to female through vaginal sex is estimated to be 0.02%. The model value is 0.002.

Movement of People Between Risk Groups

These parameters describe the flows between the risk/sex compartments. The descriptions of the data on which they were based is described in the table showing the flow of people between different groups. The descriptions of the flows, their values and the sources on which the flows were based can be found in Appendix F. The movement of percentages of populations is better demonstrated when actual numbers of people per month are shown. The table in Appendix G shows the number of people that will move from compartment to compartment in each category during the first month of the study run.

These flows between the compartments allow for members of the modelled community to change their risk status as they would likely also do in real life. The *ModelMaker* population graphs shows that the population compartments remain stable and increase with population growth over time.

Intervention Parameters

Commercial Sex Workers Intervention

The parameter for this intervention is based on data from the Project, as reported in the UNAIDS/WHO report called "Consultation on STI Interventions for Preventing HIV: What is the Evidence?" (UNAIDS/WHO, 2000) as well as other Project documents. The three HIV-preventing elements that were measured included the following interventions: condom use, STI reduction and partner reduction.

Their data describe an increase in self-reported condom use to 80% "all the time" by sex workers in the intervention area. The non-ulcerative STI prevalence decreased from 60% to 10%. The ulcerative STI prevalence was estimated to have decreased by 50% (personal communication: Frank Plummer, September 16, 2002). The number of partners slightly reduced from 40 to 35 (UNAIDS/WHO, 2000).

Condoms provide an 85% reduction in HIV transmission when compared in "always" versus "never" users (NIH, 2000). Although the base model used an 80% reduction for effectiveness of condoms due to poor usage, breakage and inappropriate lubrication, the intervention parameter for Project CSWs were increased to a 90% reduction. This is due to the comprehensive teaching that the CSWs receive on the usage, storage and lubrication of condoms in the intervention cohort.

ORM Intervention

This parameter is based on the men in professions that appear to carry a high-risk for acquiring HIV. Again, this intervention involves peer counselling to promote condom use, STI reduction and partner reduction. The data is based on studies that were found in the literature. These studies were from Kenya, Malawi (25-33% reduction in HIV) and

Zimbabwe that describe the results of projects that are similar to the *Strengthening STD/AIDS Control in Kenya* Project (Jackson *et al.*, 1997; Cohen *et al.*, 1997; Celentano *et al.*, 2000). While all of the studies saw a significant reduction in at least one of the behavioural risk factors, the AMREF East African Truck Driver's study was primarily used to represent the effectiveness of the ORM intervention.

The Kenyan truck drivers' risk-reduction study followed 556 high-risk male truck drivers who work in Kenya. The study recorded a 30% decrease in reported extramarital sex ($p < 0.001$) and a 50% reduction in CSW contact ($p < 0.001$). Condom use was unchanged. Reductions in STI incidence were observed in that there was a 60% reduction in non-ulcerative STIs and a 75% reduction in ulcerative STIs (Jackson *et al.*, 1997).

An NIH literature review estimated that generally, condoms provide an 85% reduction in HIV transmission when compared in "always" versus "never" users (NIH, 2000). Although the base model used a 75% reduction for effectiveness of condoms due to poor usage, breakage and inappropriate lubrication, the intervention parameter for Project ORM were increased to an 85% reduction. This is due to the comprehensive teaching that the ORMs receive on the usage, storage and lubrication of condoms in the intervention cohort.

STI Intervention

This data is based on the findings from a study in Mwanza, Tanzania. This was similar to the STI programme that the *Strengthening STD/AIDS Control in Kenya* Project has implemented. It was a simple intervention that prepared and equipped health care workers to provide syndromic treatment of STIs. The Mwanza project demonstrated an HIV reduction of 40% in the intervention group. There was no change in condom use or number of sexual partners during the study. The follow-up showed about a 10% reduction in ulcerative STIs and about a 17% reduction in non-ulcerative STIs in the general population.

Each intervention resulted in a unique output in risk reduction for HIV. The specific changes to the risk due to the interventions is listed in the following table.

Table 5F: Intervention Parameters

Intervention	No. of Partners	Ulcerative STI	Non-Ulc. STIs	Condom Use
CSW (effects CSWs)	Reduced by 10%	50% reduction	10%	80%
OFIM (effects ORM)	# female per ORM reduced by 10% # CSW per ORM reduced by 40%	0.018	0.16%	No change
SM of STIs (effects all population)	No change	10% reduction	17% reduction	No change

Flows

Flows are the movement of the modelled community members from one compartment to another. Parameters are used to regulate the flow between the compartments. Flows are determined by mathematical equations using parameter estimates. The first flow equation below "Male Infection" has been written in full as an example. The subsequent flows are written in the model's abbreviation.

Male Infection

The flow of men from the Male Negative compartment to the Male Positive compartment is called Male Infection. This flow represents the men (those not in high-risk professions) who move from being HIV negative to HIV positive. This flow was estimated based on the following parameter equation: Moderately Risked Male negative compartment * (condom use for population males * condom effectiveness) * population contacts * different females per male * ((1- Ulcerative STD prevalence for men + ulcerative STD prevalence for Men) * non-ulcerative STD prevalence for Men * Non-ulcerative STD multiplier + Ulcerative STD multiplier * (1-ulcerative STD prevalence for Men) * (1 – non-ulcerative STD prevalence for Men)) * transmission from Females to Males * (female positive compartment) / (all Females).

Next, the men's contact with CSWs was considered and added to the risk of the flow between the compartments. The following equation describes this risk: Moderately Risked Male negative compartment * (condom use for population males * condom effectiveness) * CSW contacts * different CSWs per male * ((1- Ulcerative STD prevalence for men + ulcerative STD prevalence for Men) * non-ulcerative STD prevalence for Men * Non-ulcerative STD multiplier + Ulcerative STD multiplier * (1-ulcerative STD prevalence for Men) * (1 – non-ulcerative STD prevalence for Men)) * transmission from Females to Males * (CSW positive compartment) / (all CSWs).

CSW Infection

This flow was represents the movement of CSWs from a negative HIV status to a positive HIV status. The flow was based on the following equation that included sexual contact with both men in the general population and ORMs. CSW_infection = CSW_neg * (condomuseCSW * condomeff) * contactsCSW * DiffORMperCSW * ((1-STDprevulcCSW) * STDprevnonulcCSW * STDmultiplierNonulcer + STDmultiplierUlcer * STDprevUlcCSW + (1-STD prevulccsw) * (1-STD prevnonulccsw)) * transmissionMtoF * (ORM_pos) / (ORM) + CSW_neg*(condomuseCSW* condomeff) * contactsCSW * DiffMenperCSW * ((1-STDprevulcCSW) * STDprevnonulcCSW * STDmultiplier Nonulcer + STDmultiplierUlcer * STDprevUlcCSW + (1-STDprevulccsw) * (1-STDprev nonulccsw))* transmissionMtoF * (MRmale_pos) / (MRmales).

ORM Infection

The ORM Infection flow represents the flow of men who are in high-risk occupations that change from a negative HIV status to an HIV positive status. The flow is based on the following equation of parameters: ORM_infection = ORM_neg * (condomuseORM * condomeff) * contactsCSW * DiffCSWperORM * ((1-STDprevulcORM) * STDprevnonulcORM * STDmultiplierNonulcer + STDmultiplierUlcer * STDprevUlcORM + (1-STDprevulcORM) * (1-STDprevnonulcORM)) * transmissionFtoM * (CSW_pos) / (CSW)

The sexual contact with the non-CSW females is also considered in this flow. The following equation is added to the flow: ORM_neg * (condomuseORM* condomeff) * contactsORM*DifffemperORM * ((1-STDprevulCorm)* STDprevnonulcORM * STDmultiplierNonulcer + STDmultiplierUlcer * STDprevUlcORM + (1-STDprevulcORM) * (1-STDprevnonulcORM)) * transmissionFtoM*(female_pos) / (females).

Female Infection

The Female Infection flow represents the flow of females who are not CSWs from a negative HIV status to a positive HIV status. The flow is based on the following equation of parameters: female_neg * DiffMENperFEM * condomeff * contactspop * condomusepopF * ((1-STDprevulcfem) * STDprevnonulcfem * STDmultiplierNonulcer + STDmultiplierUlcer * STDprevUlcfem + (1-STDprevulcfem) * (1-STDprevnonulcfem)) * transmissionMtoF * (MRmale_pos) / (MRmales) + female_neg * DiffORMperFEM * condomeff * contactsORM * condomusepopF * ((1-STDprevulcfem) * STDprevnonulcfem * STDmultiplierNonulcer + STDmultiplierUlcer * STDprevUlcfem + (1-STDprevulcfem) * (1-STDprevnonulcfem)) * transmissionMtoF * (ORM_pos) / (ORM).

Male, Female, ORM, and CSW Death

The flow of people from the HIV positive compartments (CSW positive, occupationally risked male positive, male positive and female positive) into the HIV/AIDS Death compartment is guided by the death flows. All flows are based on the same parameter "deathrate". This flow is estimated based on data from a study in Uganda looking at the median times to death for people with HIV (Morgan *et al.*, 2002), median times to death for CSWs with HIV (Anzala, 1995) and the non-HIV death rate.

Calculating Flows

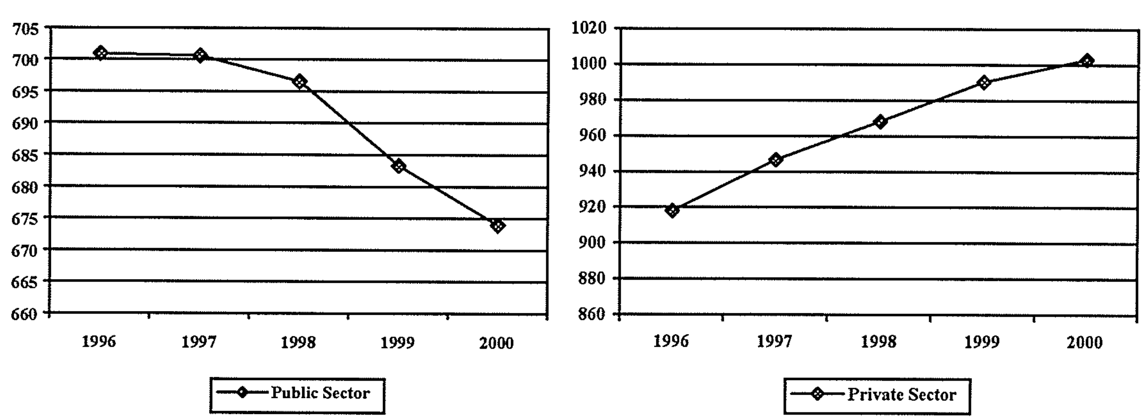
In order to accurately calculate the flow of people between HIV risk categories, a number of factors were taken into account. Firstly, the proportion of people moving out of a compartment was compared to the number moving into the compartment. The expected relative proportion of people moving in to and out of a compartment was estimated either from the economic survey (GOK, 2001b), the Project staff discussion group, Project surveys, or the Demographic Health Survey (1999).

Male Compartment Flows

These flows represent the movement between ORM and MRM risk groups. The men are grouped both by occupational risk and HIV status. These flows were calculated using trends in employment in Kenya, input from the Project staff discussion group, and the expected population growth over the next ten years.

Employment in Kenya has changed as a result of government efforts to restructure the public health sector. Data from the Economic Survey of Kenya (2000) showed that private sector jobs are increasing (+1.3% between 1999 and 2000) as the public sector jobs decrease (-1.4% between 1999 and 2000) (GOK, 2001b). This movement in employment from the public to the private sector is represented by Figure 5C.

Figure 5C: The Movement of Employment from Public Sector to Private Sector in Kenya (1996-2000) in Thousands



Source: Economic Survey 2000 (GOK , 2001b)

Many private sector jobs (especially agriculture, mining and transport) carry a higher risk for HIV. Figure 5C demonstrates a trend towards more men in the private sector and fewer in the public sector. With this trend in mind, the model was used to estimate the appropriate rate of increase in the ORM and MRM populations over the next ten years. The rate that followed the expected population increase was used to represent the flow parameters.

Therefore, it is expected that more men will move from MRM categories to ORM categories. It is also expected that movement towards ORM categories to be less pronounced in the HIV positive male categories. The population trends for each of the compartments also needed to follow the expected trends for general population growth over the next ten years.

In light of the criteria mentioned above, the flow from ORM negative to Male negative was estimated to be 0.001. The flow from ORM negative to Male negative was estimated to be 0.004. In the HIV positive category, it is expected that there would be a slightly higher number of men losing their jobs due to illness as a result of their HIV status. Therefore, the flow from ORM positive to Male positive is estimated to be 0.0048. The flow from Male positive to ORM positive is estimated to be 0.015. The table below outlines the total number of men moving from one compartment to another per month.

Table 5G: Flow of Men Between Risk Compartments

Flow (Original Number in Compartment)	Percentage Moving to New Compartment per Month	Number Moving to New Compartment per Month
MRM pos (50,089) to ORM pos (25,648)	0.008	401
ORM pos (25,648) to MRM pos (50,089)	0.015	385
MRM neg (307,691) to ORM neg (47,632)	0.0025	769
ORM neg (47,632) to MRM neg (307,691)	0.01	476

Female Flow Rates

These flows represent the movement between the CSW compartments to the non-CSW female compartments. The flows are based on information from the Alternative Economic Activities (AEA) Baseline Report for CSWs in the Western Province of Kenya (Strengthening STD/AIDS Control in Kenya, 2001), questionnaires regarding sex work and HIV status, and the Project focus group. The compartment groups also follow the expected population increases.

In a Project report of Kenyan sex workers, only 20% of CSWs claimed that they had a steady income source other than sex work. Of these, 52.6% reported that it came from their boyfriends. Therefore, less than 10% had access to a complementary source of income. In times of emergency, over 63.4% of the women claimed that they were completely unable to raise support from anywhere. Therefore, it is very unlikely that many women would be able to stop sex work, even if they knew that they were HIV positive or became ill with AIDS. Unpublished data from Kenya (ICROSS, 2002) also found that CSWs rarely take breaks from sex work, even when they are very ill and aware of their HIV status. Strengthening STI/AIDS Control staff members observed that many women work as CSWs even up to the week of their death. Women who are unwell due to HIV-related illnesses are unlikely to be hired elsewhere. The discussion group reported that the cycle of sex work is difficult to break and most women who enter sex work continue in the profession at least part-time for their entire lives.

The flow of women into sex work is estimated to be higher than the flow of women out of sex work. Given that even very ill CSWs continue sex work, it is estimated that the flow from CSW positive to non-CSW female positive is lower than the flow in the opposite direction.

Table 5H: Flow of Women Between Risk Compartments

Flow (Original Number in Compartment)	Percentage Moving to New Compartment per Month	Number Moving to New Compartment per Month
FEM pos (50,653) to CSW pos (15,731)	0.005	304
CSW pos (15,731) to FEM pos (50,653)	0.012	189
FEM neg (311,156) to CSW neg (15,731)	0.001	311
CSW neg (15,731) to FEM neg (311,156)	0.005	79

Variables

Variables are the outputs of modelling HIV transmission in the hypothetical community. These were grouped so that different aspects of the dynamics of the population could be observed. Some of the variables that were assessed were the following: CSW prevalence, total males, ORM incidence rate etc. In fact, using the variables, prevalence and incidence rates could be measured for any compartment, over any length of time.

Incidence

Incidence is measured by counting all of the new cases of HIV that occur over a model run. All of the new infections per round are measured. This measured by the following equation: round (CSW_infection + female_infection + ORM_infection + MRM_infection). Cumulative incidence is calculated so that the incidence over the run of the studies can be easily compared.

Prevalence

Prevalence is the total percentage of the population in the model that is HIV positive. This variable was further broken down into female and male prevalence. Prevalence for the whole population is measured by the following equation: (OccRiskMen_pos + MRmale_pos)/totalmales + (CSW_pos+female_pos)/totalfemales.

Refinement of the Model: Adjusting the Total Number of Sexual Acts of Men and Women in Nairobi

The initial model runs yielded first estimations of reported sexual acts showing that women had reported fewer sexual contacts than men (6.7 million verses 8.5 million). The sexual activity that was reported by women in Kenya is described in the Table 5I below.

Table 5I: Reported Monthly Sexual Activity: Female

Female Group	Paid (part * freq * pop)	Unpaid (part * freq * pop)	Total
CSWs	(20 * 3 * 31462) = 1,887,720	(0.6 * 8 * 31,462) = 151,018	2,038,738
Non-CSWs	0	(1.07 * 12 * 361,809) = 4,645,628	4,645,628
Total			6,684,366

Source: Model data with inputs from the DHS, 1999

Men reported sex acts with both women who were CSWs and women who were not CSWs. The following table describes their reported sexual behaviour.

Table 5J: Reported Monthly Sexual Activity: Male

Male Group	CSW	FEM	Total
ORMs	(1.35 * 5 * 73,280) = 949640	(2 * 8 * 73,280) = 1,172,480	2,122,120
Non-ORMs	(1.05 * 3* 357,780)= 1,127,007	(1.5 * 12 * 357,780) = 6,440,040	6,440,040
Total			8,552,160

Given the discrepancy in the outcome of the reported sexual frequency, it was decided that a compromise on the overall sexual behaviour estimations would have to be made. Therefore, the parameters were adjusted to match the most likely responses (CSWs for all CSW sex and men for all unpaid sex) and used the female parameters to determine the demand and supply of sex. The result was that the current number of sexual acts was now equal for men and women. The adjusted parameters also maintain the most likely sexual frequencies, as collected from the literature.

Unfortunately, by basing the sexual frequency on only the female groups, the sex between CSWs and long-term partners verses paid partner behaviour was not measured. It was the researcher's original intention to include this dynamic. However, the current model was able to capture sexual behaviour with the male categories available: ORM and MRM.

Some of the parameters were modified slightly to comply with the goodness of fit of the model over a longer time period (ten years). For example, it was revealed that the flow of females to the CSW compartment was most likely 0.003 in order to maintain the appropriate population levels in each compartment over time. This allows for the model to maintain population equilibrium that mimics what is seen in reality. The following table lists the parameters that were inputted into the model.

Table 5K: Sexual Contact Parameters Chosen

Female Group	Parameter Chosen (Over one month)
Different Men per Female	1.5
Different Men per CSW (incl. Partners and non-ORM)	3
Different ORM per Female	0.4
Different ORM per CSW	14

The model now has equal numbers of sex acts for men and women. Clearly within the different risk compartments, the CSWs and ORMs are having more frequent sex, but overall the partnerships are matched (1 man: 1 women).

The Movement of Intervention Populations in and out of the Compartments

In the initial model, there was a movement of people between the groups from higher to lower risk and from lower to higher risk. This allowed a woman to become a sex worker or quit sex work over the course of the model time period and a man to become an occupationally risked man who was once a moderately risked man etc. In the intervention compartments of the intervention models, the same movement occurs. People can move into the intervention groups and out of the intervention groups as they are recruited into the programme. The following table outlines the movement of new people into the ORM project intervention group and the CSW project intervention group.

Table 5L: Equilibrium of Project Compartment Groups

Programme	Movement over 1 month	Movement over 1 year
CSW	32-42	454
ORM	58	731

There is clearly a higher rate of new men entering the programme in the ORM groups than the women's groups. This is because the men are highly mobile (especially the military and prisoners. Therefore, a greater number of new recruits are seen over the one-year period. Impacts of the different numbers of new recruits into each of these programmes are discussed in the Sensitivity Analysis chapter.

The SM of STI programme was not included in the table above. This is because the SM project strengthens the overall health care for all people seeking treatment of STIs. The impact of intervention is seen in the entire population.

The interventions yielded a variety of outcomes. Changes were made to the intervention group's number of partners, STI prevalence, condom use, and condom using the results from past studies. Those outcomes are outlined in the table below.

Table 5M: Changes to the Model Parameters for Intervention Participants

Intervention	Change in number of partners	Change in ulcerative STIs	Change in non-ulcerative STIs	Change in Condom Use	Change in condom effectiveness
CSW (UNAIDS/ WHO, 2000)	10% reduction	Decreased by 50%	Decreased by 10%	Increased to 80%	Increased to 85%
OFIM (Jackson *et al.*, 1997)	40% reduction	Decreased to 1.8%	Decreased to 16%	No change	No change
SM of STIs (Grosskurth *et al.*, 1995)	No change	10% reduction	17% reduction	No change	No change

The models were changed to reflect the decrease in risk that occurred as a result of the interventions. Now that the models were created and fed with the data, the researcher needed to collect information on the cost of the interventions.

Summary of the Parameters

The parameters are based on information from various sources. The parameter sources were deemed to be the most accurate picture of the situation in Nairobi for the year 2000. Below is a table that outlines the population parameters and their sources.

Table 5N: Population Parameters

Parameter	Number in Model (per month)	Source
% of Women who are CSWs	8%	➢ 6.17% of pregnant women- (Strengthening HIV/STD Control in Kenya, 2000) ➢ 12.7% of urban women- Kenya (DHS, 1999) ➢ 8% (Discussion group with Project staff)
CSW, HIV+ population	30%	Fonck et al, 2000
CSW, HIV- population	70%	UNAIDS/WHO, 2000
Female, HIV+, population	14%	GOK 2000
Female, HIV-, population	86%	GOK 2000
% of men who are ORM	17%	Economic Survey (GOK, 2001)
ORM, HIV+, population	20%	Mbugua et al, 1995
ORM, HIV-, population	80%	Mbugua, 1995
Male, HIV+, population	14.4%	GOK 2000
Male, HIV-, population	85.6%	GOK 2000

The parameters that represented the condom effectiveness and sexual contacts were also estimated. These estimates and their sources are listed in the following table.

Table 5O: Condom Effectiveness and Partner Contacts

Parameter	Monthly Number in Model	Sources
Condom effectiveness	80%	➢ reduction in HIV transmission when compared in always verses never users (NIH, 2000) ➢ Strengthening HIV/STD Control in Kenya, 1999
Condom Use CSWs	22.75% condom use	Strengthening HIV/STD Control in Kenya, 1999
Condom Use females	7% condom use	➢ 5.5% during last intercourse (Kenya DHS, 1998) ➢ condom use last 3 months 10%(Strengthening HIV/STD Control in Kenya, 1999) ➢ On-going data collection from women in Nairobi less than 10% (Dr. E Bukusi, 2002)
Condom Use ORMs	10% condom use	Strengthening HIV/STD Control in Kenya, 1999
Condom Use males	21% condom use	21% during last intercourse (Kenya DHS 1998)
Sexual Contacts for regular couples	12	➢ 3-4 times per week based on interviews with gynaecological patients in Kenya (Expert opinion- Kimani and five other Kenyan doctors 2002) ➢ 2-3 per week. On-going data collection from women in Nairobi (Dr. Bukusi, 2002) & Moses *et al.*, 1994
Number of different men-women	1.5	WHO country update 2000
Number of different ORM-women	0.4	ICROSS 2002- unpublished
Sexual Contact per client for each -CSW	5	➢ Strengthening HIV/STD Control in Kenya, 1999 ➢ Discussion group with *Project* Staff, 2002 ➢ Fonck *et al.*, 2000
Number of different ORM-CSW	14	Strengthening HIV/STD Control in Kenya, 2002
Number of different regular partners-CSW	3	ICROSS (2002)

Parameters were also estimated for the prevalence of STIs and the rates of transmission of HIV associated with sex with and without the presence of STIs. Table 5P lists the parameters chosen and their sources.

Table 5P: STI Prevalence and Transmission Implications

Parameter	Number in Model (per month)	Source
HIV transmission F to M	0.001	➢ Anderson and May, 1988 ➢ Gray RH, *et al.*, 2001
HIV transmission M to F	0.002	➢ Anderson and May, 1988 ➢ Gray RH, *et al.*, 2001
Genital discharge multiplier for HIV transmission	2.58	Deschamps, 1996
Syphilis (sero-positive) multiplier for HIV transmission	3	Deschamps, 1996
Ulcerative STD multiplier for HIV transmission	6.82	Deschamps, 1996
Ulcerative STD prevalence-CSW	2%	Fonck *et al.*, 2000
Syphilis (sero-positive) - CSW	6%	Fonck *et al.*, 2000
Genital discharge prevalence-CSW	22%	Fonck *et al.*, 2000
Ulcerative STD prevalence-female	1%	➢ Srenthening HIV/STD in Control Kenya 1991-2000 ➢ Daly *et al.*, 1994 ➢ Richardson *et al.*, 2001
Syphilis (sero-positive)-female	2%	➢ Temmerman *et al.*, 2000 ➢ Valadez *et al.*, 1999
Vaginal discharge prevalence-female	7.2%	Paxton *et al.*, 1998
Ulcerative STD prevalence-ORM	4.5%	Ng'weshemi *et al.*, 1996
Syphilis (sero-positive)- ORM	4%	➢ Jackson *et al.*, 1997 ➢ Grosskurth et al, 1995
Genital discharge prevalence-ORM	9%	Ng'weshemi et al, 1996
Ulcerative STD prevalence- male	2.6%	Wawer *et al.*, 1999
Syphilis (sero-positive)- male	4%	➢ Jackson *et al.*, 1997 ➢ Grosskurth et al, 1995
Genital discharge prevalence-male	6.5%	Wawer *et al.*, 1999

CHAPTER SIX: **MEASURING COST**

There are several ways to measure the costs of HIV prevention interventions. In the case of this analysis, a CEA was performed from the perspective of the provider. This means that all costs incurred by the provider as well as donated items were measured and accounted for. Costs such as those for the transportation of the intervention's consumers were not directly considered except in the case of the CSW and ORM peer intervention where stipends for travel were included (only provided when out of work and off-site time was used). The modelled effectiveness for each intervention in the Nairobi population (that is attributable to each project) will be divided by the total cost of each programme. This will yield a cost per case of HIV averted ratio.

In order to work out the rates of the different currencies, exchange rates were identified and the costs were converted. Some of the costs were in shillings, while others were originally in US or Canadian dollars. For the US rate, the average exchange rates for the year 2000 according to the Central Bureau of Statistics for Kenya were used (76.2 KSh per US$). For the Canadian rate, the project had rounded the average exchange rate to 45 Kenyan shillings per Canadian dollar. This figure was used to maintain consistency with the Project's own conversion rate.

Cost of Condoms

The Government of Kenya donates the condoms that are distributed by the Project. These condoms were purchased with money borrowed from the World Bank. This loan covered all the condoms that were required during the year 2000. This loan money ran out in July 2001. A German aid agency procured the condoms on behalf of the GOK and found what they considered to be the best deals from a variety of condom makers. The cost of 300 million condoms was US$10 million (personal communication, Dr. Chebet, NASCOP). This means that the average cost of the condoms issued by the Government of Kenya in 2000 was 3.3 US cents. The condoms are supplied to the project target groups at no charge. The researcher also visited PSI in Nairobi (an international NGO supplying 20 million "Trust" brand condoms annually to Kenyans at a subsidised price). PSI confirmed NASCOP's estimate as they provided a similar cost of the condoms. PSI estimated that it cost them 3 US cents per condom to bring them into Nairobi (personal communication David Walker, April 18, 2002). PSI sells their condoms all over the country in retail stores at three condoms for 10 Kenya shillings.

Cost of STI Treatment

There are many different STIs in Kenya. The treatable STIs or symptoms that were most commonly treated by project staff included vaginal discharge, urethral discharge, pelvic inflammatory disease and genital ulcer disease. Flow charts provided by the Project show the most common syndromes and treatments for STIs in Kenya. These are based on the National STD Treatment Guidelines of Kenya and are included in flow charts (adapted from WHO SM flow charts) so that trained health workers can use syndromic management to treat STIs and prevent further spread. The Government of Kenya considers all STI drugs "essential" and distributed them to the project for free in the year 2000. The drugs and the treatment are in turn given to the patients for free. Overall, the supply of drugs cost US$ 2 million for the nation and the population served was 1,320,000 (personal communication, Dr. Chebet, NASCOP). Therefore, the average cost of STI drugs to the Kenyan government in the year 2000 was US$ 0.66 per patient.

Cost of a Nurse's Salary

In order to run the STI treatment centres, trained nurses must be present. The nurses are trained in SM of STIs and in counselling. The salaries for municipal council employees range from 10,625 shillings to 17,405 shillings per month. The average salary for nurses in STI clinics is 13,765 shillings per month or 165,180 shillings per year.

Cost of Needles and Syringes

When antibiotics are given for GUD, needles and syringes are used. Nurses reported using 10cc syringes with 21 gauge needles. The needles and syringes come together in sealed packages, ready for use. According to the Kenya Medical Supplies Agency, the needles and syringes that are used in the STI clinics cost US$0.04, or 4 cents each or 3 shillings each. This wholesale, bulk price is much less expensive than the retail price at local pharmacies. At a dispensary in Nairobi, to buy the needle is 4 shillings and the 10cc syringe is 20 shillings. The cost of the needles and syringes for the STI clinics is therefore 4 cents each.

The Cost of Alcohol, Cotton and Disinfectant

In order for injectable antibiotics to be given, the skin must first be cleaned with a cotton swab dipped in alcohol. The cost of the swabs and alcohol were attained from the Special Treatment Centre STI clinic budgets. The Special Treatment Centre is located in Nairobi. Disinfectant must also be used to clean the STI treatment office daily and the treatment couch between patients. The cost of this disinfectant was also attained from the Special Treatment Centre STD clinic budgets. Together, the alcohol and swab cost 0.74 of a shilling.

The Cost of Syndromic Management Flow Charts

The Government of Kenya created the SM flow charts for treatment of STIs nationally. These are based on the National Guidelines for STD Control and modelled after the WHO syndromic management flow charts. It was estimated that the flow charts cost the government 20 shillings each to produce but were often photocopied for three shillings (personal communication, Dr. Chebet, NASCOP). This means that you could buy just over two originals for one Canadian dollar or 15 copies for one Canadian dollar. Every person trained in SM was given one original and two copies of flow charts (personal communication, Aine Costigan, *Strengthening HIV/STD Treatment in Kenya*). The researcher saw syndromic management flow charts at all STI treatment sites that were visited in Nairobi. This means that the cost of flow charts per person trained in SM was 26 Kenyan shillings.

The Cost of Training Materials

For each of the projects, training materials needed to be developed in order to update and inform the staff and volunteers. The Project developed all training materials for use in their projects in the form of teacher's manuals. The training manuals are also shared with other groups that run similar programmes. Every TOT trained was given a manual.

Each manual cost 500 shillings to print in 1999. Overall 1,000 syndromic management manuals were printed and 1,000 counselling manuals. The other manual, the peer leader manual is an informal, 70-page manual that changes constantly and is photocopied. It is expected that 1,000 of each of the manuals will be used in projects over the five years and the excess will be sold at cost price. The cost of photocopying the peer counsellor manual is 234 shillings or $5.20 each.

Manuals

The three manuals that are used for training in the Project are the Peer Leader's Manual, the Counselling Manual and the Syndromic Management Manual. Below is a description of the three manuals, the programmes that they are used for, and other information.

Table 6A: Usage, Revision and Printing of Manuals

Manual	Who Uses it?	When was it revised?	Next revision?	How many manuals were printed?
Peer Leader's Manual	TOTs, Peer leaders, VCT	1997	2002	Copied on demand
Counselling Manual	All sites, KMTC, and sold	1997	2002	1,000
Syndromic Management Manual	TOTs, health care workers and sold	1999	2004	1,000

Project staff and consultants developed the manuals. Manuals are given to TOTs during their training to be used as a resource for future meetings that are then lead by them. The plan is to update the manuals every five years. The syndromic management manual is updated when the flow charts are updated.

Dividing the Costs of Training Materials between the Programmes from the Five Year budget for 1996-2001

While the five-year budget goes back to 1996, the Project only began to measure budget by activity in 1999. As the training needs differ by years, it was decided to take the overall training costs of the entire phase of the Project and divide them by the number of projects that the training covered (five). This included the total cost of curriculum and material development. The training materials (costing Can$465,000) were expected to last at least six years and were shared between eight Project programmes within the STI project (OFIM, two CSW projects, two STI projects, VCT, KMTC and AEA) and 15 other programmes in Kenya (Strengthening STD/AIDS Control in Kenya, Report to CIDA: April 1999-March 2000). The cost per project would then be $20,217 over five years. The three projects that this project was concerned with (OFIM, Nairobi original sites CSWs and Nairobi STI treatment) are then thought to have spent $4,043 per year on training materials.

The Course Delivery Costs

In the year 2000, the cost of training 10 peer leaders was 32,474 shillings or Can $721.64. This means that each peer leader trained cost $72.16 each. The cost of training 30 TOTs in the year 1999 (no TOTs were trained in the year 2000) was Can $4,200. This means that the cost per TOT trained was $140. The training and refresher training of TOTs and peer leaders takes place every 5 to 6 years. As the training is expected to last at least five years, the annual cost of training a peer leader is $14.32 and TOT training costs $28 per year.

Table 6B: Cost of Training Peer Leaders and TOTs

Programme	OFIM	CSW	STD
Cost per curriculum and Material development per 1 year	$7,650	$7,650	$7,650
Cost of course delivery per 1 year for peer leaders	$801.92	$1,575.2	$11,155.28
Cost of course delivery per 1 year for TOTs	$700	$280	$252
Number of peer leaders trained	56	110	779
Number of TOTs trained	25	10	9

Cost of a Meeting Place

The groups meet at different places every time they get together. It is usual practice for the groups to meet at the health clinics and then find space where it is available. Meetings attended by the researcher included both outdoor and indoor venues. Locations varied including benches outside the clinic and a tiny District Commissioner's office where over 20 people sat on desks. At one time, the CSWs had rented an office to use for meeting and administrative purposes. However, due to harassment from thieves and police, the women decided that meeting informally at different, unpredictable places made more sense. Given the various locations and the informal nature of their meeting places, it was decided that meeting space would not be considered in the cost analysis. The ORM met at their workplaces or at their work places or at the prison (for inmates) during breaks from work. The STI treatment space was an actual fixed office, and therefore this cost was included in the analysis. The STI treatment space was provided by the local clinic as a part of their usual care. The estimated annual rental costs of a similar space would be 5,000 shillings (personal communication with Mary Pere, nurse in charge of Thika STI programme University of Nairobi and Charity Chenge, nurse in charge of STI clinic, Thika). This cost was confirmed during the focus group.

For calculating the budgets and the outcomes, the fiscal year 2000 that ran from April 2000 to March 2001 was used. This was necessary as the project measures its cost and outcomes in this way and dividing the year into the actual calendar year would have caused inaccuracies.

Project Management/Operational Costs

There are a number of costs that are shared by all of the projects such as management, vehicles and maintenance, phone etc. The project also provides 15% of the University of Nairobi's administrative overhead for the use of their office space, and the provision of water, electricity, and security. Salaries for a number of University of Manitoba staff on long-term field assignments were also included in the analysis. These staff members were the part-time (0.6) project manager, a full time community development and training expert, a part-time (0.2) monitoring and evaluation expert, and half-time STD specialist. The cost of providing benefits for these positions was also included.

The Project costs were divided between eight sub-projects (OFIM, two CSW projects, two STI control projects, VCT, KMTC and AEA). The total operational costs for the year 2000 was Can$500,595.15 or KSh 22,526,780. Therefore, one eighth of this amount was charged to each of the three projects. The operational and equipment cost for each of the interventions measured was estimated to be to $62,574. The following table outlines the overall operational and equipment costs of the Project. Table 6C shows the costs in both Canadian dollars and Kenyan Shillings.

Table 6C: Overall Operational and Equipment Costs

Expenses	4/2000-3/2001	CAD1=45Ksh.
Office Expenses/Supplies/Stationery	45,490.85	1,010.91
U of M Salaries and Benefits	16,725,690	371,682
University of Nairobi Salaries + Gratuity	1,018,711.00	22,638.02
Fuel-Vehicles	278,006.45	6,177.92
Vehicle Maintenance	53,807.75	1,195.73
Vehicle Insurance	170,842.00	3,796.49
Phone/Fax	269,276.70	5,983.93
E-Mail	145,200.00	3,226.67
Computer Maintenance	35,500.00	788.89
Photocopier Maintenance	112,700.00	2,504.44
Equipment Insurance	50,000.00	1,111.11
DHL Courier	40,000.00	888.89
Project Salaries/Gratuity/OT/Allowances	2,702,500.50	60,055.57
15% U of N Admin. Overhead	152,806.00	3,395.69
Medical Insurance	525,000.00	11,666.67
Strategic Planning Meeting	150,000.00	3,333.33
Miscellaneous/Other	51,250.00	1,138.89
Total operational expenses	22,526,780.4	$500,595.15
Expenses per programme	**2,815,848**	**$62,574**

Included in the costs of operating and managing the projects is the cost of local U of N staff. There are both support staff and clinical staff. One staff member is assigned to oversee each of the projects. This staff member is usually a nurse or a midwife with counselling experience. The Project office is located at Kenyatta National Hospital, in Nairobi, in the departments of Medical Microbiology and Community Health. The project covers part of the U of N administration costs in exchange for the use of these rooms.

Occupationally Risked Men Costs

The ORM project trained 42 new peer leaders in the year 2000. Overall, nine community groups were active during the year. Three barazas (public meetings) were also held to promote the intervention, encourage commitment and to teach about HIV prevention. Overall 3,015 men were included in the intervention. This number is based on reports from each of the TOTs responsible for groups in the project as well as former reports to the Project (Annual Report 1999-2000 and Annual Report 2000-2001). The ORM intervention participants distributed 95,596 condoms and 122 men were referred for STD treatment.

The total budgetary costs for the ORM intervention was Can$89,240, including $62,574 for management costs, $21,187.80 for project costs and $5,478.26 for donated items. Therefore the overall ORM project total is Can$49,747.65. Dividing the total number of men reached (3,015) by the overall costs will give the process indicator: "cost per man in the intervention". This cost was shown to be 639 shillings or $29.60 Canadian.

Of interest to this project however, is the cost per case of HIV prevented. Therefore, the effectiveness data modelled from the behavioural and prevalence parameters was used to calculate a cost per case averted of HIV. Next, the estimated number of cases of HIV that were attributable to the project intervention was divided by the total cost of the project. This yielded a cost per case of HIV averted ratio. This finding will be further discussed in the Results chapter.

Table 6D: Occupationally Risked Men Peer Intervention Costs- Project Budget

	Expenses Budgeted For	4/2000-3/2001 KSh	CAD (=45Ksh)
Occupationally	TOT/Project Meetings	57,504	1,277.87
Risked Men	TOT/Peer Meetings	73,510	1,633.56
(Project Budget)	Cost per curriculum and Material development per 1 year	344,250	7,650
	Cost of course delivery per 1 year for peer leaders	36,086	801.92
	Cost of course delivery per 1 year for TOTs	31,500	700
	Evaluation	10,250	227.78
	Baraza x3	400,350	8,896.67
Project Sub-Total		953,451	21,187.80

Table 6E: Occupationally Risked Men Peer Intervention- Total Costs

	Expenses Budgeted For	**4/2000-3/2001 KSh**	**CAD$ (=45Ksh)**
Donated Items	STD Drugs (122 * US$ 0.66 = US$ 80.52) 1 USD = 76.2 Ksh	6,135.62	136.35
	Condoms (95,596 * US$ 0.033 = US$ 3,154.67) 1 USD = 76.2 Ksh	240,385.85	5,341.91
	Meeting Space	0	0
Donated Sub-Total		246,521.47	5,478.26
Project Sub-Total		953,451	21,187.80
Operational/ Management Sub-Total		2,815,848	62,574
Total		**4,015,803**	**$89,240**

CSW Peer Interventions Costs

CSW interventions have existed in this area since 1982 and are well established. Bi-monthly meetings were held with the TOTs and approximately 1,929 women attended each meeting. Ten peer leaders were trained, with 97 peer leaders attending a "harmonisation meeting". Peer group meetings were held monthly. NGO networking took place in the form of collaborating with other NGOs working in the areas with CSWs. This entailed meeting to share ideas at the Kenya AIDS NGO Consortium. The costs of NGO networking were made up from extra staff time, presentations, travel and holding a workshop. Re-mapping also took place. This involved geographic changes in the management and supervision boundaries of the CSW interventions. The project previously had four zones. This was increased to seven.

Travel reimbursement was given to the TOTs and the peer leaders (approximately 100 shillings) to cover the expenses of the CSWs' time and travel (all of the women had walked to the meeting). The Project also provided refreshments at these meetings and all of these costs are included in the cost of the meetings.

A baraza (community meeting) was held to bring all of the women together, provide information, and promote new membership and retainment of existing members. Overall, more than 2,000 women attended the barazas. 1,929 women were enrolled in the project in the year 2000. During the year 247,140 condoms were distributed by the CSWs in the project areas in Nairobi. The peers (those who were trained in SM of STIs) also referred a total of 61 women for STI treatment.

The total budgetary cost for the CSW Peer intervention was Can$99,523. Of this amount, $62,574 were management costs, $12,843.84 were project costs, and $13,878.35 were donated costs. The cost per each of the estimated 5,000 CSW reached in 2000 was Ksh 896 or Can$19.90.

Table 6F: Commercial Sex Worker Peer Intervention Costs- Project Budget

	Expenses Budgeted For	**4/2000-3/2001**	**CAD1=45K sh.**
CSW Interventions	TOT Bi-monthly Meetings (including travel reimbursement)	2,597	57.71
(Project Budget)	Peer Monthly Meetings (including travel reimbursement)	172,800	3,840
	NGO Networking	36,000	800
	1 Day NGO Sensitisation Meeting	52,300	1,162.22
	Cost per curriculum and Material development per 1 year	344,250	7,650
	Cost of course delivery per 1 year for peer leaders	70,884	1,575.2
	Cost of course delivery per 1 year for TOTs	12,600	280
	Re-mapping	37,000	822.22
	Baraza	309,750	6,883.33
Sub - Total		*1,038,181*	*23,070.68*

Table 6G: Commercial Sex Worker Peer Intervention- Total Costs

	Expenses Budgeted For	4/2000-3/2001 KSh	CAD$ (=45Ksh)
Donated Items	STD Drugs (61 * US$ 0.66 = US$ 40.26) 1 USD = 76.2 Ksh	3,067.81	68.17
	Condoms (247,140* US$ 0.033 = US$ 8,155.62) 1 USD = 76.2 Ksh	621,458.24	13,810.18
	Meeting Space	0	0
Project Sub-Total		1,038,181	23,070.68
Donated Sub-Total		624,526.05	13,878.35
Operational/ Management Sub-Total		2,815,848	62,574
Total		**4,478,536**	**$99,523**

SM of STI Costs

The STI Treatment intervention includes the training of nurses at STI clinics to recognise the signs and symptoms of a number of different STIs in both men and women, and to treat them according to the government approved SM algorithms. Although there is a lot of turn over in staff, the project attempts to keep at least two nurses trained in SM in each of the clinics serving the area. This means that ten trained nurses are in the project area during the year. The clinics each have one full-time position for STI management that is covered by two nurses. When the nurses are not in the clinic, she/he is off duty or working in the regular clinic. Clinics are open Monday to Friday. All five of the STI clinics are part of the general health clinics. None are free-standing clinics.

The Ministry of Health pays the nurses' salaries. The cost of each STI SM Clinic nurse's salary is included in this analysis. A nurse working in an STI clinic is rated on the government pay scale as either a seven or an eight. This means that she/he would be paid between 10,625- 17,405 KSh per month. The average of this pay scale is KSh 165,180 per month. In all the clinics, there are five full-time nursing salaries dedicated to STI treatment each year, the average cost of nurses' salaries is KSh 825,900 (personal communication, Anne Gikuni 28/11/01).

Costs for the donated items such as gloves and disinfectant were retrieved from overall city-wide budgets from the Nairobi STI Health Management Board 2001 (this is where the supplies were distributed from) and divided by the number of patients that were served by the budget that year (29,664 patients). The cost was then multiplied by the number of clients who were served by the intervention sites (6,637), or the number that had GUD and required gloves and injections (1098).

No health care workers were trained in Nairobi that year. For the Strengthening STD/AIDS Control in Kenya Project, the direct project costs are limited. However, the costs of the STI treatment and the condoms that are paid for by the GOK are counted in this analysis. STI treatment is administered by the National AIDS Control Programme (NASCOP), but are funded by international donors. The Ministry of Health's medical stores supplied the condoms. In Nairobi, the intervention directly treated 6,875 people and distributed 64,133 condoms in the year 2000.

The goal of the intervention was to strengthen the health care system to respond to STIs through SM. The number of participants that were served by Project supported STI clinics (6,637) in the year 2000 was measured. The number of people who received SM of STI treatment at other government STI facilities that also benefited from the SM training was also measured (29,664). However, given the widespread training of health care professionals from pharmacists to non-Project nurses, it is impossible to estimate accurately how many other people benefited from the intervention.

The total budgetary cost for the SM of STI intervention was Can$119,250. This cost was distributed between the following categories: $62,574 was management costs, $19,662.24 was project costs, and $37,013.75 donated costs. The cost per each of the estimated 6,875 STI patients reached in 2000 was 781Ksh or Canadian $17.35.

Table 6H: SM of STI Costs- Project Budget

	Expenses Budgeted For	**4/2000-3/2001**	**CAD1=45K sh.**
Strengthen STD-related	Surveillance	27,223	604.96
	Cost per curriculum and Material development per 1 year	344,250	7,650
	Cost of course delivery per 1 year for peer leaders	501,987.60	11,155.28
services in Nairobi	Cost of course delivery per 1 year for TOTs	11,340	252
	Sub-Total	884,801	19,662.24

Table 6I: SM of STI- Total Costs

	Expenses	4/2000-3/2001 KSh	CAD$ (=45Ksh)
Donated Items	STD Drugs (6,875 * US$ 0.66 = US$ 4,537.50) 1 USD = 76.2 Ksh	345,757.50	7,683.50
	Condoms (64,133 * US$ 0.033 = US$ 2,116.39) 1 USD = 76.2 Ksh	161,268.92	3,583.75
	Nurse's salary (165,180 x 5)	825,900	18,353.33
	Flow Charts (26 shillings each x 10)	260	5.78
	Cotton Wool (0.42 shilling each x 1098)	461.16	10.25
	Alcohol (0.32 shilling each x 1098)	351.36	7.81
	Syringes/Needles (3 shillings each x 1098)	3,294	73.20
	Gloves (18 shillings each x 1098)	19,764	439.20
	Disinfectant (1.29 shillings each x 6,637)	8,561.73	190.26
	Treatment Space (5,000 pm)	300,000	6,666.67
Donated Sub-Total		1,665,619	37,013.75
Project Sub-Total		884,801	19,662.24
Management/Operational Sub-Total		725,136.41	62,574
Total		**5,366,250**	**$119,250**

It is interesting to note that the CSW intervention was more expensive than the ORM intervention. The main difference in the overall cost of the two projects was due to the larger number of condoms used in the CSW project. Clearly, the SM of STI intervention was the most expensive. This is mostly due to the higher costs of training, the nurses' salaries and STI drugs. The total cost for each programme in Canadian, Kenyan and US funds is listed below.

Table 6J: Total Programme Cost, by Intervention

Intervention	Cost in Can$	Cost in KSh	Cost in US$
CSW	$99,523	4,478,536	$58,773
SM of STI	$119,250	5,366,250	$70,423
ORM	$89,240	4,015,803	$52,701

The Cost per Person Reached by Each Intervention

The cost per person reached is a process indicator that looks at the cost of including someone from the target population person in each intervention. The table below lists the numbers reached and the cost per person (in both Kenya Shillings and Canadian dollars).

Table 6K: Process Indicator- The Cost per Person Reached by Each Intervention

Project	Number Reached	Cost per person reached (KSh)	Cost per person reached (Can$)
CSW Peer Intervention	5,000	896	19.90
STD Treatment	6,637	809	17.97
ORM Peer Intervention	3,015	1,332	29.60

It is interesting to note that the projects all carried similar costs per person reached, with ORM interventions being the most expensive. The cost per ORM reached is higher because fewer men were involved in the overall project, than in the other two interventions.

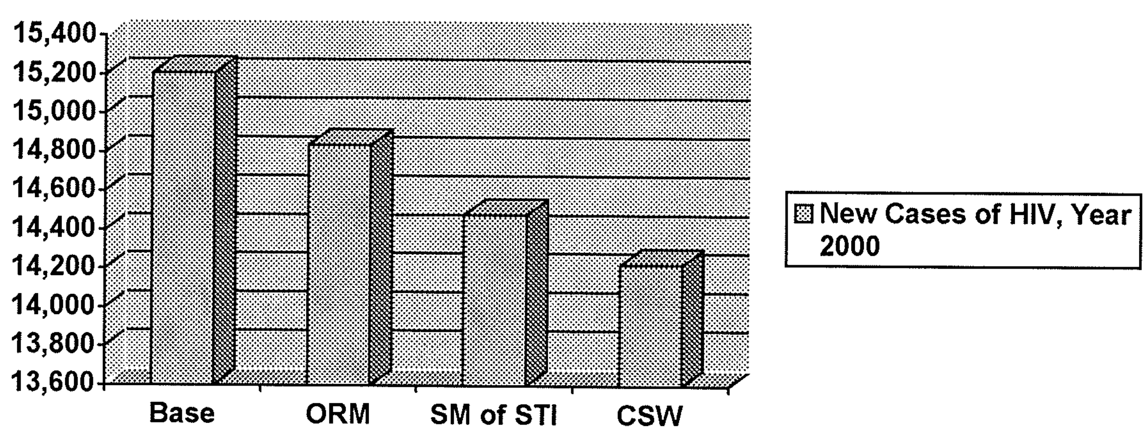
CHAPTER SEVEN: **THE RESULTS**

While the main question of interest for this project was, "What are the costs of averting a single case of HIV using each of the interventions?" a number of other interesting results were yielded as well. These included the HIV incidence for Nairobi over one year, the cases of HIV that were averted due to the interventions, gender differences in the cases of HIV averted, and the cost per DALY averted. These are the results for the year 2000, unless otherwise specified. The results are listed in Canadian dollars, unless otherwise described.

HIV Incidence Rates for Each Model Run

Each of the models yielded a different number of new cases of HIV over the year 2000. Those rates were the numbers that were subtracted from the base to give us a measure of effectiveness. The figure below shows the number of new cases of HIV in each of the models.

Figure 7A: Number of New Cases of HIV in Each of the Models



Cases of HIV Averted

The number of cases averted measures the overall preventive effectiveness of each of the three programmes. It was found that all three of the interventions measured resulted in a notable annual number of cases of HIV averted. Table 7A lists the actual number of cases of HIV averted. For each intervention model, the effectiveness was calculated by subtracting the number of new cases of HIV in the year 2000 in the intervention model from the base model (the model without any project intervention).

Table 7A: Cases of HIV Averted by Intervention

Project	Number of Cases of HIV Averted
CSW Peer Interventions	983
SM of STIs	787
Occupationally-Focussed Interventions for Men	369

The CSW peer intervention project yielded the highest number of cases averted overall with 983. Next, the syndromic management of STIs project resulted in 787 cases averted. Lastly, the occupationally focussed intervention was estimated to have averted 369 cases. These numbers suggest that a large number of cases of HIV (well over 2,000) were averted in Nairobi in the year 2000 as a result of the University of Manitoba/University of Nairobi programmes.

<u>CSW Peer Interventions</u>

The programmes that aim to avert cases of HIV through reduction in risky sex between CSWs and their partners were shown to reduce the largest number of cases of HIV of the three interventions measured. This is due to impact made by risk-reduction behaviour change that was seen in this population. The 5,000 CSWs involved in the intervention, while still highly active in commercial sex, increased their condom use and effectiveness and reduced their number of partners somewhat. The intervention model demonstrated a reduction in HIV prevalence by 1% in the sex worker population and 0.1% in the non-CSW population as compared to the base model. The model showed that 477 of the 983 cases of HIV that did not occur were prevented in the non-CSW populations. This means that about half of those cases of HIV that were averted resulted from CSWs, and the remainder were from the rest of the population. In fact, more non-

CSW cases of HIV were averted in the CSW model than with the ORM model (264). A slightly higher number was seen in the SM of STI model (566).

The above findings may be useful for the purpose of influencing policy. Therefore, interventions designed to look at overall population reduction of HIV incidence may want to initiate or scale up CSW peer intervention programmes.

SM of STIs

This intervention is aimed at reducing HIV risk in the whole population through strengthening the health care system to effectively diagnose and treat STIs through syndromic management. This programme averted a large number of cases of HIV over the one year period (787). About 18% of the cases of HIV averted due to the SM of STI intervention were in CSWs. The cases of HIV that were averted in this intervention were nearly all in the non-CSW populations (82%).

Occupationally Focussed Interventions for Men

The programme to prevent HIV infection through working with high-risk men involved the fewest number of participants (3,015) and was the least expensive programme (Can $89,240). This programme prevented the fewest overall cases of HIV and a reduction of HIV of only 369 cases was estimated.

The reason that this intervention appears to be less effective is that the number of men reached by the project was small in comparison to the other two interventions. This does not mean that the intervention is ineffective. When just the ORM population is considered, it appears that within 12 months the HIV prevalence rate rises from 20% to 23%, in the absence of any intervention. When the ORM intervention is run, it appears that while the HIV rate still rises in this population, the growth is slowed by 1.1% overall (the intervention HIV prevalence is 21.9% at the end of the year 2000). This finding has implications for the private sector who may be interested in reducing rates of HIV in certain employee populations. Table 7B shows the decrease in ORM HIV from the base model, by intervention type.

Table 7B: Reduction in ORM Population HIV

Intervention	ORM HIV after 12 months (HIV rate was 20% at the beginning of 2000)	Reduction in ORM HIV from the base model (no intervention)
Base (No Intervention)	23%	
ORM	21.9	2.1%
CSW	22.6	0.4%
SM of STI	22.9	1.1

The numbers of cases averted however are less interesting to us in this exercise than finding the cost per case of HIV averted. If there were no resource constraints, then simply knowing which of the projects was most effective would be enough. However, this project sought to attach a value of cost-effectiveness to the number averted in this resource-poor environment.

Costs per Case of HIV Averted

In order to evaluate the cost per case averted, the cases averted were first estimated, as above. Next, the numbers of cases averted were divided by the overall cost of each intervention. This result estimates the cost of averting a single case of HIV in Nairobi in the year 2000. The model results (as shown in Table 7C) revealed that the CSW peer intervention was the most cost-effective intervention, followed by SM of STIs and occupationally focused interventions for men.

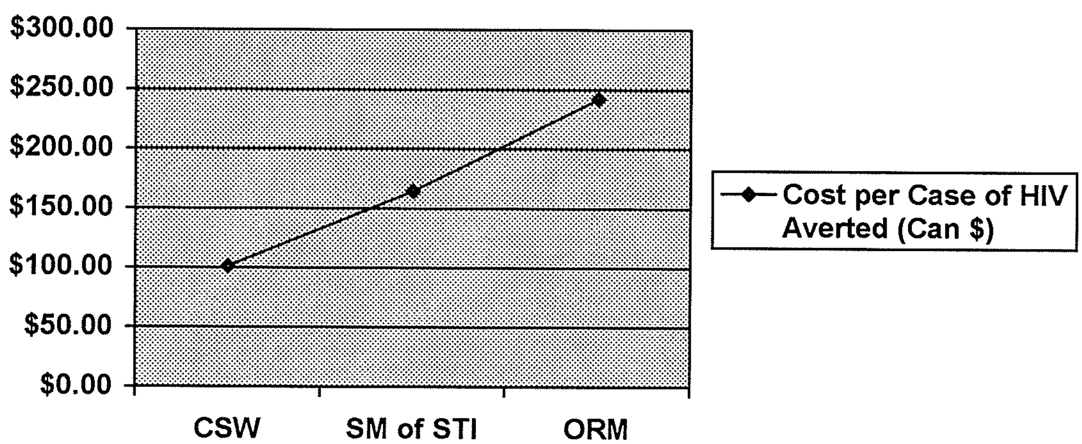
Table 7C: The Cost of Cases Averted by Intervention

Project	Cost of Total Project $/(KSh)	Number of Cases of HIV Infection Averted	Cost/Case of HIV Cost per Infection Averted in $Can (also KSh/US$)
CSW	$99,523 (4,478,536 KSh)	983	**$101.24 (4,556 KSh) (US$ 59.79)**
SM of STIs	$119,250 (5,366,250 KSh)	726	**$164.26 (KSh 7,392) (US$ 97.01)**
OFIM	$89,240 (4,015,803 KSh)	369	**$241.84 (KSh 10,883) (US$142.82)**

Relative Cost Effectiveness

To look at whether an intervention is effective or not, it must be ranked against other interventions which are intended to produce the same outcome. The cost of preventing a case of HIV in each of the interventions is described in the graph and paragraph below.

Figure 7B: Relative of Costs of a Case of HIV Prevented in Each of the Interventions



The intervention cost-effectiveness ratios are compared to each other in the graph above. The cost of preventing a case of HIV with the CSW peer intervention model was clearly the lowest, with SM of STI programmes and ORM interventions following with costlier rates. The SM of STI programme ranked second overall in cost-effectiveness. This programme was the most expensive intervention (overall costs were Can $119,250) but directly affected the largest number of participants (6,637 people treated). The ORM intervention appears to be the least cost-effective of the three programmes. While OFIM was shown to be the least cost-effective, this certainly does not mean that OFIM is not cost-effective. It means simply that this project was not as cost-effective at reducing cases of HIV as CSW interventions, and SM of STI interventions under the conditions described in the model.

Disability Adjusted Life Years

In calculating DALYs, it was important to identify a process of estimating the value in a way that would be comparable to other outcomes found in the literature. For the purposes of this project, DALYs were measured according to the method used in the Mwanza CEA (Gilson *et al.*, 1997), and as outlined by Homedes (2002). Obviously, all of the input numbers will be different, as they pertain to Kenya, and to the year 2000.

First the baseline Kenyan life expectancy was ascertained. These data were found in the CIA Factbook (2002) which estimated Kenyan life expectancy at birth (2001) for Kenyan women to be 48.44 years. Kenyan men were estimated to live 46.59 years. Life expectancy for Kenya was estimated by the World Bank to be 48 years (World Bank, 2002). Thus a compromise in the life expectancy of 47.5 was used for the purposes of calculating the DALYs.

The Mwanza process had estimated the mean age at averted HIV infection to be 28 years of age. This is the standard age used to calculate DALYs in sub-Saharan Africa (Hyder & Morrow, 1999). However, the AIM model (Futures Group, 2002) was used to estimate the average age of HIV infection in Kenya in the year 2000. Through this analysis, the actual mean age of a Kenyan with HIV in the year 2000 was estimated to be between 20 and 25 years old. Also the published statistics from the Kenyan government state that most cases of HIV in Kenya are acquired in the early teens to late 20's (MOH, 2001). Thus for the purposes of the analysis, the age of 22.5 was used.

Next, the researcher used 9.8 years as time from infection to death, as was used in the model (Morgan *et al.*, 2002). Therefore, while the average Kenyan is expected to live 47.5 years, an HIV positive Kenyan is expected to live to be only 32.3 years. Therefore, the years of life lost per HIV infection is estimated to be 15.2 years.

The Mwanza process estimated DALYs saved per case of HIV averted as six years of limited morbidity with a disability weighting of 0.1 and one year of severe disease. The severe disease was estimated to carry a disability weighting of 0.9. This step was followed exactly. The fourth step again followed the Mwanza model and discounted the number of DALYs by a rate of 3%. The rate of three percent was chosen for discounting according to the guidelines of the American Public Health Association (Gold *et al.*, 1996).

Table 7D: The DALY Process

Calculation	Result
Years of life lost (life expectancy lost: 47.5-32.3)	15.2
Disability Calculations (0.1 * 6) + (0.9 * 1)	1.5
Disability adjusted years of life lost (15.2 years of life lost plus 0.6 + 0.9)	16.7
Discounted 3% (subtract 0.5)	16.2

Therefore, the number of DALYs saved for every case of HIV averted is estimated to be 16.2. The next step in estimating the number of DALYs saved in the year 2000 was to multiply the total number of cases of HIV averted by the DALYs saved per case. This yielded the overall DALYs saved by each intervention. Lastly, the DALYs are divided by the cost of the programme to achieve a cost per DALY averted.

Table 7E: The DALY Results

Result	CSW	SM of STIs	ORM
DALYs Saved per Infection Averted (minus 3% for discounting)	16.2	16.2	16.2
Number of Cases of HIV Averted	983	726	369
DALYs saved per programme	(983 * 16.2) = 15,925	(726 * 16.2) = 11,761	(369 * 16.2) = 5,978
Cost of the Programme in Can $ (Ksh)	$99,523 (4,478,536)	$119,250 (5,366,250)	$89,240 (4,015,803)
Total Cost /DALY Saved Can $ (Ksh) US$	 $6.25 CAN (281) KSh $ 3.69 US	 $10.14 CAN (456) KSh $ 5.99 US	 $14.93 CAN (672) KSh $ 8.82 US

Therefore, it can now be said that the DALYs saved for each of the programmes are as follows: CSW Can$6.25 (Ksh 281), SM of STIs $10.14 (KSh 456), and OFIM $14.93 (KSh 672). The costs in US dollars were $3.69, $5.99 and $8.82 for the CSW, SM of STI, and ORM programmes respectively.

The interventions can now conceivably be measured against other interventions that are described in the literature. The DALYs saved were similar to a number of other interventions such as the prevention of mother to child HIV transmission (Marseille *et al.*, 1999: US$5.25-11.29 depending upon method and prevalence) and breast feeding programmes (Horton *et al.*, 1996: US$2-4 per DALY saved). The interventions compared very well with other interventions such as the treatment of African *trypanosomiasis gambiense* (African Sleeping Sickness) in Uganda (Politi *et al.*, 1995: US$ 166.80 per incremental DALY saved) or malaria control programmes in Brazil (Akhavan *et al.*, 1999: US$69 per DALY saved).

Model Incident Cases

The model estimated that the cumulative HIV incident cases for Nairobi for the year 2000 was 15,208 without any intervention from the Project. The model also predicted that without intervention from the Project, Nairobi had experienced 73,027 deaths from all causes, with 12,127 of those deaths resulting from AIDS related causes. The 12,127 deaths from AIDS in the year 2000 represents less than 0.1% of the city's 2.14 million residents, but about 1.5% of the city's young, sexually active residents. It is clear why nearly every person in Nairobi claims to know someone who has died of HIV-related causes.

Female verses Male Incidence and Cases of HIV Averted

It is interesting to note the differences between the male and female HIV incident cases that are seen with the base model and each of the intervention models, over the one-year time period. The ratios of female to male HIV incident cases are shown in Table 7F below.

Table 7F: Female and Male Incidence, by Intervention

Programme	Female Incident Cases (# fewer than Base Model)	% of cases averted that were in females
Base (no intervention)	9,486	
CSW intervention	8,958 (528)	54%
SM of STIs	9,098 (388)	53%
OFIM	9,311 (175)	47%

Table 7F shows that while all of the interventions are effective at reducing HIV in female populations, the CSW intervention was slightly more effective in this population, with the SM of STD intervention close behind. About half of the infections produced as a result of the ORM model were among women. The ratio of male to female cases of HIV averted between all of the programmes is similar.

Comparison of these Results to Other Results from the Literature

No comprehensive CEA of these interventions has been carried out before. However in May 2002, Creese and others published a review of costs and cost-effectiveness of a number of HIV prevention programmes. The group also standardised the studies in order to allow the results to be comparable. Below are comparisons to the costs per cases of HIV found in the literature and the cost per DALY saved.

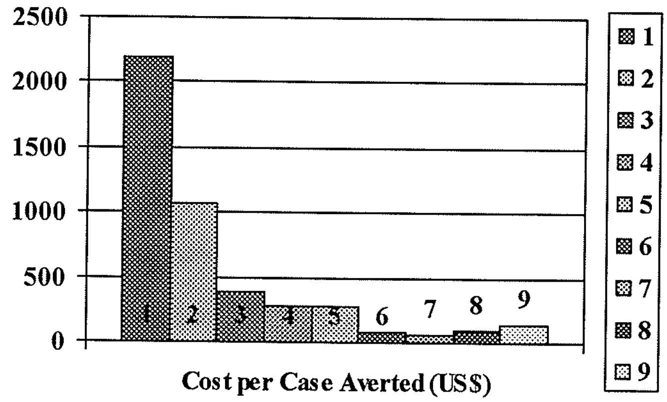
Comparison of the Results to Cost per Case of HIV Averted as Found in the Literature

A CEA by Gilson *et al.* (1997) was carried out on the Mwanza Tanzania population that looked at the CEA of SM of STIs and found that the cost for preventing a case of HIV was US$271. Unpublished data from Homan (as cited in Kumaranayake, 2002 and Creese *et al.*, 2002) from Kenya also estimated the cost per case of HIV averted associated with condom distribution programmes. This study found that programmes distributing condoms to CSWs would cost US$275 per HIV infection averted, while the same programme targeting other high-risk women (US$1,066) or moderately risked women (US$2,188) were less effective. A peer education programme for sex workers programme from Cameroon was found to cost between US$79 and $160 per HIV infection averted (Kumaranayake *et al.*, 1998). VCT costs were also evaluated in Kenya and Tanzania (Sweat *et al.*, 2000). This study estimated that the cost of preventing a case of HIV with VCT was between US$393 - $482.

It is interesting to compare these other results against the results of the Project interventions. Figure 7C below describes the different cost per case averted for these

CEA of prevention of sexually transmitted HIV in sub-Saharan Africa. The Project interventions have been converted to US dollar values and are indicated with a star.

Figure 7C: Cost per Case Averted for CEA of Different Published Results for the Prevention of Sexually Transmitted HIV in Sub-Saharan Africa

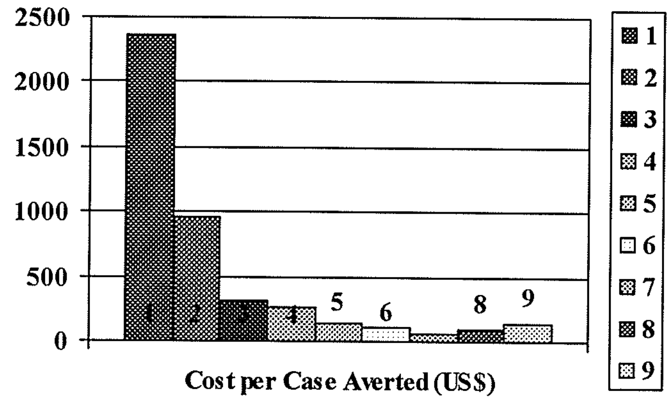


Sources: Kumaranayake, 2002 and Creese *et al.*, 2002 (1, 2, 4); Sweat *et al.*, 2000 (3), Gilson *et al.*, 1997 (5); Kumaranayake *et al.*, 1998 (6); this project* (7,8,9).

The Project interventions were converted into US dollars using the rate of 76.2KSh per US dollar (the average exchange rates for the year 2000 according to the Central Bureau of Statistics for Kenya). This was the rate used in the data collection as well. The resulting cost per case averted was as follows: CSW peer interventions- US$59.79, SM of STI programmes- US$97.01 and OFIM- US$142.82.

The cost per case of HIV averted results from these studies can also be compared to prevention intervention programmes that were not intended to prevent sexual transmission of HIV. In Table 7D, the three Project interventions are compared to prevention of mother to child transmission interventions (bars 1, 3, 4 and 5) and blood safety interventions (bars 2 and 6).

Figure 7D: Cost per Case Averted for CEA of Different Published Results for the Prevention of Non-Sexually Transmitted HIV in Sub-Saharan Africa



Sources: Wilkinson et al 2000 (1); Jacobs and Mercer, 1999 (2), Marseille et al, 1999 (3, 5); Stribnger et al, 2000; Buve and Foster, 1995 (6); CSW, SM of STIs, and OFIM (7,8,9).

The three interventions from the Project appeared to be cost-effective in comparison to non-sexual transmission HIV prevention intervention projects from the literature.

Comparison of the Results to DALYs Saved as Found in the Literature

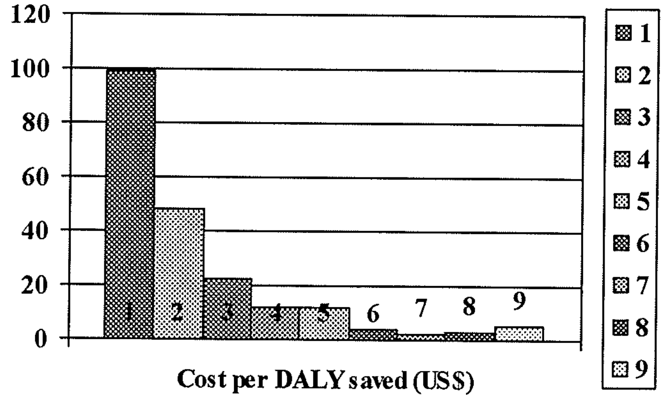
The three Project intervention results in DALYs saved were then compared against the published results from Ceese and others (2002). The same interventions to prevent sexually transmitted cases of HIV as reported in Kumaranayake (2002), were compared. This time, the standardised DALYs were used. The project DALYs were also altered to fit the specifications of Creese's standardisation. The Creese report's DALYs saved are much greater than the ones used in this thesis report. The major difference observed in the Creese calculation for DALYs saved per HIV infection is seen in the years of life expectancy, average age at infection, and the expected time from infection to death.

Table 7G: Standardising the DALYs

Project Intervention	Model Result DALYs Saved	Creese's Standardisation DALYs Saved	Creese's Standardisation US$/DALY saved
CSW (983)	(983 * 16.2) = 15,925	(983* 29.2) = 28,704	($58,773/28,704) = US$2.05
SM of STI (726)	(726 * 16.2) = 11,761	(726 * 29.2) = 21,199	($70,423/21,199) = US$3.32
ORM (369)	(369 * 16.2) = 5,978	(369 * 29.2) = 10,775	($52,701/10,775) = US$4.89

Now the results per DALY saved can fairly be compared to the results in Creese's report. It is fortunate for the researcher that Creese chose to use the year 2000 for the year of prices, and the Provider perspective. He also excluded productivity losses and the discount rate of 3%, which are the same in the researcher's model calculations.

Figure 7E: Cost Per DALY Saved from Different Published Results for the Prevention of Sexually Transmitted HIV in Sub-Saharan Africa

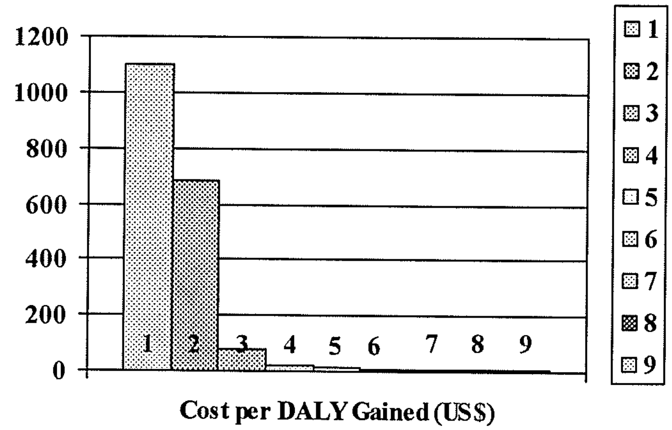


Sources: Kumaranayake, 2002 and Creese *et al.*, 2002 (1, 2, 4); Sweat *et al.*, 2000 (3), Gilson *et al.*, 1997 (5); Kumaranayake *et al.*, 1998 (6); this project* (7,8,9).

Using the other published results in a standardised comparison, it appears that the Project interventions are again very cost-effective. The results are very favourable and demonstrate that firstly, the project is performing their HIV prevention activities in an efficient way. Secondly, these interventions appear to be effective. Of course, the effectiveness and cost-effectiveness of the ratios are affected by the parameters that feed the model. The next chapter is a report from the sensitivity analysis and includes a description of the ways in which a number of factors influence the outcome.

However, DALY results do not only allow you to compare the CEA outcomes to HIV prevention interventions. By using DALYs, we are now able to compare the three interventions to other interventions from the literature such as care for people with HIV and prevention of other diseases that are common to Africa. Figure 7D below shows the cost per DALY of the three interventions measured in this research projects against other CEAs from Africa found in the literature.

Figure 7F: Cost Per DALY Saved from Different Published Results for Different Health Programmes in Sub-Saharan Africa



Sources: Creese et al, 2002 (1); Chela et al, 1994 (2), Msobi and Musumi 2000 (3); Goodman *et al*,. 1999 (4); Floyd *et al*, 1997 (5); Guinness *et al.* from Forsythe, 2002 (6); CSW, SM of STIs, and OFIM (7,8,9).

In Figure 7F, the first three bars of the graph represent different forms of care: HAART (Creese *et al.*, 2002), facility based care (Chela *et al.*, 1994), and community based care (Msobi & Musumi, 2000). Clearly all three of these programmes cost far more per DALY gained than the interventions that were measured in this research. Bars 4, and 5 represent prevention programmes for malaria and tuberculosis (Goodman *et al*,. 1999; Floyd *et al*, 1997). The sixth bar is a co-trimoxizole intervention for people with HIV and tuberculosis (Guinness *et al.* from Forsythe, 2002). These programmes are comparable in cost per DALY gained to the three Project interventions.

CHAPTER EIGHT: **SENSITIVITY ANALYSIS**

Models are based on a number of assumptions. The research that went into locating the most appropriate information on which to estimate the parameters was exhaustive. The researcher went to great lengths to assure that the estimates were the closest reflections of reality possible. However, the robustness of the ratios derived from the model still needed to be tested. Sensitivity analyses take into account the possible deviations that may occur between the model and reality. The deviations may occur in the different populations, the stage of the epidemic, transmission dynamics, the efficacy of the condoms, or the characteristics of the provider and costs. Sensitivity analyses demonstrate how altering the different factors change the overall CEA. The outcome of the sensitivity analysis may also have implications for the generalizability of the cost-effectiveness ratios beyond the Nairobi population.

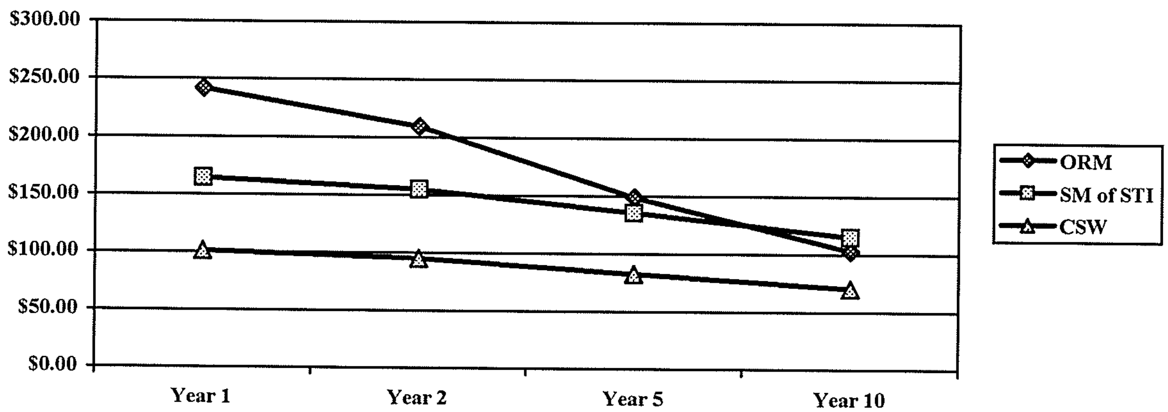
Sensitivity to Time

This model was run over a 12-month period with the interventions occurring in the first month of the model run. This time period can be increased to look at future outcomes, if the parameters were to stay the same. Therefore, the researcher ran the model over two, five, and ten-year time periods to assess if the ranking of the cost effectiveness ratios would remain the same. The researcher used the costs from the year 2000, although certainly inflation would increase the pricing and it is possible that the actual costs of condoms and STI drugs may become more or less expensive as time goes on. Normally future prices are discounted by a percentage (often 3%) to account for the decreasing value of future gains, but for the purpose of the sensitivity analysis straight prices from the year 2000 were used.

It should be emphasized that the ratios here are only to be used for the purposes of the sensitivity analysis and are not reflective of inflation or expected changes in life expectancy or costs over the time periods.

In evaluating the changes to the cost-effectiveness ratios over one to ten years, it appears that the long-term stability of their ranked order. It was decided not to look beyond ten years. At this point, the uncertainty is too great as to the impact of costing (especially for STI drugs) and the impact of interventions such as ARVs and VCT was unknown.

Figure 8A: Comparison of the Cost per Case Averted Over Time



While all of the interventions decrease in cost over time, the change in the ORM intervention is the most marked. As the programme grows and recruits new members, it becomes more effective. The results of the secondary cases of HIV being prevented are also taken into account. This means that a case of HIV prevented in year one, will not have the opportunity to spread the virus in year two and so on. In the ORM project, the model assumes that 58-62 ORM are recruited into the programme monthly.

Sensitivity to Fewer or More CSWs in the Population

The model was also altered to assess the impact of increasing and decreasing the overall population percentage of CSWs in Nairobi. The percentage of the population used in the original model (8%) was a middle-ground between the DHS (1998) data of 12% of women claiming to have exchanged sex for money, goods or services and the Project's antenatal clinic data (2000) result of 6%. Both parameter estimates were put into the analysis to assess the impact on the overall ranking of the cost-effectiveness ratios. This percentage represents the proportion of sexually active females who are exchanging sex for money or gifts in kind.

The cost-effectiveness ratio for the CSW intervention was evaluated with the population percentage of sex workers changed to only 6%. The number of intervention CSWs remained the same (as these were directly measured), while the overall CSW percentage dropped from 8% to 6%. This affected the Project CSW to Other CSW ratio, resulting in an increase to 21% of overall Nairobi sex workers belonging to the project (the original model estimated that about 16% of all CSWs were project CSWs). The table below outlines the changes seen in the ratio between Project CSWs and non-Project CSWs as the estimations of the number of women in Nairobi engaged in sex work changes.

Table 8A: Changes Seen in the Ratio between Project CSWs and Non-Project CSWs

Model % of CSWs in the Population	Number of Sex Workers	Percentage of Sex Workers Belonging to the Intervention
6%	23,596	21%
8%	31,462	16%
12%	47,193	11%

*note that the number of CSWs involved in the Project remains at 5,000

It was then interesting to see if there was a difference in the cost-effectiveness rankings when the higher percentage in the range was used (12%). The population percentage of sex worker was then increased to 12% in the model for the sensitivity analysis. Again, the number of intervention CSWs remained the same (as these were directly measured), while the overall CSW percentage was raised from 8% to 12%. This affected the Project CSW (5,000 women) to non-Project CSW ratios, resulting in a decrease to 11% of overall Nairobi sex workers belonging to the project. The overall cost per case averted with the increased number of CSWs was $76.50.

Table 8B: Model Sensitivity to Changes in the Percentage of Population Sex Workers

Percentage of Sexually Active Women Involved in Sex Work	Cases Averted	Cost per Cases Averted	Difference	Cost per DALY Saved- Can$ (DALYs Saved)
6%	935	$106.44	$5.20	$6.57 (15,147)
8%	983	$101.24	$0	$6.25 (15,925)
12%	1301	$76.50	-$24.74	$4.73 (21,062)

*The number of Project CSWs remained stable at 5,000 in all of these scenarios.

The cost of the intervention per case averted is highest in the scenario where there are only 6% of the sexually active female population engaging in sex work ($106.44) per case of HIV averted). Reducing the number of sex workers in the population lowers the cost effectiveness of the intervention. This is obviously an increasingly effective strategy for areas of the highest concentration of CSWs. While there is clearly a difference in the number of cases averted and the cost per case averted, there would still be no change in the overall ranking of the interventions, whichever percentage of sex workers was chosen.

Sensitivity to the Numbers of CSWs Recruited per Month

The model was adjusted to account for the impact of having fewer or more CSWs recruited into the intervention. At the beginning of an intervention, it would be expected that a project would have few numbers of women. If the snowballing technique is used, it may take some time for the numbers to rise and the peer groups to form. The next step in the sensitivity analysis was to test the impact on the outcome if half the number of CSWs were recruited into the CSW programme. The initial model assessed that approximately 60 new CSWs would be recruited into the peer intervention programmes every month. Over one year, this represented 736 new women in the programme. This is about a 15% annual growth rate. The outcome was assessed for the impact on the cost effectiveness rankings if the annual number of new members in the groups was restricted to 375 new women or a 7.5% growth rate. If half of the women originally anticipated were recruited in the programme, than 953 cases of HIV would have been averted and each case would have cost $104.43 to prevent. Likewise, increasing the growth of the rate of the cohort recruitment by two times to 30% yearly growth made a difference (decreasing the cost per case averted by $5.64 to $95.60) but would not have changed the rank order of the interventions.

Table 8C: Model Sensitivity to Growth in Annual Project CSW Compartment

Increase in Annual Growth of CSW Cohort	Cases Averted	Cost per Cases Averted	Difference	Cost per DALY Saved (DALYs Saved
7.5%	953	$104.43	$3.19	$6.45 (15,439)
15%	983	$101.24	$0	$6.25 (15,925)
30%	1,041	$95.60	-$5.64	$5.90 (16,862)

Sensitivity to the Numbers of ORM Recruited per Month

It was again, possible that the number of men recruited into the programme would have an effect on the overall outcome of the intervention cost effectiveness ranking. Therefore, the model rankings were again challenged to hold up against movement in the groups. The question was asked, "what would be the impact on the cost-effectiveness ratios if there was a change in the annual recruitment of ORM into the intervention compartment?" The original model compartment saw a recruitment of 58 men per month, or about 690 men per year (a 23% increase). This is quite feasible with the major increase seen in the private sector's interest in HIV prevention programmes. What if the rate was reduced by half to 345 men per year? What impact would increasing the rate to 900 new members have on the outcome? The following table (Table 8D) describes the outcome of both halving and increasing the currently used rate of recruitment for the ORM model.

Table 8D: Model Sensitivity to Rate of ORM Project Recruitment

Increase in Annual Growth of ORM Project Cohort	Cases Averted	Cost per Cases Averted	Difference	Cost per DALY Saved (DALYs Saved)
11%	351	$254.25	$12.41	$15.70 (5,686)
23%	369	$241.84	$0	$14.93 (5,978)
30%	376	$237.34	-$4.50	$14.65 (6,091)

The project becomes more cost-effectiveness as more men are recruited into the programme but the actual difference in numbers of cases averted is very small. This is because the actual numbers of people and overall percentage of the population are still too small to see any major impact. Modifying the rate of ORM recruitment showed little effect on the numbers of cases, but a more significant impact on the cost per case averted. This is because the programme itself is relatively inexpensive (and certainly the least expensive of the three interventions measured in this project). As was shown above, however, the project increases in effectiveness over time. Again, the ranked order of the cost-effectiveness ratios was unchanged.

Sensitivity to the Number of Different Partners Seen by CSWs per Month

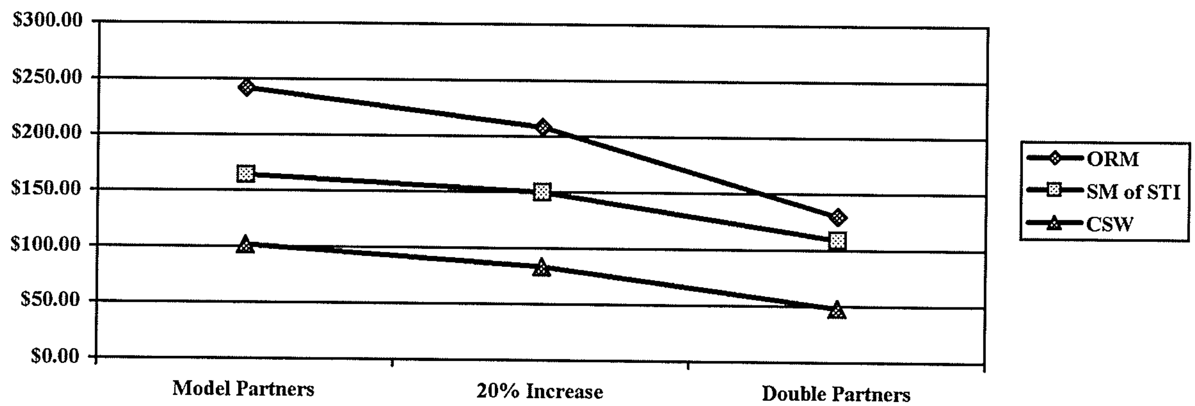
The monthly number of sex partners that CSWs had was estimated to be 17 (14 ORM and three non-ORM men). All men were estimated to have had sex with the CSWs five times per month. This number was estimated based on a number of KAP studies carried out by the *Project* as well as on the discussion group results. It was of interest to see how the outcome would be influenced if higher ranges of the parameter were used.

The first step taken was to increase the overall number of all partners of CSWs by 20%. This meant that each month the CSWs saw 16.8 different higher risk men and 3.6 different moderately risked men. The men were assumed to have seen the CSW five times during that month on average. The order of the ranked cost-effectiveness ratios did not change. CSW peer interventions were still the least expensive at $83.42. The SM of

STI programme ranked second at $149.81 and the ORM programme came in third at $208.02.

Next, the number of different partners for CSWs was doubled. This meant that each CSW had on average six non-ORM and 24 ORM partners per month, again having sex with them on average five times a month. Again, the ranking stayed as follows: CSW interventions ($47.73), SM of STI interventions ($109.10), and followed closely by OFIM ($129.90). The impact of increasing the numbers of different partners for CSWs are shown in Figure 8B below.

Figure 8B: Model Sensitivity to Increasing the Number of CSW Partners

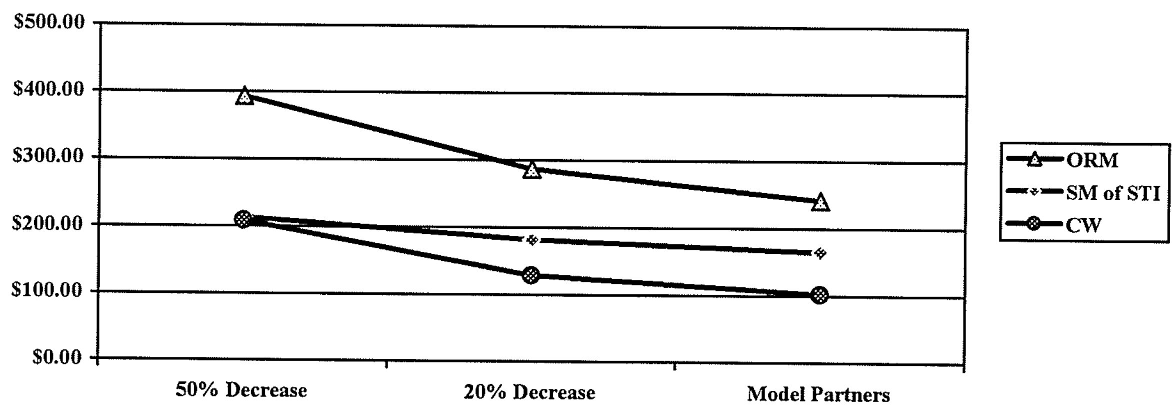


The ORM Project was most affected by the change in number of CSW partners. Due to the increased effectiveness seen in the ORM intervention, the gap in cost between the SM of STD intervention and the OFIM was closed considerably.

Next, the model was tested for its sensitivity to decreasing the number of sex partners for the CSWs. In this case, the overall number of different partners was decreased by 20%. The result of decreasing the CSW sex partners by 20% was that they only had 11.2 ORM and 2.4 men per month. In the 20% reduction scenario, the same ranking order of cost-effectiveness ratios as before was seen: CSW - $128.09, SM of STI - $181.23, ORM - $286.94).

When the number of partners was reduced by half, the effectiveness of the CSW intervention began to decline quickly. For the scenario in which a 50% reduction in partners was introduced, the following results were found: CSW - $208.21, SM of STI - $212.97, ORM - $393.13). Figure 8C shows the trends of the models that result from decreasing the number of CSW partners.

Figure 8C: Model Sensitivity to Decreasing the Number of CSW Partners



Clearly, the CSW and ORM interventions are the most sensitive to the change in the number of partners that CSWs have. The estimated number of partners per CSW influenced the model outcomes. The CSW programme cost per case of HIV averted ranged from $47.73 to $208.21 depending on the number of partners that the CSWs had. The SM of STI intervention also increased in cost as the percentage of partners for CSWs decreased, but in a less dramatic way. Clearly, this is an important parameter that influences the outcome of the CEA. It is interesting to note that the ranking of the interventions remains unchanged.

Sensitivity to the Coital Frequency of Regular Partners in the General Population

The base model assumed the monthly number of sexual encounters for regular (non-paid) couples to be 12 per month. The original data collection resulted in an estimate of two to three times per week. The sensitivity analysis required us to modify the model to see if a lesser number of eight altered the outcome of the CEA. The model was also altered to assess the impact of a higher coital frequency on the cost effectiveness rankings of the three interventions.

Reducing the regular couple coital frequency to eight did not change the overall rankings, but it does reduce the cost per case averted of the CSW peer intervention, while raising the overall cost of the other two programmes. This scenario resulted in a cost per case of HIV averted for CSW intervention of $101.76. For SM of STI interventions the cost was $196.78 and with high-risk men $243.16.

The analysis also assessed the impact of increasing the overall monthly coital frequency of regular partners by four times more. The overall cost effectiveness rankings did not change when the coital frequency was dramatically increased. CSW interventions remained the least expensive ($100.83 per case of HIV averted) and ORM interventions were slightly increased to $240.54. SM of STI had the most dramatic impact with the result of $140.29. Clearly, the SM of STI intervention relies more heavily on coital frequency in the population than the OFIM and the peer interventions with CSWs.

Sensitivity to the HIV Prevalence of CSWs

The impact of the CSW HIV prevalence was assessed to see if other plausible parameter inputs would change the overall ranking of the cost-effectiveness ratios. When the HIV prevalence of the CSWs was changed to 50% (as in the University of Manitoba Pumwani Cohort Study), the outcome was interesting, but did not change the rankings of the interventions according to their cost-effectiveness ratios.

Table 8E: Model Sensitivity to a Decrease in HIV Prevalence of CSWs to 50%

Project	Cost/Case of HIV Averted at 30% CSW HIV Prevalence (Can$)	Cost/Case of HIV Averted at 50% CSW HIV Prevalence	Difference (reduction in cost per case averted)
CSW	$101.24	$90.48	$10.76 (10.6% reduction)
SM of STIs	$164.26	$159.21	$5.05 (3.1% reduction)
OFIM	$241.84	$215.56	$26.28 (10.9% reduction)

The increase in HIV prevalence resulted in decreased cost per case averted in each of the interventions. The decrease in the cost per case averted is especially marked in the CSW and ORM interventions. Again, these interventions rely heavily on interrupting the transmission of HIV between sex workers and clients.

Sensitivity to the HIV Prevalence of ORM

The ORM HIV prevalence parameter was altered to assess the model sensitivity to a range of plausible scenarios. The HIV ratio was changed from the original model estimate of 20% HIV positive to 35% HIV positive. The Mombassa Truck Driver Study yielded varying results over the years for the HIV prevalence of these occupationally risked men. Bwayo *et al.* (1991), Mbugua *et al.* (1995), and Jackson *et al.* (1997) had described situations where occupationally risked men had HIV prevalence rates of between 17% and 20%. The most conservative estimates were chosen for this project. However, higher estimates could have been used. By the mid-1990s, some estimates had reached 35% in East African truck drivers (Laukamm-Josten *et al.*, 2000). Table 8F shows the impact of using the higher estimate.

Table 8F: Model Sensitivity to Changes in Prevalence in the ORM Population

Project	Cost/Case of HIV Averted at 20% ORM HIV Prevalence	Cost/Case of HIV Averted at 35% ORM HIV Prevalence	Difference (reduction in cost per case averted)
CSW	$101.24	$84.85	$16.39 (16.2% reduction)
SM of STIs	$164.26	$146.14	$18.12 (11% reduction)
OFIM	$241.84	$195.27	$46.57 (19.3% reduction)

The cost per case of HIV averted has decreased by 10-20% in each of the models as a result of increasing the estimated HIV prevalence of the ORM. Clearly the OFIM project had the greatest reduction in cost. This result has implications for recruiting groups of men where the HIV prevalence is the highest in all intervention programmes.

Sensitivity to Increasing the Percentage of the Population that is Sexually Active

The current model is based on the stated sexual activity of people from Nairobi, Kenya. It is possible that the stated sexual activity is an underestimation. Therefore, the percentage of sexually active people in the population was increased to assess what impact this would have on the cost-effectiveness ratio rankings. The altered model produced the following outcomes. CSW interventions remained the model's most cost-effective intervention ($96.53), followed by SM of STI ($137.39) and OFIM ($172.27).

Table 8G: Changes to the Population Compartments, with a 20% Increase in the Sexually Active Proportion of the Population

Population Compartment	Original Population	Increased Sexually Active Population by 20%
CSW positive	9,439	11,327
CSW negative	22,023	26,428
Female positive	50,653	60,784
Female negative	311,156	373,387
ORM positive	14,656	17,587
ORM negative	58,624	70,370
MRM positive	50,089	60,107
MRM negative	307,691	369,229

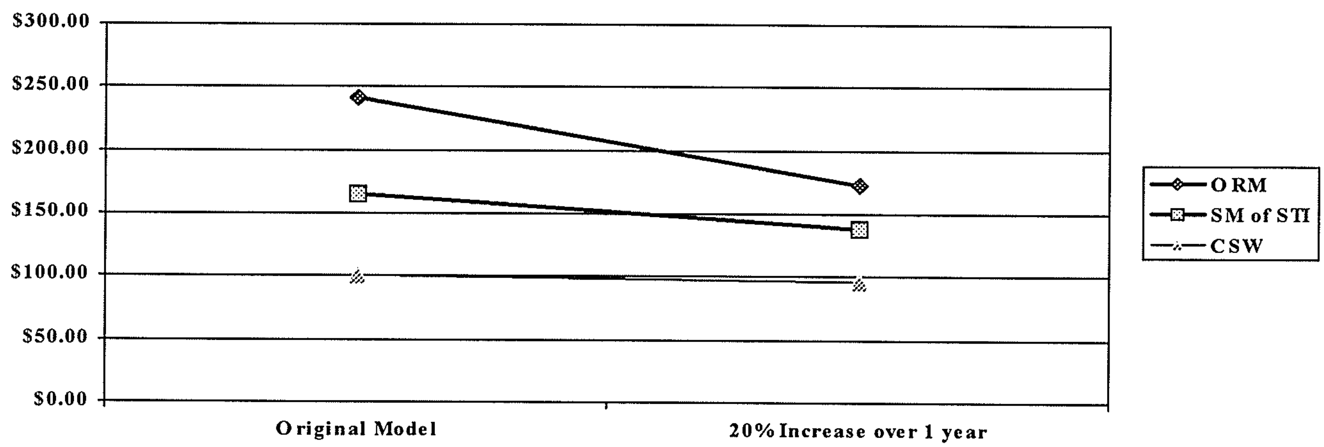
Using the above new compartment groups, the models were rerun to assess if there was a change to the ranked order of the cost-effective ratios. The results are shown in Table 8H.

Table 8H: Ranked Order of Cost per cases Averted, when the Population of Sexually Active People is Increased by 20%

Model	# of Cases Averted	Cost per case averted	# of Cases Averted with 20% increase	Cost per case averted with 20% increase
CSW	983	$101.24	1,031	$96.53
SM of STI	726	$164.26	868	$137.39
ORM	369	$241.84	391	$172.27

Clearly, the greatest impact was made by increasing the overall population of the model by 20% over one year (without increasing our intervention groups) is in the ORM Model. The larger population allows the impact of the intervention to be seen more clearly.

Figure 8D: Sensitivity to Changes in Percentage of the Population that is Sexually Active



Sensitivity to Changes in Prevalence of STIs

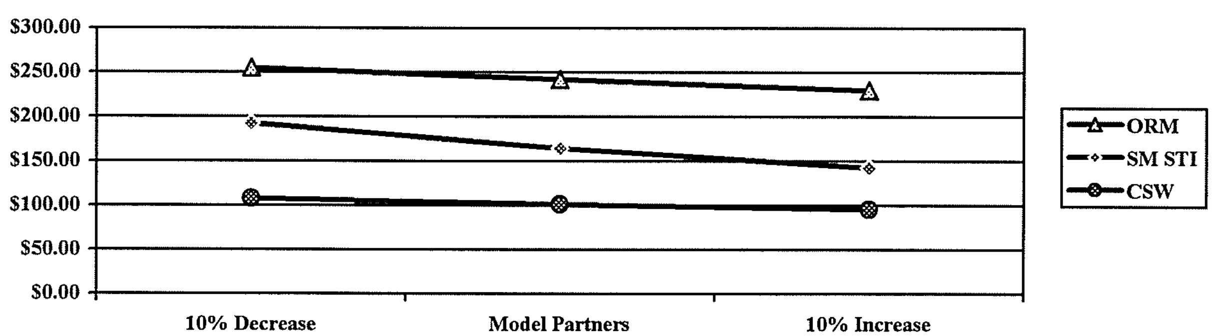
The current model is based in STI prevalence estimates from the East African region to closely simulate the average STI prevalence in Nairobi. However it is possible that the actual STI prevalence may be a few percentages higher or lower than our estimates. The model was altered to assess the impact of increasing and decreasing the STI prevalence in each group by 10%. Table 8I outlines the findings when the rates of STIs are altered.

Table 8I: Sensitivity to Changes STI Prevalence

Model	# of Cases Averted with 10% Increase in STIs (Cost per case averted, $ Can)	# of Cases Averted with 10% Decrease in STIs (Cost per case averted, $ Can)	Cost per case Averted with the Original Model STI Prevalence
CSW	1,043 ($95.42)	923 ($107.82)	$101.24
SM of STI	834 ($142.99)	618 ($192.96)	$164.26
ORM	389 ($229.41)	350 ($254.97)	$241.84

As the prevalence of STIs increase, the cost-effectiveness of the interventions increases as well. Changing the STI prevalence had the greatest effect on the SM of STI intervention. Depending upon the percentage of STIs in the population, the cost of the intervention varied by almost $50. Figure 8E shows the impact trends of these models with varying levels of STIs in the whole population.

Figure 8E: Model Sensitivity to Changes in STI Prevalence



Sensitivity to Least and Highest Risk Scenarios in the HIV Epidemic

The model was used to estimate the intervention CEA ratios based on our understanding of the HIV risk parameters for the year 2000. However, it was interesting to calculate the impact of changing the HIV risk factors to represent the least and highest risk scenarios as measured in the sensitivity analysis. In doing this, the researcher looked at the impact on the CEA ratios when a scenario that had the lowest percentage of CSWs, low rates of HIV, and lowest rates of STIs was compared to high rates of those parameters. The Table 8J below lists the new parameters given to the models under each risk scenario.

Table 8J: Model Parameters, by Risk Scenario

	CSW Prevalence	% of Women in CSW	ORM Prevalence	STI Prevalence	# of Sex Partners
Least Risk	25%	6	15%	Subtract 10%	Subtract 10%
Original Model	30%	8	20%	As in parameters	As in parameters
Highest Risk	50%	12	35%	Add 10%	Add 10%

The models were run with a combination of factors that coincided with either a high risk or a low risk for HIV transmission. The results of the model impacts are outlined in the Table 8K.

Table 8K: Cost per Case Averted, According to Risk Scenario

Model	Least Risk Scenario	Highest Risk Scenario	Original Model
CSW	774 ($128.58)	1,264 ($78.74)	983 ($101.24)
SM of STI	476 ($250.53)	1,093 ($109.10)	726 ($164.26)
ORM	259 ($344.56)	548 ($162.85)	369 ($241.84)

Therefore, it is clear that under the most extreme epidemic scenario measured in the sensitivity analysis, the interventions remained ranked as they were in the original model. The interventions are more expensive per case averted in the low risk situation than they are in the original or high-risk situations. The estimates that are used in the model were chosen to reflect the most conservative estimates of the Nairobi HIV epidemic in the year 2000. It is possible that the actual cases averted by the Project interventions were higher and therefore the costs lower.

Sensitivity to Intervention Costs With and Without the International Personnel Salaries

Clearly the international staff brings a great deal of expertise and experience into the Project. It is unknown what the difference in effectiveness of the Project would be without them. However, the model was used to estimate the impact on the CEA ratios with and without the international Project staff, while maintaining the same Project effectiveness. The results are described in the Table 8L.

Table 8L: Impact of International Staff Costs

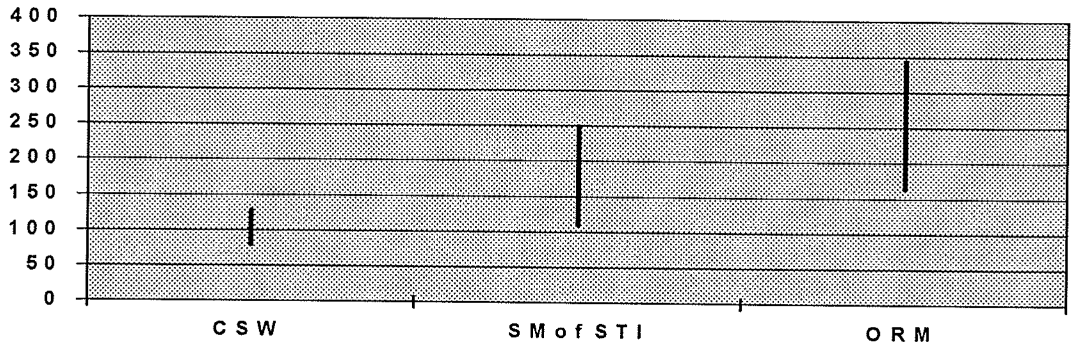
Model	Costs with the International Staff Costs (Can$)	Costs without the International Staff Costs	Cost per Case Averted With and Without the International Staff
CSW	$99,523	$53,063	$101.24/$53.98
SM of STI	$119,250	$72,790	$164.26/$100.26
ORM	$89,240	$42,780	$241.84/$115.94

As seen above, the projects could be considerably less expensive if they were run solely by local staff. Of course, this information is only useful if the effectiveness of the project is expected to remain the same.

Overall Results of the Sensitivity Analysis

While the models were sensitive to certain important parameter changes, overall there was no parameter or compartment change that altered the overall ranking of the cost-effectiveness ratios. The sensitivity analysis was able to show that depending on the individual parameter changes analysed, the CSW peer intervention programmes would cost between $76.50 and $208.21, the SM of STI programmes would cost between $142.99 and $212.97, and the ORM interventions would cost between $164.26 and $393.13. The range in the price of each intervention depends upon HIV prevalence, the STI prevalence, the percentage of CSWs in the population, the coital frequency of various populations, and the percentage of the population that is sexually active. The single changes are interesting but the range of the models is best described by the differences in the high and low risk scenarios (see Figure 8F).

Figure 8F: Range of High and Low Risk Scenarios, by Intervention

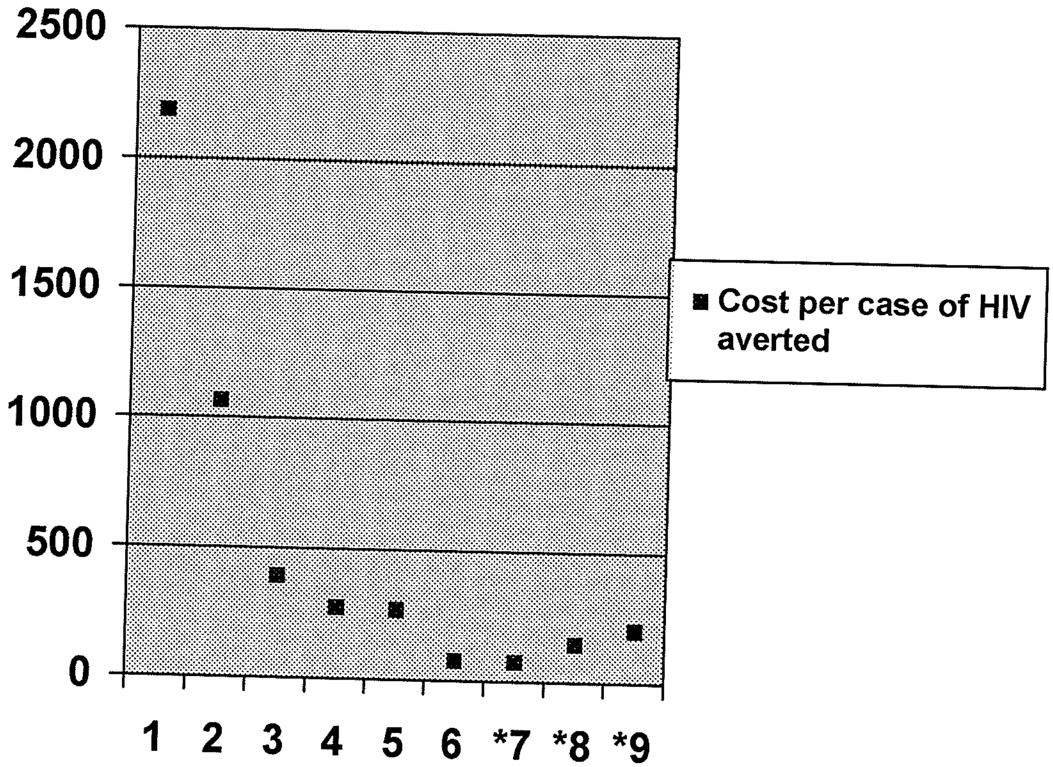


The ratios remained stable despite rigorous assessment. The CSW peer interventions remaining the least changed. The sensitivity analysis points to ranges of a number of different parameters under which the ranking of the three interventions remained stable. Although the interventions overlap under extreme and varied changes to the sensitivity analysis, they never overlapped during the individual alterations to the model. The implications of a number of the findings and the results of the sensitivity analysis will be examined in the Discussion chapter.

Comparing the Range of Costs of the Project Interventions to the Published Results

The sensitivity analysis yielded a range of results that can be used to compare with the results in the published literature. In US dollars, the results ranges from $46.50–$75.93 for CSW peer interventions, from $64.43 – $147.95 for SM of STIs and from $96.17 - $203.48 for OFIM per HIV infection averted. Using the highest cost per case averted of the range, to compare with the published results, showed that while CSW interventions remains the least costly, the OFIM and SM of STI programme's highest cost is higher than the result from the CSW project in Cameroon (Kumaranayake *et al.*, 1998). The SM of STI at US$ 145.95 remains less expensive than the programme in Mwanza, Tanzania at $271.

Figure 8G: Highest Range of Project Sensitivity Analysis Compared to Published Results



Sources: Kumaranayake, 2002 and Creese *et al.*, 2002 (1, 2, 4); Sweat *et al.*, 2000 (3), Gilson *et al.*, 1997 (5); Kumaranayake *et al.*, 1998 (6); this project* (7,8,9).

CHAPTER NINE: **LIMITATIONS OF THE STUDY**

Models are especially useful when the results of empiric studies are difficult to obtain. Empiric studies may be difficult as a result of length of time required to obtain results, cost, ethical considerations etc. While models can be used to identify problems and estimate the most effective and cost effective intervention programmes, there are limitations to their ability to predict or estimate events that occur in reality. Caution should be taken when interpreting the results of any model and other sources of information should be sought before policy decisions are made. Modelling results are intended to estimate only the intervention outcome on the population studied. Extrapolating data from one geographical and cultural area to another may not be possible. On the other hand, the model results may act as a guide for people who are looking for a large body of evidence with which to make important community health decisions.

Overall Limitations of Models

Models are based on estimations and often, assumptions. The reliability of the model is dependent upon the accuracy of the parameter estimates that are gathered from people's accounts or measured from people who agree to be tested. Especially where sexual behaviour is concerned, no amount of careful modelling can ever truly reflect the complex nature of human choices. The exact sexual behaviour of a population can never be measured with 100% accuracy.

One of the reasons that the methods and patterns of sexual behaviour are so difficult to predict is that the determinants of sexual behaviour are not clearly understood (Donovan & Ross, 2000). People choose to have sex, and even high-risk sex, for reasons that have not been adequately explained. Also, there are definition issues that make modelling sexual behaviour difficult.

People sometimes have difficulty relaying accurate estimates of their sexual activity. For example, generally men claim to have more heterosexual sexual intercourse encounters than women do. This is of course, impossible. In modelling therefore, the modeler must find ways of marrying the results that they are finding, with what is possible in reality.

Furthermore, part of the effectiveness of the interventions is based on the overall average change in behaviour. Clearly, all behaviour change is not uniform. Some people, perhaps those who are less likely to co-operate with a study, will not change their sexual behaviour despite very high risk. Other people take precautions immediately in order to avoid even the narrowest threat. In the model, the risk is decreased according to the intervention outcomes. Individually, of course, only those people who actually changed their behaviour (and their partners) would directly benefit from the intervention.

Models are limited to the parameters that can be measured. Some of the factors that influence the outcome may be unknown and therefore are not included in the models. In some cultures, many questions that may be relevant to the dynamics of the epidemic (such as prevalence of anal sex, spouse sharing or drug use) may not be culturally appropriate to ask. In fact, in the CSW population, all of their paid sexual activity is illegal and many women are not willing to be identified publicly as CSWs. Some women may not even admit that they are sex workers to themselves. Therefore, many women who exchange sex for money or in kind may not identify themselves as sex workers but would still be at high risk for HIV.

Even parameters that are based on data that is collected empirically must be interpreted as estimates and not as absolute fact. Equipment used to measure the outcomes may be faulty and there is always the possibility of human error. Mistakes in the data may occur in the selection of subjects to include in the data collection, in the measurement and in the recording.

There are a number of choices of mathematical models that can be used to estimate the impact of an HIV prevention intervention. These models range from very simple equations to complex, sophisticated, dynamic models. The model that was developed for this project is quite simple and straightforward, but it suits the question that was asked.

Generally models that look at HIV prevalence base their population data on results from women who present at antenatal clinics. This is because the data are routinely collected and the women are clearly sexually active. It is possible that the antenatal clinic data are not representative of the HIV prevalence in the overall population. One study found that HIV prevalence in a rural East African population was significantly lower in antenatal clinic attendees (by 3.6% versus 4.7% HIV positive, P = 0.025) than in women from the general population (Changalucha *et al.*, 2002). Therefore, using ANC data are certainly a limitation to modelling cost-effectiveness of HIV prevention activities.

Limitations of This Project

This project was carried out in a careful, thoughtful and thorough way and was guided by the input of many expert and experienced advisors. However, despite the attention to creating an excellent and accurate assessment of the cost-effectiveness of the programmes, the process was not without limitations. This section describes the limitations of the project including the design, the data that fed the model, and the process of calculating the DALYs.

Limitations to the Model Design

The model that has been created for this project is "open". This means that more people are entering the model as time moves forward. However, the influx of people is mainly there to account for normal sexual maturation and a slight population growth (as seen over ten years). Other populations that are interacting with the target populations may be influencing the impact, but have not been measured. The model influx of new people, only includes HIV negative people into the population. Obviously, some people entering the population of Nairobi (i.e. through immigration or migration) would in reality be HIV positive.

The model robustness is tested by how well it maintains stable population trends and compartment population balance over long periods of time. This model was tested over 1, 2, 5 and 10 year periods in order to assess if the population parameters made sense within the context of the epidemic. The Spectrum model (Futures Group International, 2002) acted as a guide in looking at the expected future trends of the HIV epidemic in Kenya. The model was found to be robust and followed a reasonable and expected population balance and HIV prevalence. In no one compartment (i.e. CSWs or Men) did the population become depleted or grow at an unexpected rate.

Not all sex acts were included in the model. The parameters, number of people per compartment and flows were estimated using the national statistics, surveillance data, literature and KAP studies. The data assumes an epidemic that is driven by vaginal, heterosexual sex. The KAP studies show that there is some sex between men (4.2% ever, none in last three months- Thika KAP) and some anal heterosexual sex (1.8% ever practiced- Thika KAP; 1.6% ever Youth), but these were not accounted for as the data over the last three months was zero in both categories. While significant numbers of anal and homosexual intercourse are denied in Kenya, the actual sexual behaviour is again unknown.

Not all modes of HIV transmission were captured in this analysis. This model was only designed to capture cases of HIV averted through sexual transmission. The reason that mother-to-child transmission was not included was that the intention of this thesis project was to capture the impact of a number of HIV prevention programmes in a comparable way. As babies will not transmit the virus for many years (if ever), it is important to study their HIV infection separately from the adult population. The CEA of interventions to prevent infant and childhood HIV infection is a separate, but related public health problem to the question that this project addresses. Mother-to-child transmission is an important and serious concern in Africa and has been addressed by other studies for effectiveness and cost-effectiveness (Halpern *et al.*, 2000; Marseille *et al.*, 1999; Marseille, Kahn & Saba, 1998; Newell *et al.*, 1998; Mansergh *et al.*, 1996; Skordis and Nattrass, 2002; Wilkinson *et al.*, 2000).

As mentioned above, a challenge arose to the modelling process when it was shown that the number of sexual encounters between men and women did not match. Men claimed to be having more sexual encounters with women than women were admitting to. To remedy this, a mathematical formula was used, basing the men's sexual behaviour on the women's, while increasing the women's behaviour to compensate for underestimation. In this way, a compromise was made between the coital encounters of men and women and the current model shows that each man has a female partner for every claimed encounter. Another limitation in the study is that the model measures only the costs and outcomes from the perspective of the provider. It was the intention of the researcher to assess the costs and effectiveness of the programmes from the perspective of the University of Manitoba and the University of Nairobi collaborative project. The data was collected with the question in mind, "What would it cost to replicate this study in a similar environment?" The costs are therefore considered incremental. While training for staff on syndromic management was considered, for example, the basic nursing training that the person had already received was not. Therefore the study assumed that there was already a basic health care system with nurses, doctors and pharmacists to educate in this area. Also, in some cases, the groups met outside, under trees and in the shade of the health care centre. These informal meeting places already existed and no charge was associated with them. However, if these places did not exist or people decided to meet in a formal place, then a cost would be incurred.

The model was only designed to capture the difference between the cumulative HIV incidence with and without the Project prevention interventions. Clearly, there are other HIV prevention interventions being carried out in Nairobi. Any synergy resulting from these projects were not measured. However, there is no clear way to know what other organisations were operating in the areas during the year 2000. Only now in 2002, through the new Joint AIDS Programme Review, is the exact coverage and scope of activity in HIV prevention arena beginning to be understood.

Limitations to the Data that Fed the Model

The data that fed this model were based upon people's reported sexual behaviour, ANC data, reports and the published literature. This was the best available evidence of the actual situation that was occurring in Nairobi in the year 2000. However, there were limitations to this data.

Some of the data in the model were based on results from antenatal clinic surveillance data. This could influence the data if there was something about the people who visit antenatal attendees that was not true of the general public. Antenatal attendees are used as they represent many economic and social sectors of the general public, are in the reproductive age group, and all have been sexually active. The ANC data are also routinely collected, and no new data collection programmes need to be created. However, there are drawbacks to using ANC data. One study has demonstrated that ANC data is representative of a group of people that are less at risk of HIV than the rest of the sexually active population (Changalucha *et al.*, 2002). This study from Mwanza, Tanzania found that in a rural population, HIV prevalence was significantly lower in antenatal clinic attendees than women in the general population. Also, abortion amongst CSWs is known to be high (ICROSS, 2002). Therefore, many women in this high-risk category may never attend ANC or even have pregnancies that are carried to term.

The population of Nairobi likely followed a steady increase over the year 2000 as was modelled for this project. There is no indication that there was any great rise or fall in the population during that year. Much of the data used in the model came from the census which is taken every ten years (last done in 1999). The census estimates trends to predict what is happening with the overall population of Nairobi. Of course, even the census has flaws and some people are clearly not counted such as nomadic people, refugees and illegal immigrants. The East African region was fairly stable during this time and there is no reason to expect that there was any major change in the population of Nairobi in the year 2000.

The death categories may also pose a limitation to the accuracy of the model. The death categories are namely "AIDS Death", "AIDS Death CSW" and "Other Death". These death categories were based on the known rates of death from the literature or routinely collected data in Kenya. It is possible that other unknown factors influenced HIV transmissibility and time to death from infection. Other possible death categories such as "Deaths Related to People with both Tuberculosis and HIV" could have been considered, but were not. Furthermore, there are many deaths in Nairobi that go unregistered and therefore, an estimate could only be used to measure each of the category's death rates.

Some of the data used to estimate the parameters were not from the year 2000, but rather from a few years before or after. An exhaustive search in Kenya took place to find the most recent data possible to describe the sexual behaviour in Nairobi. Nairobi data from the year 2000 would have been used for all compartments and parameters if they had been available. Therefore, another limitation to the model is that some of the data that were used to estimate the parameters were in fact not from the year that was being measured. Likewise, where data from Nairobi, or Kenya was not available, the researcher used results from studies in other countries in the region. An example of this is the results of the Mwanza, Tanzania study that was used to estimate the syndromic management of STI effectiveness.

The sexual activity that was used for estimations in this study was based on self-reported behaviour. It is possible that there were cases of sexual abuse of children and rape of adult women that occurred. Women may not include this sex in their reported sexual contacts. One study found that 30% of women in Nairobi over the age of 18 had been sexually abused (UNAIDS, 2000). This sexual contact, although highly likely to result in cases of HIV, was not simulated in the model. Studies would need to be done in order to better understand the rate of rape among the different populations of women.

It is possible that some of the effectiveness parameters that were used in the model did not reflect the actual effectiveness of the University of Manitoba/University of Nairobi programmes. While much of the data used was obtained from Project studies, some of the data were taken from recent published literature from other interventions in the region. The programmes may have been more or less efficient than the ones in the literature. This issue has been partly addressed in the sensitivity analysis but clearly it is also a limitation of the study. However, the closest possible results were used in this project to estimate the CEA of each of the programmes.

Limitations to Calculating DALYs

Assumptions were made during the process that allowed the researcher to calculate DALYs. The researcher based the DALY process on a similar method used by Gilson *et al.* (1997) in the CEA from Mwanza, Tanzania. The process required estimating the disability adjusted life years for a person with HIV/AIDS in East Africa.

This means that an estimate must be calculated of the discounted value that an individual may put onto his/her life due to the illness.

The DALY discounting numbers are an estimate based on work by Mulder from Uganda (Mulder, 1996). Although they are assumed to be adequate DALY estimates for the purposes of comparing HIV interventions, the reports are in Dutch and were therefore not assessable to the researcher. Clearly, these numbers have to be standardised in order to be meaningful. Therefore, the published standards for reducing life years for disability caused by HIV/AIDS in East Africa were used (Gilson *et al.*, 1997).

CHAPTER TEN: **DISCUSSION**

Clearly, the results have shown that the interventions are relatively inexpensive under many different circumstances. A number of areas of the study have opened up interesting points for further discussion. The following chapter includes discussions on the results, the sensitivity analysis and the implications of the thesis project findings.

Discussion of the Results

The three interventions were analyzed to assess the cost-effectiveness of preventing HIV in Nairobi in the year 2000. The CEA results have shown that while there is variation in the cost per case averted in different programmes, all of the programmes yielded good value for money. This is particularly true in light of the high cost that would be required if these programmes were not in place. Cost due to care of the ill, the loss of skilled workers and the economic impact of parentlessness are not measured in this analysis.

The Ranking of Models

While the differences were not enormous, the peer intervention programme for sex workers was found to be the most cost-effective at preventing HIV in Nairobi. The intervention to strengthening the health care system by better treatment of STIs by syndromic management ranked in second place. The least cost-effective programme of the three was the intervention for men in high-risk professions. This is the first time that a single CEA has attempted to compare the results of these interventions in a comprehensive way.

There are a number of plausible explanations for why the CSW programme is the most effective intervention of the three measured. Firstly, the sex workers are highly sexually active and are both exposed and expose others to a high number of STIs (including HIV). Therefore, interventions to reduce HIV high-risk behaviour in these women protect them and many others too.

The CSW programme reduced the incidence of HIV in the non-CSW female population in the first year, more efficiently than either of the other two programmes.

This number increased even further over the subsequent years. Consequently the whole population tends to feel the impact of the CSW programme, even though the overall percentage of CSWs in the population is small (CSWs represent only 4% of the sexually active population, and 1.5% of the overall population).

Another reason that the CSW intervention is so successful is that the programmes are effective at getting the women to use condoms consistently and effectively. The programmes also see a small reduction in the number of partners and STIs in this population. However, this reduction is not as important in reducing cases of HIV as the increase in condom use. Also, by changing the behaviour of one woman, you are changing the behaviour of all of her partners.

Scaling Up CSW Peer Interventions

As CSW programmes seem to be the most cost-effective programmes, it would be expected that those working in HIV prevention in Kenya would be keen to initiate new programmes and scale-up existing ones. However, there is often resistance to working with sex workers for a number of reasons. Sex work is illegal and dangerous. Those dealing with sex workers risk being arrested, beaten or robbed. Many people feel that sex work is immoral and that sex workers are not worth helping.

The Government of Kenya has not come out with a policy on how to involve the sex workers in the fight against HIV/AIDS. Therefore, convincing policy makers and governments to devote resources to reducing HIV risky behaviour through CSW peer-mediated interventions is difficult. However, the results of this CEA may be helpful. By demonstrating that CSW programmes efficiently and cost-effectively save both CSWs and non-CSW lives, the support of policy makers may be won.

Impacts of Time and Prevalence on the Results

Over time, the interventions were able to prevent more cases of HIV and therefore, are less expensive. In the sensitivity analysis, the future "snap shot" over ten years showed that the cost of averting HIV decreased from $101.24 to $70.05 in the CSW programme, from $164.26 to $114.91 in the SM of STI programme and from $241.84 to

$102.94 in the ORM intervention. Clearly, the averted cases of HIV are compounded over time. This has implications for policy makers as they plan their resource commitments over time.

By the tenth year of the model, the gap between the programmes is narrowed. The difference in cost between the least and most cost-effective intervention in year one is $141, but by year 10, the difference is only $52. Clearly, the OFIM is the newest programme to the project and may become increasingly more effective as time goes on.

HIV prevalence and STI prevalence also heavily influence the results of the intervention's cost-effectiveness ratios. The costs were shown to decrease as the existing population prevalence of both STIs and HIV increased. This has implications for the choice of target group when designing an HIV prevention intervention.

The parameters that were chosen in the model used were often the most conservative likely estimate found from studies in the East African Region. ANC data was also used and this may produce some underestimating of the prevalence of HIV in the population (Changalucha *et al.*, 2002). It is possible that as a result of our conservative stance the actual impact of the Project interventions may have been slightly underestimated. It was decided that it was more sensible to be conservative than to overestimate.

The Impact of the Interventions on Disability and Death

The DALY analysis shows that there is also a great amount of suffering and disability that is prevented, when a case of HIV is averted. In fact, the gain in disability adjusted life years is 16.2 years for every case of HIV that is averted. The DALYs saved showed that the University of Manitoba/University of Nairobi programme averted a lot of suffering as well as just lives lost (CSW: 15,925 DALYs saved, SM of STIs: 11,761 DALYs saved, and OFIM: 5,978 DALYs saved in one year).

Even the DALYs do not fully capture the whole impact of the intervention on people in Nairobi. The suffering that was averted, or the resulting health care costs and missing days of work were not directly calculated in the CEA. Clearly, this would make the projects even less expensive and could even result in a negative programme cost.

Gender Differences in Cases of HIV Averted

The ratio of female to male cases of HIV averted was also measured. It is important to look at the overall effect of the programmes by gender to assess that the programmes are fairly distributed to the whole population without prejudice. The model demonstrated that the female to male ratios of cumulative HIV incidence were altered according to the different programmes that are implemented. The mechanisms underlying these patterns are a function of which population groups are the focus of the intervention. The difference in gender HIV incidence has social implications. In some cases, it may be politically more attractive to protect men as they have been the traditional wage earners in Kenya. On the other hand, there may be practical reasons for focussing on prevention interventions that protect mainly women.

Male to female transmission of HIV is twice as efficient as female to male transmission. Therefore, if the practice of risky sex was evenly distributed throughout the population, then a doubling of female incidence over male incidence would be expected. However, the model estimated that the female incidence is only 1.66 times the men's over one year. It makes logical sense that all sex acts are matched one woman to one man. Therefore, it can be said that a greater proportion of men is engaging in risky sex with a smaller proportion of women. Much of this is sex in the context of the commercial sex trade.

Women have the added risk of passing HIV on to their babies through mother-to-child transmission. Although not measured in this model, the impact of mother-to-child transmission cases of HIV averted would be seen predominantly in the interventions that prevent larger numbers of cases of HIV.

Discussion of the Sensitivity Analysis

A sensitivity analysis was performed in order to assess the robustness of the model and its ability to maintain the overall ranking of the cost-effectiveness ratios, despite plausible changes to the parameters. The sensitivity analysis found that the interventions remained consistently ranked under the conditions that are outlined in Figure 10A.

Figure 10A: Parameters Measured in the Sensitivity Analysis

CEA Ratios Remain Ranked CSW, ORM, SM of STI under the following conditions:

- Programmes measurement over 1-10 years
- 6-12% of the sexually active population CSWs
- 1.5 to 6 moderately risked men sex partners per CSW
- 7 to 24 high risk men per CSW per month
- HIV prevalence CSWs from 35-50%
- HIV prevalence ORM from 20-35%
- Coital frequency in the general population from 8-16 per month
- STI Prevalence within 20% of stated results
- Total population sexually active in a one month period from 31-50%
- The least and highest risk combinations of the above

Therefore it can be said that under those conditions, CSW peer interventions cost $2.95 to $12.85 per DALY. SM of STI programmes cost $6.74 to $15.47 per DALY. ORM programmes cost $6.35 to$24.27 per DALY. There was no single condition measured that resulted in a change in the ranked order of cost-effectiveness. US dollars and Kenyan Shillings were also calculated for these ranges. Table 10A below shows the ranges in these currencies.

Table 10A: Range of Cost per DALY for Each Intervention, by Currency Type

Intervention	Canadian Dollars (Model DALY)	US Dollars (Model DALY)	Kenyan Shillings (Model DALY)
CSW	\$2.95 to \$12.85 (\$6.25)	\$1.75 to \$7.59 (\$3.69)	133-578 (281)
SM of STI	\$6.74 to \$15.47 (\$10.14)	\$3.99 to \$9.13 (\$5.98)	303-696 (456)
OFIM	\$6.35 to\$24.27 (14.93)	\$3.75 to \$14.33 (\$8.82)	286-1,092 (672)

Even at their most expensive cost per case of HIV averted as calculated in the sensitivity analysis range, the interventions are still among the least expensive of the results found in the published literature. The CSW Peer intervention remained by far the least expensive, with the SM of STI intervention ranking second.

The objective of this project was to compare the three interventions against each other to obtain their relative cost-effectiveness ratio. In this analysis the ORM project was shown to be the least cost-effective of the three interventions measured. This certainly does not mean that interventions with men at work are not cost-effective, simply that it is not as cost-effective at reducing cases of HIV as the other two interventions measured. In fact as was demonstrated earlier over time, the ORM intervention may become even more cost-effective than the SM of STI project.

Discussion of the Implications of the Findings

These results should not be used independently to guide policy, but should be used within a body of other evidence to guide decision-makers to make difficult choices. Models are used to generate estimates based on specific populations. Also, the process that was used to estimate the costs of the programmes made many assumptions based on the situation in Nairobi. The analysis assumed that there was an existing health care system in the area, and that trained carers were available. This means that while the nurses' salaries were included in the SM of STI programme costing, the nurses' original training in basic nursing was not included.

Other projects should use caution if making decisions based solely on these cost-effectiveness ratios. In fact, there is even a variation between cost of the SM of STI programme in Tanzania (US$271 per case of HIV averted, Gilson *et al.*, 1997) and the results that this project generated (US$97.10). Part of why the Project costs are so low is that one management team oversees a number of different programmes, making the actual management cost per programme relatively low. Table 10B outlines the costs that would be seen if all of the Project management costs were attributed solely to the SM of STI intervention. This new estimate is then compared to the Mwanza, Tanzania result (Gilson *et al.*, 1997).

Table 10B: Cost of the SM of STI Intervention with the Entire Project Management Costs

Actual SM of STI Costs per case of HIV averted (in $US)	SM of STI Costs with Entire Project Management Costs	Mwanza, Tanzania Estimates (Gilson et al, 1997)
$97.10	$418.16	$271

The Project staff team has built up a phenomenal programme of interventions over the years that have allowed them to become very efficient at preventing HIV. By taking on a number of programmes, the resources at the Project can be shared and taking on a number of programmes lowers individual programme costs. This is another incentive for people to build comprehensive HIV prevention programmes.

The Project CSW peer intervention programme was only slightly less expensive in cost per case of HIV averted than the intervention that was carried out in Cameroon (US$79 verses US$59.79). The Cameroon intervention was mainly focused on condom distribution. The Kenya CSW Project appears to have been more comprehensive.

It is convenient to carry out interventions in cities, where resources are available. Kenyan salaries are low and there are many intelligent, educated people who live in Nairobi. Nairobi is a big enough city to allow for all supplies to be accessed, if there is a will for it. Infrastructure already exists to move supplies and people around the city of Nairobi. In places where supplies are difficult or expensive to access, salaries are higher, and medical staff is not sufficiently trained, the results may not be as favourable.

The University of Manitoba/University of Nairobi Project must also be acknowledged for the efficient and professional way that they do business. The projects are run in such a way that they are low-key and cost-effective. Management and operational costs are minimal and many projects are run out of the same office, making the individual project operational costs low. The training materials are also shared among many projects, again cutting the overall costs to each project.

A great deal of credit for the inexpensive way that the project is run must go to the project staff and the participants themselves. Participation in the HIV prevention activities only takes place because of the mutual respect that exists between the Project staff and the participants. It is clear from spending time with the Project staff and the people that they serve that there is genuine caring that occurs. This sort of efficiency, caring and professionalism may be reflected in the results of the CEA, in a way that can not be easily replicated.

The cost per DALY gained of the three Project interventions was considerably less expensive than any of the cost per DALY gained care interventions for people with HIV that were found in the literature. Clearly preventing HIV saves not only suffering, the loss of skilled labour and parentlessness but also direct costs. It should be acknowledged that the society could in fact save money by implementing HIV prevention interventions such as peer interventions for CSWs, SM of STI, and OFIM.

CHAPTER ELEVEN: **CONCLUSIONS**

In recent years, more emphasis has been placed on the use of cost-effectiveness of health interventions to determine if resources are being allocated efficiently. Now, in the face of a growing worldwide HIV epidemic, it is even more imperative to identify those interventions that prevent the greatest amount of suffering for the least cost. Interventions may have been overlooked in the past because they are controversial or include sectors of the population that are discriminated against. By using CEA, this project has been able to demonstrate the value of using all three of the interventions measured, regardless of which people were being targeted.

All of the interventions prevented many cases of HIV. In fact, the Project's interventions were more cost-effective at preventing HIV transmission than many of the other published results from CEAs of sexually transmitted cases of HIV in sub-Saharan Africa. The continent of Africa is facing a deadly, widespread epidemic that has proven difficult to slow. However, the model demonstrates that a number of effective and cost-effective strategies are being implemented to slow the spread. Clearly without the interventions that are being carried out by the University of Nairobi and other groups, the situation would be even worse than it currently is.

HIV prevention programmes are more effective when they target the people who are most active in risky sex. This was demonstrated in the scenario where the CSW partners were reduced by 50%. Clearly, if CSWs are not having a great number of partners, interventions that target them for prevention are less effective. At 50% decrease in sex partners, the CSWs have only seven ORM partners per month and 1.5 moderately risked men partners. In this case, the CEA was only marginally more cost-effective than the SM of STI programme. The ORM programme became very costly. This is due to the fact that both the CSW intervention and the OFIM rely on their ability to block transmission between sex workers and their partners. Clearly if there are few partners, the intervention appears to be less cost-effective. This emphasizes the need to target those women who are most active in the sex trade.

Targeting sex workers for HIV prevention not only prevents cases of HIV in that particular population, but also serves to reduce the overall population HIV incidence. CSW interventions are the most cost-effective overall and prevent a significant number of cases of HIV in the non-CSW population. Often policy makers find it difficult to lobby support for prevention programmes that involve illicit and illegal activity. However, in Kenya, the Government has declared the HIV epidemic a National Disaster. Perhaps in light of this and the obvious negative impact the epidemic is having to the societal and economical health of the country, the policy makers in Kenya will decide to work with CSWs to reduce the spread of HIV. Clearly the CEA results emphasize that the cost of over-looking this vital and potentially co-operative group of women may have devastating results on an already desperate situation.

Given that the sex worker programmes were shown to prevent the greatest number of cases of HIV, and were also shown to be the most cost-effective of the three interventions (and in fact any HIV prevention intervention found in the literature), it may be tempting to say that Kenya should focus all of its resources on this one project. There clearly is a need to scale up exiting programmes and enroll all CSWs who are interested in peer groups. However, there are only so many CSWs who will voluntarily come forward to participate. Beyond facilitating the peer intervention interventions for CSWs, Kenya can also create a comprehensive mix of other effective programmes. Efforts must be made based on National goals and interests to produce effective and cost-effective programmes that also make sense within the context of the country.

These HIV prevention interventions are effective. Presently, there is no efficacious vaccine for HIV. There is no cure for HIV and there are few treatments for the opportunistic infections that Africa as a continent can afford. Therefore, behavioural and risk-reducing interventions must be implemented to reduce the burden of the HIV/AIDS epidemic. Interventions that prevent the greatest number of infections with the least amount of resources must be identified for a logical, strategic HIV prevention programme to be designed.

Spending on HIV prevention activities yields good value for money. Economic analysis provides a standardized measure of effectiveness per unit of resource input.

Large funding bodies such as the World Bank are now beginning to demand evidence of cost effectiveness before monies are released for HIV prevention. The Government of Kenya is now looking at CEA as one of the tools used to direct policy decisions in Kenya. Many people are starting to look at the interventions that are likely to result in the greatest desired effect with the least amount of resource. Therefore, the results of CEA must be made readily available to all parties who are looking for evidence on which to make policy decisions.

Strategically implemented behaviour change and risk reduction can be carried out in Kenya to slow or even reverse the trend of HIV incidence. The evidence is now available to allow us to equip people with the tools to prevent or reduce viral transmission. Half-hearted, piece-meal attempts at HIV prevention in Kenya must come to an end. A unified, strategic, scaled up national programme must be implemented and supported by community, national, and international stakeholders. Resources to meet this need should be distributed in an equitable and strategic way. Armed with these CEA results, policy makers have no excuse but to act.

CHAPTER TWELVE: **RECOMMENDATIONS**

The results have demonstrated that the interventions are all highly affordable and effective at reducing HIV in comparison with other interventions from the literature. It is important for policy makers and those who are planning HIV prevention programmes to be aware of programmes that work and are cost-effective. Where there is the possibility to do so, prevention programmes that are effective and cost-effective should be scaled up. It is also important for people interested in preventing HIV to know that a great impact can be made with an efficient programme, and a relatively small amount of resource.

There should be CSW peer interventions available to all CSWs who volunteer to be involved and incentives should be offered. Agreements should be made under the law not to interfere with efforts to prevent HIV through safer sex with CSWs. Mapping should be done to identify hot spots of sex work in Kenya. Active enrollment should be instigated in all urban slums and in areas that are known to have high concentrations of sex workers.

Given the outcome of this study, one might conclude that most resources in Nairobi should be diverted to CSW peer interventions. However, no one intervention will be effective enough to reverse the tide of the epidemic. Rather, a realistic, comprehensive plan must be created within the political and cultural context of Kenya. A widespread, earnest effort must be made by all sectors of the population in order to make a great impact on the HIV epidemic. The highly effective interventions must not be neglected because of legal or moral objections to working with marginalised populations such as CSWs or their clients.

It is possible to assess the best mix of HIV prevention programmes for Kenya on a national scale. The researcher and others have already done a preliminary study based in Nairobi using the GOALS model to answer this question (Futures Group International, 2002). This assessment was a collaborative effort between the NACC and a number of major funding bodies (including DIFID and USAID) in preparation for the first Joint AIDS Programme Review. The assessment looked at resource input from a sample of groups in the private sector, NGOs, the government, and UN agencies. The model then assessed the overall effectiveness of these activities and calculated national coverage of specific interventions, the impact on national prevalence and the costs per case of HIV prevented. A comprehensive assessment should be carried out to guide the country in the next phase of their prevention programme. This process also identifies the areas within the country's HIV control programme that are severely lacking.

The Project and its funding bodies can use these data to verify for themselves that their programmes are effective and are being carried out at a low cost. The Project should also continue to collect the kind of data that is needed to feed this model so that on-going internal evaluation can be carried out. Deciding which activities should be scaled up can be assisted by the results of this CEA. Caution should be used though to consider other sources of information and assess the political and economic environment to insure that project scale-up is possible.

Additional studies could look at the cost effectiveness of a solely Kenyan-led project. International staff members' salaries increase the overall costs of the programme considerably, but likely have other impacts on the effectiveness and accountability of the projects. Knowing the impact on both cost and effectiveness will be especially important and relevant as the University of Manitoba programmes phase out and more responsibility and authority is passed to the University of Nairobi staff. In the sensitivity analysis, the costs with and without the international staff were considered. It was clear that while the costs of the interventions declined without the international staff, the impact on effectiveness and spending on other areas without these people is unknown.

Further research should continue to assess the cost effectiveness of other programmes that are active in Nairobi. Programmes such as the University of Manitoba/University of Nairobi's collaborative VCT effort could be assessed in a CEA. As of 2003, VCT has become much more accessible in Nairobi. The increased accessibility is seen both in lowered costs and increased number of overall centres in the city. The impact of citywide VCT will also be seen throughout the other interventions, as the participants have access to knowing their HIV status.

This thesis has described the outcome of a CEA for three HIV prevention interventions in Kenya, using a mathematical modelling approach. The model method that was used to assess the CEA for these projects in Nairobi, can now be used to assess other programmes in other countries. Good data on local parameters to feed the model and information on project effectiveness are needed in order to use this method in new areas. Of late, there has been a heartening move towards evidence-based public health in developing countries. If reliable data collection methods are put into place in countries such as India whose epidemics are still young, decision-makers will be able to create models such as this to better understand how to fight HIV in their populations. This will guide policy decisions early on and enable the possibility of staving off scenarios such as that seen in Kenya and other areas of the African continent.

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Appendix A: **Literature Review: Popular Interventions to Prevent Sexual Transmission of HIV that Were Not Measured in the CEA**

An Introduction to Mass Media

Throughout the 1980s and 1990's, a large amount of HIV prevention resource was dedicated to using the mass media as a vehicle for delivering HIV prevention messages. Early in the epidemic, many governments of high-risk countries hastily produced mass media messages as a "knee-jerk" reaction to the threat of AIDS (UNAIDS, 2000a). Mass media's objective was to raise the general population's awareness about HIV/AIDS and to improve their knowledge about transmission. The idea behind the media campaigns was that knowledge would influence attitudes that would in turn modify behaviours. The programmes specifically intended to increase condom usage, decrease frequency of sexual partner change and discourage sex with high-risk people (UNAIDS, 2000a).

Evaluating Mass Media Programmes

According to UNAIDS (2000b), most HIV prevention programmes that are intended for the general population, promote mutual monogamy or condom use. The success of a mass media campaign is measured by the extent to which the intended messages reached the target audience. UNAIDS gives priority to measuring "knowledge" when evaluating epidemics. "Knowledge" is considered a core indicator for measuring the success of a national programme, whether high levels of prevalence are found in the general population or are limited to core groups. Many studies have sought to examine the source of that knowledge and link it to the effect of mass media interventions (Chatterjee, 1999; Hofstetter et al., 1995; Pitts & Jackson, 1993; Wolitski et al., 1996).

The Effectiveness of Mass Media

Throughout the last two decades, many creative ways of delivering HIV prevention methods have been tried. HIV prevention methods were included in comic books, bus stops, billboards and pamphlets. Even video games, and special bingo tournaments were presented to people to make the information relevant and fun (Lechky, 1997; Thomas, Cahill & Santilli, 1997). Celebrities also became involved, appearing on radio and television advertisements to promote information, education and communication (IEC) messages. Debates ensued about whether paid or unpaid advertisements should be used (Donovan et al., 1991). General knowledge, in many places, soared due to the use of mass media. Although media campaigns have been shown to increase counselling and testing, the effect tended to be short-lived (Griffith et al., 1995; Sandbaek & Kragstrup, 1998). Even a legitimate increase in public knowledge about HIV proved to have little influence on people's actual behaviour (Lindan et al., 1992). Celebrity admissions of HIV positive status have brought an increase in public awareness but failed to identify significant numbers of HIV positive people in the community (Kalichman, 1994; Langer et al., 1992). Studies measuring the response of celebrity admission show that the "worried well" were convinced to become tested (Ross & Scott, 1993). This is likely to have little impact on the overall epidemic, as the high-risk groups were not being reached.

Within developing countries the possible reasons for the failure of HIV prevention programmes using the media differ. One study in Zimbabwe showed that although a media programme facilitated an increase in knowledge and the intention to change behaviour, it was believed that change was impeded due to low female autonomy, poor economic status, labour migration, and alcohol consumption (Gregson et al., 1998). Moreover, a study in China identified the distrust of health information from the media as a reason for non-compliance to a media-centred HIV prevention programme (Walsh et al., 1997). In one study from Kuwait, changes were seen in knowledge and intended behaviour. However, the data suggested that changes did not occur in specific aggregates (under 40, single, lower socio-economic status, etc.) that were potentially at the greatest risk (al Owaish et al., 1999).

Media campaigns can also have negative side effects. Mass media messages that intend to discourage interaction with high-risk people may only prove to further stigmatize commercial sex workers and drug users. In Thailand, media messages resulted in labelling CSWs as the "Feared Other" and "threatening agents of infection" (Lyttleton, 1996). This can alienate CSWs from health workers and drive the practice of sex work further underground. In this way, the valuable opportunity to partner with CSWs is lost.

Another example of a potentially dangerous use of media is illustrated in an HIV prevention commercial that was being broadcast in North America in 2001. In the advertisement, a pretty, young woman is gleefully dancing barefoot and singing a carefree song. The dancer is oblivious to a broken glass that is on the floor. She cuts herself on the glass and is seen bleeding and crying. Someone hands her a pair of shoes and she resumes her dance. Although seemingly benign, this commercial may be sending messages that are contrary to the goals of HIV prevention. According to Tolloch and Lupton (1997), young people may actually be challenged to take risks by being exposed to such messages. Many young, disadvantaged people live in a dangerous sub-culture where risk-taking is glorified. Many youths feel 'invincible' and potential consequences for risky actions are underestimated. One sample of sexually active youth in a high prevalence area of Burkina Faso, did not believe that there would be consequences to practicing unprotected sex (Ouedraogo et al., 1996). By equating casual sex with fun, light-hearted, barefoot dancing, and condoms with shoes, one may actually be saying that people who wear condoms are cowards. The message may make young people wonder if they are willing to take the risk of pain for the pleasure of freedom.

Although media-based education programmes can deliver information to vast portions of the population quickly, measuring the real impact that they make is difficult. In 1990, the annual cost of programmes aimed at promoting safe sex through mass media in Gabon was 32 cents US per capita. Unfortunately, the study was unable to attach measures of "effectiveness" to those costs (Sonderlund et al., 1993). No study adequately measuring the effectiveness of media on HIV behaviour change was found.

An Introduction to School-based HIV Education

HIV prevention education in schools involves a programme targeted at youth and taught by teachers and educational staff during school time. Normally, it is incorporated into the existing sex education programme. The objectives are comparable to those of mass media programmes: provide information, raise awareness, encourage discussion, develop and encourage safe behaviour (i.e. delaying age of first sexual activity, condom use etc.) and prevent stereotypes and fear. It is usually assumed that the target audience is HIV uninfected, so the focus is on primary prevention (UNAIDS, 2000a). The media used for the educational sessions can consist of pamphlets, books, handouts, videos, and posters.

The effectiveness of all prevention interventions depends upon the amount of risk that exists in the target group. Overall, prevalence of HIV tends to be higher in teenaged girls than boys (Ng'weshemi et al 1996). HIV positive teenaged girls outnumber HIV positive teenaged boys in Kenya as well (NACC, 2000). One multi-site study looking at four different countries in Central and East Africa, found that the reason for the up to 20% difference in prevalence rates between teenaged boys and girls was commercial sex work and sex with men older than 25 years (UNAIDSa, 1999).

Evaluating School-based Education Programmes

The success of a school-based education prevention programme is often evaluated according to the increase in knowledge gained about HIV transmission, the attitudes towards people with AIDS and the intention of the students to engage in risky behaviours. Some studies have attempted to measure behavioural outcomes such as condom utilization (Harvey, Stuart & Swan, 2000) and age of first sexual contact (Stanton et al., 1998).

As the prevalence of HIV increases, the likelihood of contracting the virus earlier in a person's sexual experience escalates. Compiling accurate data on the age of first sexual experience is necessary to target the most effective audience (UNAIDS, 2000b). One African study found that by the age of 20 virtually all people were sexually active (97% boys, 99% girls). However, another study found that in the 15-19 year old group, only 20-49% of young people were sexually active (UNAIDSa, 1999). Therefore, interventions that are intending to increase the age of first sexual contact must target teens that are no older than 15 years of age.

Only one study found in the literature specifically targeted younger students (Klepp et al., 1997). Other studies evaluated the impact of HIV prevention messages on older youth (Fitzgerald et al., 1999; Peltzer, Cherian & Cherian, 1998; Sallah et al., 1999; Stanton et al., 1999). Yet, programmes that target younger teens may be more effective from a public health prospective. Firstly, the proportion of the population of youth in a community who are attending school decreases over time. Secondly, younger teens that have not yet had their first sexual encounter may be more amenable to behaviour change. The only evidence of positive behaviour change found in the literature was in an aggregate of female virgins (Stanton et al., 1998). Another study showed that an increase in knowledge was seen only in females less than 16 years of age (Migliori et al., 1996).

The Effectiveness of School-based Education Programmes

There is conflicting evidence amongst studies that have aimed to prevent HIV through school-based programmes. One study that was looking at primary school children in Tanzania observed statistically significant increases in safer behavioural intentions after being exposed to their programme. However, there was no significant difference between the two groups in their attitude towards having sex and the initiation of sexual intercourse in the previous year (Klepp et al., 1997). One study reported a significant increase in condom use amongst South African youths who were exposed to a school based drama programme (Harvey, Stuart & Swan, 2000). The previously mentioned study in Namibia suggested that female youths in their project area who were sexually inexperienced at baseline were less likely than the control group ($p<0.05$) to be sexually experienced a year later (Stanton et al., 1998). Risk factors that were reduced in the intervention group included not using alcohol, failing to communicate previous HIV exposure or risk, and not using condoms. Follow-up and repeated studies are needed to verify these findings.

A number of studies have observed improvements in the knowledge and attitudes of students who have been exposed to school-based programmes (Aplasca et al., 1995; Migliori et al., 1996; Sunwood et al., 1995; Teka, 1997). But very few have shown evidence of sustained improvements in safe behaviour.

As with media, there is a potential for school-based education programmes to be harmful. Trainers may not have access to appropriate educational materials. Studies have found evidence suggesting that knowledge about HIV amongst teachers and student nurses is not always adequate (Bester & Aredse, 1996; & Elzubier, el-Nour & Ansari 1996). There is a serious risk of reinforcing stereotypes and misconceptions about HIV and people living with AIDS.

One US study modeled the pregnancy, STD and HIV outcomes for 345 sexually active youth involved in a school-based prevention programme. This intervention was thought to be cost effective in this context (Wang et al., 2000). However, this study was done in a low-prevalence, high cost of care area. In 1990, the annual cost of programmes aimed at promoting safe sex in Hungarian schools (ages 11-14) was $1.33 US per pupil year of education. Unfortunately, the paper was not able to attach measures of "effectiveness" to those costs (Sonderlund et al., 1993). No studies were found in the literature that looked at the cost-effectiveness of school-based programmes in Africa.

An Introduction to Social Marketing of Condoms

Condoms are estimated to be 87% effective against transmission of HIV between sero-discordant couples (Davis & Weller, 1999). Social marketing is the adaptation of business techniques to increase social goals (UNAIDS, 2000c). The goal of Condom Social Marketing (CSM) programmes is to make condoms available, affordable and acceptable to low-income communities and high-risk groups in Africa. When high quality condoms are used properly and consistently, they can reduce the transmission of both HIV and STDs. Condoms can be packaged attractively and sold to the target group at a price that is affordable. Marketing research is used to determine the right look and price for the condoms. WHO and USAID have subsidized condoms heavily, selling them for only 2.4 and 4.5 cents US respectively (Ng'weshemi et al., 1996). The National AIDS Control Council of Kenya was recently able to buy the condoms that they distribute for cost 3.3 cents US (Personal Communication Dr. Chebet). Social marketing programmes involve the commercial sector in selling the subsidized condoms to the people who most need them. Market research has shown that people believe *bought* products to be of greater value than those that they are given free of charge (UNAIDS, 1998).

An advertising campaign must accompany the increased accessibility of the condoms. This will ensure that people are aware of what condoms are, where to buy them, and how to use them. The expectation is that education through media will increase the demand for the condoms and the distribution programme will supply the necessary product.

Evaluating Condom Social Marketing Programmes

CSM projects must ensure that a number of components are in place. First of all, the condoms have to be available in order for people to use them. Condom vending should occur in close proximity to where people have risky sex (bars, hotels etc.). One study in Kenya found that the 74% of men who had sex with female sex workers did not use a condom because they did not have one (Ndinya-Achola et al., 1997). Next, the condoms have to be of good quality. If poor quality condoms are used, they will not be effective. If some low-quality condoms are found to break easily, then people will lose confidence in the ability of condoms to protect against HIV (UNAIDSb, 2000). Measuring condom availability can be done at a national, district, project, or shop level. Assessing people's willingness to use condoms is also important. This can be done through a Knowledge, Attitude, and Practice (KAP) study. Even if good quality condoms are available, if there are social, religious, and cultural reasons for not using them, the programme will not be effective.

Often CSM is measured by tracking the sales of the subsidized condoms. Some projects measure success by their substantiated increase in condom sales between the project's initiation and a specified time period. Measuring effectiveness according to the success of sales presumes that the purchase of a condom equates to its use (UNAIDS, 1998). To triangulate these results KAP studies and qualitative information from sales people and consumers can be assessed simultaneously.

The Effectiveness of Condom Social Marketing Programmes

Many of the studies in the literature assessed self-reported condoms use (Kamya et al., 1997; Konde-Lule, Tumwesigye & Lubanga, 1997; Mehret et al., 1996; Reddy et al., 1999; Welsh et al., 2001). A number of studies showed that even when people were aware of the usefulness of condoms, the majority was unwilling to use them (Araoye, Onile & Jolayemi, 1996; Mnyika, Kvale & Klepp, 1995). Numerous people who are engaged in high-risk activities do not believe themselves to be at risk of HIV (Meda et al., 1998). Nonetheless, the trend towards increased condom use in many study areas in sub-Saharan Africa appears to be on the rise (Konde-Lule, Tumwesigye & Lubanga, 1997). This may be due in part to the increase in prevalence of AIDS in the region. A study looking at HIV transmission in sub-Saharan African cities found that women who lived in low prevalence areas were less likely to use condoms than those living in high prevalence cities (UNAIDSa, 1999).

One study in South Africa discovered a significant increase in condom use with the respondent's spouse after a CSM campaign. Interestingly, a similar increase in condom use amongst "other partners" was not observed (Meekers, 2000). Knowledge about condoms is also increasing, but there is still unwillingness on the part of many educators and family planning educators to promote condom use for HIV prevention (Abdool-Karim, Abdool-Karim & Preston, 1992; Teka, 1997). One study in Tanzania found that the majority of women who were not using condoms claimed that the reason was that "men did not like them" (Kapiga et al., 1995).

Female condoms may also become an effective way of preventing HIV. Female condoms (also known as femidoms) are devices made from two plastic rings connected by a sheath made of polyurethane plastic. The ring at the closed end is inserted into the vagina to keep the device in place, while the other is left outside of the vagina. In a Thai study looking at the sexually transmitted infections among commercial sex workers, the female condom was shown to decrease the number of new infections by 34% (UNAIDSd, 2000). Some women have claimed that using the female condom gives them more freedom and feels more like unprotected sex than its male-worn counterpart (CHGE, 2000). However, a Kenyan controlled study that provided both female and male condoms to women working in plantations found that female condoms did not enhance STD prevention (Feldblum et al., 2001). In fact, almost 40% of the women didn't even try the female condom. The major reason that was given for not using the female condom was partner objection.

Despite the fact that female condoms are women-controlled, there is a limit as to how much power women will gain over their sexual experiences. In many partnerships, men may still object to the woman's use of the condom for cultural or fertility reasons. Women who would choose to use the device surreptitiously would be unable to do so, as the outside ring is visible during sex. Some of the drawbacks that have been described with female condom use are: difficulty with insertion, dislodging during sexual activity, noise, and cost (in Canada a three-pack of female condoms is Can$10.00, while a twelve pack of male condoms is Can$6.29-9.99). The cost of producing the female condom in developing countries would have to be very highly subsidized in order to make it an effective, protective, woman-controlled weapon in the battle against HIV.

Economic, political, religious and cultural environments influence the effectiveness of social marketing programmes. The long-term sustainability of social marketing programmes and their effect on the existing commercial sector are issues of particular concern. Condom promotion is especially effective when used in conjunction with a high-risk aggregate. Discussions about the endorsement of condoms are included in the sections below on programmes that involve commercial sex workers and occupationally focused interventions with men.

In 1990, the annual cost of programmes that promoted condoms through social marketing in Zaire and Cote d'Ivoire were 11 and 15 cents US respectively per condom. Unfortunately, the study was unable to attach measures of "effectiveness" to those costs (Sonderlund, 1993). No studies were found in the literature that looked at the CEA of condom social marketing for male or female condoms in sub-Saharan Africa.

An Introduction to Voluntary Counselling and Testing

Voluntary Counselling and Testing (VCT) can be the community's entry point to both prevention and care (Van de Perre, 2000). As the options for care of people with HIV increases, so does the role of VCT in HIV prevention. Interventions to prevent mother-to-child transmission, management of opportunistic infections, and palliative care services for people with AIDS are some of the reasons that HIV positive people may want to know their status. Screening for HIV could be, in theory, completed on the entire population. This would neither be practical or a wise use of limited resources. Also, specific high-risk aggregates could be targeted for counselling and testing (i.e. pregnant women or CSWs) but this would still need to be voluntary to comply with issues of human rights. People may seek counselling because they are starting a new relationship, are about to get married, or they are embarking on a new phase of their lives. Only 5% of clients in one Ugandan study claimed to be pursuing VCT because they were pregnant (UNAIDS, 1997).

Some of the barriers that prevent people from volunteering to have an HIV test have been identified. These include fear of taking the test; possible violence and discrimination related to HIV positively; lack of economic resources to provide care if positive; and distrust of test results and disbelief that HIV causes AIDS (UNAIDSd, 2000). Despite these barriers, many people are still willing to be tested if the facilities exist to meet the need.

The setting where the VCT takes place is important. Using existing service sites such as STD treatment centres, pediatric services and family planning clinics may provide a less stigmatized atmosphere to offer counselling and testing. Places where antenatal services are held allow testing to be offered to women already pregnant (UNAIDSb, 1999).

Once a person has decided to be tested for HIV and has located a testing centre, the actual process of VCT is quite simple. There are generally five steps (registration, pre-test counselling, blood drawing, prevention counselling, and test results counselling) that can be done as quickly as one day (UNAIDSc, 1999). First they are registered for the test. This is done anonymously to protect the identification of the patient. Next the person engages in pre-test counselling. This should occur in a way that allows for interaction or discussion of the implications of testing in relation to an individual's own health, reproductive, marital or social situation (UNAIDSd, 1999). Thirdly, the blood is drawn and analyzed. The project may consider the implications of charging a user fee for the procedure (Van de Perre, 2000). Fourthly, the person is counseled on prevention.

This counselling should include information about how HIV is spread and how they can protect themselves against HIV. This should include information on the proper use of a condom, where condoms can be purchased, and where local STD treatment centres can be found. Lastly, the client is given his or her test results (UNAIDSa, 2000). If they are negative, they can be counseled about how they can maintain their HIV negative status. This is a good opportunity to reinforce the information and answer questions. If a client is HIV positive, information can be given on protecting their sex partners and unborn children and babies, treating opportunistic infections, and prolonging and improving the quality of their life (UNAIDSc, 1999).

Evaluating VCT Programmes

The purpose of VCT is two-fold: to counsel HIV negative people to remain virus-free and to identify those that are already HIV positive. Regardless of the outcome of their test, individual clients receive counselling to reduce the risk of STDs and HIV infection to themselves and others. The effectiveness of VCT programmes can be measured in a variety of ways. Oftentimes the quality of the counselling is measured. This can be done by observing the counselling directly, asking clients to give feedback on the counselling, or observing the techniques of the counsellor first-hand as a "mystery client" (UNAIDSb, 2000). Other aspects of VCT programmes should be evaluated including the matching of client unique identifier number to their blood sample and laboratory testing for accuracy (UNAIDSd, 2000).

Behavioural intentions are often measured, as following up with patients can be tricky due to issues of confidentiality. Despite the difficulties, some studies have managed to periodically check back with clients to assess their behavioural change UNAIDSd, 2000). Following the sero-status of discordant couples through time has also provided insight into the effectiveness of the project.

The Effectiveness of VCT Programmes

Reviews of projects from the literature on VCT have shown inconsistent results (Cotes et al., 2000; De Zoysa et al., 1995; Higgins et al., 1991; Wolitski et al., 1997). A meta-analysis of 27 published studies found that although VCT was not an effective primary prevention strategy, it was an effective means of secondary prevention for people who were already HIV positive (Weinhardt et al., 1999). Studies have shown an increase in condom use (Kamenga et al., 1991; Tice et al., 1992), monogamy, or abstinence (Muller et al., 1992) among people that have attended VCT clinics. A study in Kenya found that there was insignificant change in the prevention behaviours of women after one year of follow-up after a single session post-partum VCT (Temmerman et al., 1990). In fact, only 37% of the HIV infected women had informed their partners that they were at risk for the virus.

In Rwanda, discordant couples who underwent VCT were much more likely to use condoms than those who did not (Allen et al., 1992). After one year of follow-up, the proportion of VCT attendees who were using condoms increased from 4 to 57%. This change significantly decreased the transmission of HIV in men. Another project in Uganda claims that while only 10% of HIV positive clients reported using condoms before they received their test result, six months after their test date, they were reporting consistent condom use with 89% of their regular and nearly 100% of their casual partners (UNAIDSd, 2000).

Although VCT is clearly *voluntary*, health providers can refer their patients to VCT clinics. In this way, they act as the link between community members and the testing centre. Sadly, a study in Uganda found that 26% of health care workers claimed to have never referred any patients to HIV/AIDS counselling and 31% had never advised patients whom they suspected of having AIDS to be tested (Mungherera et al., 1997). The reasons given for this were time constraints and a lack of knowledge. The question remains whether the people who are engaging in the most risky behaviour would volunteer for counselling and testing. Oftentimes, the people who come forward for testing, particularly after health education campaigns and celebrity admissions of HIV positivity, are the "worried well" (Ross & Scott, 1993). These people are not likely to be HIV positive and are certainly not frequent transmitters. Therefore, they are of little importance to the epidemic from a public health perspective.

The costs of running a VCT programme depend largely on the method of testing, the educational materials used, the cost of trained counsellors or the use of volunteers, and whether condoms are distributed freely. One study recently looked at the cost-effectiveness of a VCT programme in urban East Africa (Sweat et al., 2000). This study modeled the CE in a hypothetical cohort of 10,000 people using data from a randomized control trial that they conducted in Tanzania and Kenya. This CEA found that the average cost per DALY saved was between $5.16 and $27.36 in Kenya and $6.58 and $45.03 in Tanzania. In populations that have an HIV prevalence of 45% (such as many CSW populations), the cost would be decreased to $8.36 in Kenya and $11.74 in Tanzania.

There are potentially negative consequences to VCT if it is not carried out with confidentiality and respect. Isolation, the threat of violence, and discrimination can occur if HIV positive results are made known in some communities. In the case where the sero-status of the husband and wife differ, there is also the threat of divorce. However, a study from Rwanda suggests that home-based counselling by trained nurses may ease some of the psychological challenges that these couples face (Kamenga et al., 1991).

The target group must trust and respect the testing centre staff. If high-risk people perceive that their anonymity will not be respected at the testing centre, they will refuse to go. Testing can be a time of vulnerability for anyone. Psychological problems reported during HIV/AIDS counselling were assessed in infectious disease clinics in Nairobi (Vollmer & Valdez, 1999). This study found that 65% of females and 49% of males encountered greater than 8 psychological complaints from attending a single session.

Appendix B: **Details of the Site Visits to the Projects: An informal Account of the Site Visits**

The researcher visited a number of different areas where project activities were carried out in order to understand the inner workings and spending that occurred at the sites. Below are the descriptions of these visits.

Site Visits to CSW Peer Intervention Meetings

In order to give the reader a personal reflection on the site visits, the researcher will be expressing the following findings informally. The researcher has every intention of describing these people in their everyday environment, and not merely as research subjects. Two site visits were carried out in September 2001. The first visit was to a group of 40 CSWs at the Kariobangi Health Center. If all members had been present, there would have been 25 Trainers of Trainers (TOTs) and 50 peer leaders. The TOTs are themselves CSWs (or former CSWs) who have been trained by the project to train the peer leaders and organise the peer groups. The TOTs also distribute condoms and are important information "bridges" between the project staff and the CSW community. At this meeting, four TOTs were present and 36 peer leaders. This group was called Korogocho and had been together for several years. The women were approximately 30-40 years in age. The women's clothing and hairstyles were not exceptional for Nairobi and they looked like the other people attending the clinic that day. The crowd was joyful and the CSWs were socialising as they met outside of the clinic. There was no specific place in the clinic that they met. The group formed informally outside the building and waited for the social worker to tell them where to meet. In this case, the group was appointed a shaded area outside of the clinic where there were benches. A few peer leaders who were not TOTs were also in attendance.

The meeting began with a prayer and then the researcher and the staff member from the University of Nairobi were introduced. The TOTs were trained in HIV/AIDS prevention and care, banking/saving, counselling, communication and team building, and they passed on valuable information at meetings such as this one. A TOT ran the meeting and discussed condom distribution, counselling and visiting the sick. The members were instructed that they must visit sick group members and wash them, clean their clothes and help them financially. They were also told to buy them nutritious food. The women were reminded to be treated for STIs and to encourage others to do so.

All of the women share a savings account. Twice a month, they are asked to donate ten shillings (about 20 cents Canadian) to a savings account for their futures. The women also donate 20 shillings (40 cents Canadian) twice a month to be used for sick members and funerals). This is called a merry-go-round. All giving is voluntary and the women benefit from the savings and merry-go-round according to what they give. Unfortunately, the office was robbed several times by gangs of men with guns. The group then decided to meet less formally at a safer venue - the health center.

The women were all given a small travel payment of up to 100 shillings for their time and travel expenses. This compared well to the cost of work as a CSW. An alternative economic activity study (Strengthening STD/HIV/AIDS Control in Kenya, 2002) found that the mean weekly income from sex work was 800 shillings (about Can$18). The group had a small office to keep their finances and was used also as a place to meet.

All of the women walked to the clinic, and were wearing shoes. Three of the women carried babies with them. The time was very social and the women claimed to enjoy coming to the meetings. The women had a time of sharing where anyone could come up to the front and share some news or advice. They claimed to enjoy discussing their problems with people who understood and encouraged each other. The women also formed support networks to protect themselves from abusive men. The meeting lasted about two hours. At the end of the meeting, huge boxes of condoms were distributed and the women were encouraged to take as many as they liked. The researcher was told that condoms are always available and of good quality.

The second group that met at the Kariobangi Health Center were a younger group of women. This group was newly formed and had many more members and peer leaders and just two TOTs. The women originally met outside but it was afternoon by this time and they were called in to move inside when the clinic closed. The women were better dressed, healthier looking and had stylish hairdos. While the meeting ran much the same way as the first one, the information given was much more basic and there was less cohesiveness, clapping and singing. The mood of the group was less joyful and more serious. The group were also given sodas, buns and travel reimbursements. The resources that were used by the peer leader groups were as follows: condoms, time/travel reimbursements for the CSWs, soda and buns, and the time and travel of the University of Nairobi employee.

Site Visit to ORM TOTs Meeting

The site visit to the ORM TOTs meeting took place in October 2001 at the Thika District Hospital. 14 TOTs were expected to attend the meeting but only 11 were present. The TOTs were volunteers who were unemployed social worker/health workers, hospital employees or local church leaders. TOTs are trained by the project staff to teach the peer leaders about HIV prevention and healthy lifestyles, distribute condoms and organise the peer groups. The group formed at the hospital and then looked for a place to meet. The meeting hall was being used so they met in the District AIDS Commissioner's office. The other choice would have been to meet outside but this was a noon meeting and the sun was very intense. It was clear that finding a meeting place was not a major issue and the group was content to go wherever there was space.

The TOT group meets every two weeks for a brief meeting with the other TOTs or for an hour with their respective community groups. The groups include prisoners, bus drivers, sand harvesters, touts (people that work on minibuses), CSWs, college students, and military men. The majority of the people in this programme are men. Other people included are those that may have the biggest impact on the sexual health of the men (CSWs and female students). The researcher was present at the clinic on another day when the TOTs were going out from the clinic to meet the men at their workplaces. The TOTs really enjoyed themselves, as was evidenced by the big smiles, clapping and singing.

In 2001, the TOTs and Peer Leaders were supplied with uniforms but these were not available in 2000. The researcher was present at two meetings where the uniforms were being discussed. The TOTs and peer leaders were very excited about getting the T-shirts and slacks or skirts. It is believed that the uniforms will help the Peer Leaders especially to become more readily identifiable as leaders. Condom dispensers are also being bought by the Project in 2002 for the various workplaces and key areas for sexual activity (bars and hotels).

Site Visits to STI Treatment Facilities

Site visits to STI Treatment Facilities occurred in February 2002. The first site visit was to an STI treatment center in Thika at the Thika District Hospital. The hospital is centrally located in Thika town and there are minibuses transporting patients and staff from outlying areas. The researcher and the staff member from the University of Nairobi arrived at the hospital at nine in the morning as the clinic was just beginning to see patients. There was already a queue of 50-60 people waiting outside the general clinic. Within the clinic was what was known as Room 14.

Room 14 is not like most other STI clinics in Nairobi. Most STI clinics just see patients with STIs. They treat the STI and then the person is not required to return, unless the infection does not subside. At Room 14 however, people with STIs are seen, assessed according to SM and treated. The patient is then referred to the on-site VCT centre and is also counselled directly by the STI nurse. Patients who are found to be HIV positive continue to visit the nurse at Room 14 for continued counselling, condoms, STI treatment, and treatment of opportunistic infections. Rapport is built between the nurse and HIV infected individual and the nurses believe that the trust achieves results in more effective counselling.

During her visit, the researcher assessed the environment of the STI clinic. This room was down a dark hallway deep inside the main clinic. Outside of Room 14, there were eight women waiting to be seen. The researcher was later told that the average wait is about 2.5 hours. The majority of them had been referred to the room from the antenatal clinic. They were simply told, "Queue for tea at Room 14". Those who had been to the room before, knew that that meant that they needed STI treatment or HIV-related care. Others were apparently not aware. The hope is that the patients will feel less stigmatised by the STI treatment if it is carried out in a place within the clinic and other clinic attenders are less likely to guess their diagnosis.

Inside, Room 14 was small (about 6 by 14 feet). There was a sink (cold water, no visible soap), a desk and three chairs. A locked cabinet that held records was at one wall and a couch was near the window at the far side. The couch was not used for patients but rather held boxes of equipment. The nurse stated that the couch would be useful for treating opportunistic infections of HIV clients but that there were no sheets to protect them. She didn't think that the couch was necessary for SM of STIs. Two charts were on the wall, a large one for STI syndromic management and another for opportunistic infections. There were no small charts for SM of STIs.

One trained nurse worked at the clinic full time and she was replaced when she was away so that the STI clinic was open Monday to Friday 8am-5pm. Often nursing students were assigned to Room 14 to assist and learn about STI treatments and counseling. In the year 2000, all drugs came in the essential drug kits supplied by a German government aid agency. The following drugs were available at the clinic on the day of visit and were supplied by "Doctors of the World- Spain" and the Ministry of Health. All drugs were available that were on the flow charts for SM of STIs.

Drugs Used for SM of STIs

Drugs Used		
• Erythromycin syrup/tablets	• Tetracycline eye ointment	• Ciprofloxacin
• Augmentin syrup	• Benzathine Penicillin	• Norfloxacin
• Spectinomycin	• Doxycycline	• Amoxycilin
• Procain Pen	• Probenecid	• Nystatin Pess
• Ceftriaxone	• Metronidazole	• Clotrimoxazole Pess

Source: Doctors of the World Form, 2002

Other supplies used in the STI clinic included needles, syringes, alcohol and cotton for injections. Condoms and a penile model were also required for the counselling sessions. All of these supplies come from the Ministry of Health and are consistently available to the Thika clinic. When the Project staff member was asked if there were any problems with equipment and supplies in any of the STI treatment centres, she replied that there were only problems in the last year (2001). In the year of study (2000), funding for all essential equipment was adequate at all of the clinics. Since then, there has been an unreliable supply of STI drugs. Obviously, the unreliability of STI drug supplies would have needed to be taken into account if the year being measured had been the year 2001.

At this clinic, patients who were presenting with their first STI and had not gone for VCT previously were counselled to do so. Likewise, patients at VCT clinics were counselled to attend the STI clinic if they had any signs or symptoms of an STI. ANC attendees were also taught about the signs and symptoms of STIs and encouraged to attend as appropriate. VCT is new (2002) to the Thika clinic and has really just begun to be scaled up as a prevention tool in Kenya.

The nurse saw approximately 15 patients per day and spends about half-an-hour with each one. The vast majority (over 75%) of her clients are STI patients and most are experiencing their first STI. The patients are asked to return to Room 14 for a revisit where almost all are found to be healthy. The nurse believed that the SM algorithm was successful at treating the vast majority of the STIs that she saw. If patients' symptoms continue after the SM treatment, the nurse follows the algorithm to the next line of treatment.

Cost sharing occurs at this clinic with each client contributing 20 shillings (about 40 cents Canadian) towards the cost of the drugs that they are prescribed. Some of the drugs cost up to 1000 shillings ($20 Canadian) a dose, which few patients could afford. A number of very poor clients are exempted even from paying the 20 shillings if they are unable to pay. It is difficult for the nurses to assess which patients are unable to pay for their medications and oftentimes a supervisor is called in to help with the decision-making.

The second STI treatment centre that was visited was called the Special Treatment Centre (STC). The STC has an STI treatment room, a large hall where HIV prevention videos are playing for eight hours a day, a VCT centre and a skin clinic (mostly for HIV and STI related skin disorders). The STC is a large, modern facility that was constructed and supported by the European Economic Community up until 1998. Today, the STC is funded by the Nairobi Health Management Board and is supported by the Project (mostly training) and others. Likewise, the Project uses the STC venue for training of other HIV prevention groups, without paying for the room.

The clinic receives on average 114 patients per day, with 92 of them being STI patients. Cost sharing for the Casino is more expensive than in Thika at 100 shillings (about $2 Canadian) per visit. About 4-5 patients every day are exempt from paying the fees. Due to the centre's role as a referral center, often the drugs and tests are more expensive. The cost sharing covers only about 20% of the costs of the drugs. In the year 2000 international donors supplied all of the drugs for treating STIs and skin disorders. At that time there was no cost sharing. The clinic is now considering increasing the user fee to assist in their ability to become more self-reliant.

Appendix C: **Organisational Visits**

Organisation	*Notes on the Outcome of Meetings*
Family Health International	Information on effectiveness studies, access to library
POLICY	AIDS in Kenya pre-publication copy
NASCOP (National AIDS/STD Control Programme)	Information on costs from Dr. Chebet, information on what's happening in AIDS modelling
NACC (National AIDS Control Council)	Information on what is happening in the country, access to other organizations
UNICEF	Regional information on HIV activities
PSI (Population Services International)	Condom costs and social marketing information
Kenya AIDS/NGO Consortium	Number and extent of NGOs involved in HIV prevention and care: over 600 Claimed only OFIM project in Kenya was AMREF truck driver's study
HAPAC	Information on UK Government programmes
US CDC	Much national activity in HIV but very little on ORM, CSW and STI
HIV/AIDS Business Council	Very little activity taking place in the private sector with HIV prevention in the workplace.
Kenya Association of Manufacturers	Programmes starting out with support from private sector and international donors. Lists of members obtained.
Family Planning Association of Kenya	Community mobilization, some workplace programmes in sugar and paper: 27,000 people involved (2002). Mass media and training also being carried out.
The Baptist Church of Kenya	Youth programmes and VCT. Baptist convention has 2,500 churches and has challenged each church to care for 10 HIV positive people and train 10 people on HIV prevention (2002).

Postbank	Workplace prevention programmes in 2001 and full care coverage for 2,000 employees nationwide. Peer interventions to begin in 2003.
Federation of Kenya Employees	Began HIV/AIDS activities in 2002 with the assistance of UNDP. Policy and IEC activities so far. Very little activity taking place in the private sector with HIV prevention in the workplace.
Anglican Church of Kenya	No HIV/AIDS programmes centrally, churches working independently.

Appendix D: **Discussion Group Response**

Discussion Group Response

Question	Answer	Source	Discussion Group Response
Population of Nairobi	2,143,254	1999 Census data	The group believed that this was the most accurate source for this parameter
Sexually active female population	585,433 Women are 50.52% of the population or 1,082,772. Of them, 50.6% report being sexually active = 547,883. Also, 15.8% of the population is between the ages of 10 and 15. 22% of this age group report being sexually active. Therefore, we include a further 37,550 females.	GOK, central bureau of statistics and DHS, 1998	The group believed that this was the most accurate source for this parameter
Sexually active male population	626,648 Men are 48.48% of the population or 1,060,482. Of them, 55.5% report being sexually active = 589,098. Also, 15.8% of the population is between the ages of 10 and 15. 22% of this age group report being sexually active. Therefore, we include a further 37,550 females.	GOK, central bureau of statistics and DHS, 1998	The group believed that this was the most accurate source for this parameter
% Women who are CSWs	8%	6.17% of pregnant women- ANC data, 2000 12.7% of urban women- Kenya DHS, 1998	According to their experience and the definition that the CSWS are women who regularly exchange sex for money or in kind, the group agreed that this was the best estimate.

% men who are ORM	17%	GOK, economic Survey, 2001	The group suggested that the researcher consult with Mr. Mbugua of the Matatu Association and Mary Kinoti who works with Jua Kali and Allen Ragi of KANCO and AMREF truck drivers study
CSW, HIV+ population	45% of CSWs positive 55% negative	UNAIDS/WHO, 2000 Consultation on STD Interventions, from Pumwani	The group agreed that this was about right but suggested that the researcher check with Joshua Kimani in the Azythromycin study (about 35%)
Female, Male HIV+, population	17% of females 83% HIV negative	GOK 2000	Could check with Prof. Mumo of Haemotology for men/women split of HIV
ORM, HIV+, population	35% (35% HIV positive, Laukamm-Josten et al., 2000) 70% negative	Mbugua, 1995	See above re % men ORM
Condom effectiveness	75% reduction in HIV transmission when compared in always verses never users	NIH, 2000- scientific evidence of condom effectiveness CIDA- Kibera baseline study, 1999, improper use by 15% of those who used them	The group believed that this was the most accurate source for this parameter
Condom Use CSWs	22.75% condom use	CIDA Kibera baseline KAP study	The group believed that this was the most accurate source for this parameter
Condom Use females	7% condom use	Kenya DHS 1998 5.5% during last intercourse ANC data 2000 condom use last 3 months 10%	The group suggested that the researcher approach the Pop Council or UNFPA for information on female use of male condoms- check FHI baseline study

Condom Use ORMs	10% condom use	Thika- CIDA KAP baseline 1999	The group agrees with the 10%
Sexual Contacts for regular couples	10	(Kimani and five other Kenyan doctors 2002) 3-4 times per week based on interviews with gynaecological patients in Kenya Moses S, et al *Social Science and Medicine* 1994; **39:**1649-1656. The mean monthly coital frequency was 8.9 per month in a study from Rakai in Uganda (Gray, 2001).	The group suggests that the researcher check with Dr. Elizabeth Bukusi of medical Microbiology
Number of different non-CSW partners-men	1.35	WHO country update 2000	The group believed that this was the most accurate source for this parameter
Number of different CSWs per men	1.05	National Youth Survey	The group believe that 30% of men see CSWs
Number of different partners-women	1.15	WHO country update 2000	The group believed that this was the most accurate source for this parameter
Sexual Contact per client for each CSW	3	CIDA Kibera baseline KAP study	The group believed that the real number is 5 and that 3 is an under estimate
Number of different clients- CSW	40	CIDA AEA baseline	The group believed that this was the most accurate source for this parameter
Number of different regular partners-CSW	0.6	ICROSS 2002 national CSW study over ½ of women lived with boyfriend/husband	The group believed that this was the most accurate source for this parameter

Sexual contact with regular partner per ORM	8	Based on 20% less than regular partners	See above re Mbugua and AMREF etc.
Number of different CSW partners- ORM	1.5	Thika-CIDA KAP baseline 1999	The group believed that ORMS would see on average 5 different CSWs per month
Number of different non-CSW- ORM	2	Thika-CIDA KAP baseline 1999	The group believed that this was the most accurate source for this parameter

Appendix E: Results of the Follow-up to the Discussion Group

Person Contacted	Subject	Result
Mr. Mbugua of the Matatu Association	• % men who are ORM • ORM, HIV+, population • Sexual contact with regular partner per ORM	No known studies
Mary Kinoti who works with Jua Kali	• % men who are ORM • ORM, HIV+, population • Sexual contact with regular partner per ORM	Mary Kinoti: "No study has been done on this information".
Allen Ragi of KANCO	• % men who are ORM • ORM, HIV+, population • Sexual contact with regular partner per ORM	Allen Ragi: "The only study is the AMREF study on truck drivers".
AMREF truck drivers study	• % men who are ORM • ORM, HIV+, population • Sexual contact with regular partner per ORM	Four articles obtained from AMREF on truck driver's study.
Joshua Kimani	CSW, HIV+ population	45% HIV positive is accurate.
Prof. Mumo of Haematology for men/women split of HIV	Female/male split for HIV positive population of Nairobi	Requested to look at book, "AIDS in Kenya" 2001. Information found.
FHI BBS	female use of male condoms	BBS located. No useful information found.
Dr. Elizabeth Bukusi of medical Microbiology	Sexual contacts for regular couples	Agreed with 10 contacts per months for regular couples.

Appendix F: **Flows Between Risk Groups**

Flows	Description	Value	Estimate based on
golowneg	ORM- to MRM-	0.01	-The Economic Survey 2000 (GOK, 2001b)
gohighneg	MRM- to ORM-	0.004	-Economic Survey 2000 (GOK, 2001b)
golowpos	ORM+ to MRM+	0.015	-Economic Survey 2000 (GOK, 2001b) -Weinhardt et al., 1999
gohighpos	MRM+ to ORM+	0.005	-Economic Survey 2000 (GOK, 2001b) -Weinhardt et al., 1999
unprofpos	CSW+ to Female+	0.012	-Alternative Economic Activities (AEA) Baseline Report for CSWs in the Western Province of Kenya (Strengthening STD/AIDS, 2001).
profpos	Female+ to CSW+	0.003	-Alternative Economic Activities (AEA) Baseline Report for CSWs in the Western Province of Kenya (Strengthening STD/AIDS, 2001).
unprofneg	CSW- to Female-	0.005	-Antenatal surveillance data for Kenya (2000)-The Alternative Economic Activities Baseline Report for CSWs in the Western Province of Kenya (Strengthening STD/AIDS, 2001) -The Kenya Economic Survey 2000 (GOK, 2001b).
profneg	Female- to CSW-	0.0025	-Antenatal surveillance data for Kenya (2000)-The Alternative Economic Activities Baseline Report for CSWs in the Western Province of Kenya (Strengthening STD/AIDS, 2001) -The Kenya Economic Survey 2000 (GOK, 2001b).

Appendix G: **Model Population Movement During the First Month of the Study Run**

Exchange	Description	Value	Total of number of people moving 1st month
golowneg	ORM- to MRM-	0.01	476
gohighneg	MRM- to ORM-	0.004	1231
golowpos	ORM+ to MRM+	0.015	385
gohighpos	MRM+ to ORM+	0.005	250
unprofpos	CSW+ to Female+	0.012	189
profpos	Female+ to CSW+	0.003	147
unprofneg	CSW- to Female-	0.005	79
profneg	Female- to CSW-	0.0025	778