Tracking the risk factors and impact of an intervention to reduce the spread of the HIV/AIDS epidemic in Carletonville, South Africa

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Dedicated to my father, my hero and my inspiration for studying.

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1 Introduction

HIV/AIDS as a pandemic is unprecedented in history in terms of the magnitude of the disease, the number of people affected and infected and the devastation caused to mankind by it. It is certainly also unprecedented in terms of the amount of research generated by the epidemic.

The Carletonville study, which provided the data for this thesis and study, was implemented to try and slow down the rate of HIV infection in the greater Carletonville area. At the time of the study, no treatment was available for the infection and prevention strategies had not recorded major successes either. At that stage the prevention strategies that were available amounted to the so-called "ABC" (an acronym for Abstinence, Be faithful to one partner and use a Condom). The study was conceived by Prof. Brian Williams and Dr Catherine Campbell who realised, while studying disease patterns in the mining industry, that HIV/AIDS was going to have a huge impact on this sector.

The study was designed to implement three different interventions among high-risk groups in the greater Carletonville area. These three interventions involved the improvement of male condom distribution; the improvement of STD treatment services, and the provision of peer education to high-risk groups. Cross-sectional surveys would be implemented to measure the outcome of the interventions. A pilot and a baseline survey were conducted in 1998 and three more surveys followed in 1999, 2000 and 2001. After the pilot and baseline surveys the intervention was altered to include residents of Khutsong, a township close to Carletonville, as the rates of infection proved to be as high in this township as in the so-called high-risk areas. Towards the end of the project another intervention was added in the form of a Preventative Periodic Treatment (PPT) for STDs. This thesis is based on the data generated by the cross-sectional surveys done.

A number of papers on the study have been published in scientific journals (Auvert *et al.*, 2001; Williams *et al.*, 1999; Williams *et al.*, 2000a; Williams *et al.*, 2003), but to date no comprehensive comparison has been undertaken between the different surveys to track the progress and the impact of the intervention. This thesis combines all the datasets and aims to track the infection rates of HIV, sexually transmitted diseases and behaviour change in the different populations of Carletonville.

I was not involved in the initial design of the interventions and was only involved in the implementation of the interventions in a consultative role. My role in the study was to design the cross-sectional surveys in terms of the data-gathering phases, with input from a great number of other parties involved. I was involved in the instrument design phase as well as in the sample design. The instrument originated from the WHO and was adapted for the use in this situation by Prof. Brian Williams, Catherine MacPhail and myself. Together we checked all the questions and through my experience of working in communities like that of Carletonville I was able to suggest rephrasing, and changing question to make them appropriate to the setting. I worked on the sample design with other experts. I was solely responsible for the practical execution of the sample in the field, based on my experience in this regard.

I was also solely responsible for conducting the fieldwork for the survey. This included recruiting, training and monitoring of all field staff. I was also responsible for the data capture of the results. I performed the data analysis myself. I received advice on statistical techniques, from Prof. Brian Williams and Prof. Bertran Auvert, who are both experienced epidemiologists who were involved with the study. I reviewed the literature after my own literature searches and made the links to literature on the findings of the study.

On completion of the study, (Williams *et al.*, 2003) published a paper on the comparison drawn between the 1998 baseline study and the 2000 survey. The 1999 survey was not included in this publication because it focused on the youth and the samples were therefore different to the 1998 and 2000 surveys. The last survey, conducted in 2001, was not incorporated into this publication.

The datasets offered a unique opportunity to track the progression of HIV in a community. The samples of all the surveys were large and the data came from four sequential years. The datasets also linked behaviour and a demographic profile of the participants to the biomedical tests that had been done on the samples collected from participants during the surveys. The data was therefore well suited to a longitudinal study of the progression of HIV in a community.

The surveys conducted followed the so-called KAP (Knowledge, Attitude and Practices) style and in my thesis I explore the advantages and limitations of this tool for gathering data. Although the debates on prevention strategies employed at the time are explored in a literature review, the main aim of this study was to analyse the data from the cross-sectional surveys to assess the changes in behaviour and in the prevalences of various sexually transmitted infections that were observed in the greater Carletonville area during the time of the intervention.

In summary, the thesis firstly considers the body of knowledge that was available at the time of the Carletonville project. This includes an overview of the pandemic in Africa, and then more specifically the epidemic in South Africa. Studies done are reviewed and different interventions that had been implemented and were available at the time are assessed.

Following this discussion, the methodology that was used is reviewed in detail. The debates around the methodology and the practical lessons from the Carletonville study are also discussed.

The research questions are posed and the study is defined in terms of its aims and objectives. The analysis of the data is subsequently reported in three parts. The first part studied the changes in the samples that emerged over the different years of the study, while the next examined the changes that occurred during the study by comparing the earlier to the later samples. The last analysis was a risk factor analysis aimed at isolating the factors associated with HIV infection.

The results of the Carletonville study are then discussed and linked to the initial literature review. Explanations for the findings are offered and discussed. Finally, more recent research undertaken in the field of HIV/AIDS prevention is briefly reviewed.

2 Literature review

The research on which this thesis is based was conducted in the Carletonville area during the late 1990s and early 2000s. Since then, our knowledge of the HIV/AIDS pandemic and the available scientific knowledge has grown considerably. To properly understand the Carletonville study, it is important to examine the body of knowledge that was available during those years. The information that became available more recently can obviously not be ignored and will be referred to later on.

In 2001 Peter Piot, the Executive Director of the Joint United Nations Programme on HIV/AIDS (UNAIDS), and his co-authors reviewed the HIV/AIDS pandemic up to that point. At that time the Carletonville study was ongoing and its findings were not yet available. In their discourse Piot *et al.* (2001) commented on a variety of issues, but what was then already absolutely clear was that the pandemic was increasing rapidly in sub-Saharan Africa and that efforts to find successful preventative measures had been relatively fruitless. They introduced their overview with the statement: "Over the 20 years since it was first identified, the HIV/AIDS epidemic has continued to exceed all expectations in the severity and scale of its impact" (Piot *et al.*, 2001). They quoted estimates that had been surpassed around the world, but mentioned that this was most apparent in sub-Saharan Africa. About three-quarters of all people who had until then died of HIV/AIDS, were from sub-Saharan Africa. "AIDS constitutes one of the most serious crises currently facing human development, and threatens to reverse progress in the most severely affected countries by decades" (Piot *et al.*, 2001). These views were expressed in the "Global report on HIV/AIDS" in 2001 (Piot *et al.*, 2001).

HIV/AIDS prevalence in other parts of the world also increased, even if the progression was not as fast as in sub-Saharan Africa. It would seem that in ethnic minority and poorer communities within high-income first world countries the beneficial effect of treatment and therapy to fight the infection was less pronounced as well. The proportion of those HIV/AIDS-infected furthermore increased more rapidly in these populations within the wealthier countries. For example, in the USA

HIV/AIDS affects minority populations more severely than more affluent populations and communities within the country. In 2001 disadvantaged rural young African Americans were the worst infected group in the USA (Piot *et al.*, 2001).

This was also confirmed by Sinclair (2001) when she reported that the UN had warned that infection rates in developed countries showed no sign of slowing down, while 45 000 new infections occurred in North America in the year 2000. In Canada there were around 4 200 new infections per year from 1996 to 2001. The incidence clearly seemed to be rising in marginalised populations in these countries.

In the adult population of seven of the sub-Saharan African countries HIV/AIDS prevalence was higher than 20%, while in a further nine prevalence was higher than 10%. The expected upper limit of the rates of infection in these counties could not be established in 2001 as the rates were still climbing. It was assumed that factors like mobility – due to a well-developed transport infrastructure and work migration of especially mineworkers – drove the epidemic in the southern part of Africa (Piot *et al.*, 2001).

Eastern Africa used to have the highest rates of infection but was overtaken by Southern Africa in 2001. West Africa was less infected than either the east or the south of the continent in 2001 (Piot *et al.*, 2001).

In some African countries the disease kept on growing strongly until 2001, while in others it did not change much in the years before 2001. Some countries in Africa had even managed to reduce the spread of HIV/AIDS through prevention efforts by then. Examples of all of the above categories are

- Zambia, where HIV/AIDS prevalence for women under the age of 20 and attending ante-natal clinics declined from 27% in 1993 to 17% in 1998;
- the Mbeya region of Tanzania, where prevalence in 15 to 24-year-old attendees of ante-natal clinics dropped from 20% in 1994 to 15% in 1999;
- Uganda, where prevalence peaked at 14% in the early 1990s and declined to around 8% in 2001; and

- Senegal, where infection rates remained at a low 2% in 2001 (Piot *et al.*, 2001).

The projections and prevalences quoted for the period referred to above have changed dramatically in recent years. An estimated 38.6 million [33.4 million - 46.0 million] people worldwide lived with HIV in 2005. In that year also an estimated 4.1 million [3.4 million - 6.2 million] became newly infected with HIV and an estimated 2.8 million [2.4 million - 3.3 million] lost their lives to AIDS (UNAIDS, 2006).

In its 2006 global report, UNAIDS indicated that even in sub-Saharan Africa – the region known to bear the largest burden of the AIDS pandemic – data have shown that the HIV incidence rate had already peaked in most countries. Shelton *et al.* (2006) agree with this point of view and suggest that in South Africa the incidence of HIV peaked in 1997. Incidence or incidence rate refers to the measure of new infections over time, while prevalence is the measure of infected people in the population at any given point in time. It stands to reason that incidence is very hard to measure due to the fact that it is almost impossible to establish exactly when an individual became infected. Therefore, rates of incidence can only be established through modelling on prevalence. Even though incidence rates should thus be treated with caution, Shelton *et al.* (2006) are confident that enough is known about the rates of infection to allow the decline in incidence figures to be trusted.

Contrary to the arguments by authors like Shelton *et al.* (2006) that a peak has been reached, the 2006 Global HIV/AIDS report indicates that the epidemics in sub-Saharan Africa are highly diverse and especially severe in southern Africa, where the disease is still expanding. If indeed the epidemics in most of sub-Saharan Africa are levelling off, this is occurring at extremely high levels of HIV prevalence (UNAIDS, 2006).

In the literature review that follows, the history of the pandemic in Africa is discussed. A closer look will subsequently be taken at the epidemic in the South African context, after which the background of this study will be discussed.

2.1 The AIDS pandemic in Africa

A number of clinical studies have suggested that although HIV might have been endemic to the African continent before, it did not become an epidemic before the late 1970s and early 1980s, which implies a pattern similar to other developed countries such as the USA (Quinn, 2001).

At the time, AIDS was seen to be a disease affecting mainly homosexuals and intravenous drug users in developed countries. Thus it was most unusual to see – in the African context – that there was an equal distribution of cases between men and women. This raised a series of debates regarding the modes of transmission of the virus in Africa. These debates finally led to the introduction of serological tests for the presence of the HI-1 virus, which allowed more detailed epidemiological studies on transmission (Quinn, 2001).

By the mid-1980s it became evident that the prevalence of HIV/AIDS was escalating in central Africa. At that stage Quinn and his collaborators (2001) concluded that the epidemic was moving rapidly and was being spread predominantly by heterosexual transmission, by being exposed during childbirth due to the HIV status of the mother, exposure to unscreened blood during blood transfusions, unsterilised needles and (perinatally) from infected mothers to babies during breastfeeding. Clinicians and epidemiologists predicted that without vigorous control programmes in Africa, the continent was heading towards major disaster. The prevailing cultural and economic conditions in Africa would favour these identified modes of transmission and the epidemic would spread rapidly to the rest of the continent.

At the end of 1997, about twenty-one million people were living with HIV/AIDS in sub-Saharan Africa, representing almost two-thirds of the world's total number of infected individuals (Balint, 1998). By the end of 1998, an estimated 67% of people living with HIV/AIDS (22.5 million people) in the world were in Sub-Saharan Africa (Gilks, 1999). UNAIDS has been producing updates – global, regional and country-specific – of the HIV epidemic based on the best available data since the late 1990s.

In a report released at the time of this study (Piot *et al.* (2001), it was estimated that around 23.3 million people were living with HIV/AIDS in Africa at the end of 1999, of whom 3.8 million were newly infected during that year alone. Since the start of the pandemic until 1999, 16.3 million people had died from HIV/AIDS and of these 2.6 million died during 1999. Four years later it was reported in the press that 375 670 people were expected to die of HIV/AIDS in South Africa in 2003 (Merten, 2003). Life expectancy in Africa, which had risen from 44 years old in the 1950s to 59 in the 1990s, was set to drop back to 45 before the year 2004 (WHO, 2000a). Studies by Hensle (1998) concurred that the projected life expectancies were dropping due to AIDS.

It should be clear that with such high levels of HIV infection the mortality rates in regions like sub-Saharan Africa would escalate as well. The UN population division predicted that in seven (unnamed) countries in Africa south of the Sahara 14 million AIDS-related deaths would occur between 1995 and 2025 (UNPD, 2004). UNAIDS projected that unless the response to the pandemic changed dramatically in these countries, populations in 38 African countries may be reduced by about 14% (UNAIDS, 2004).

Coovadia and Hadingham (2005) remarked that despite poorer countries receiving more funding, effective and affordable interventions and technical support, the pandemic was continuing unabated in many of the resource-constrained regions of the world, such as southern Africa. One of the major reasons for this unfortunate situation was the many constraints in the health systems of these countries.

However, the prevalence of HIV/AIDS was not the same in all resource poor countries. Boerma *et al.* (2003) indicated that they found significant differences in the prevalence of HIV/AIDS in two areas – Manicaland (in Zimbabwe) and Kisesa (in Tanzania). Even though there were significant differences in the socio demographic profiles of the two areas, they could not find measurable differences in the biological or behavioural factors for which data were available. The differences found also did not explain the much higher HIV prevalence found in Manicaland. It would thus seem that the differences in the infection rates of different regions could not be explained by differences in behaviour or by biological factors.

Unlike many diseases that mankind has had to face in the past, HIV/AIDS is not so much a medical, as primarily a social problem. This is demonstrated by its spread (mainly through heterosexual contact in sub-Saharan Africa) and the inability of the medical establishment to control it. It involves so much of the values and beliefs of the individuals and cultures that it has profound social and cultural components (Gilbert & Walker, 2002). For instance, different cultures or population groups have different sexual practices and the emphasis on a single sexual partner is not the same in all regions.

HIV/AIDS would inevitably have a severe impact on resource-constrained societies like South Africa. The impact would be multi-dimensional. There would probably be severe economic, political, societal and demographic consequences in these countries. Some of the impacts that were predicted at the time are very obvious today, such as the impact on health services. Some of the other impacts of high HIV infection levels are discussed below.

2.1.1 Economic impact

The economic impact of the disease had not been measured in great detail at the time of this study, but many projections and estimates had been made. Numerous studies around this impact were conducted subsequently. In contrast to other diseases, HIV/AIDS affects young adults, which implies a severe impact on the economy and a large number of orphaned children. This could generate a generation of youth who grew up without parental guidance and child-headed households with associated economic problems. Unlike some infectious diseases, HIV/AIDS also affects the skilled and educated, which will further impact on the economy. By the year 2000, HIV/AIDS had already been wiping out years of investment in education and training in many countries (Piot, 2000).

"Because it strikes adults during their most economically productive years, HIV/AIDS will have a greater social and economic impact than any other disease in sub-Saharan Africa." (WHO, 2000a).

Numerous factors concerning HIV/AIDS will increase the cost to business, make them less competitive globally, as well as reduce their productivity. Some of these factors include increased absenteeism; workers being sick at work; the replacements of sick and dying employees having had less chance of training and less experience; an increase in the workforce to try and cope with absenteeism; skilled workers becoming an even more scarce resource in highly affected countries, etc. (WHO, 2000a).

More recent studies like that of Rosen *et al.* (2000) indicate that there are numerous data available on the economic impacts of HIV/AIDS, especially in the workplace. These authors agree that the cost to business varies from the readily measurable impact on employee benefits, absenteeism and recruiting and training needs, to the effects that are more difficult to measure like individual and work unit productivity, morale and discipline. Employee productivity losses were reported in the press as ranging from 2% to 50%, but it is clear that most business are going to be severely affected, some suffering severe hardships (Rosen, 2000).

Even on a subsistence economy scale, such as the many agricultural activities in which people from developing countries in sub-Saharan Africa are engaged, the impact will be great. According to Coovadia and Hadingham (2005), agricultural output will be severely affected by the disease due to the higher mortality of the workforce. Studies project that the agricultural workforce will be reduced by 10 to 26% by 2020 in the most severely affected African countries.

In such settings where agricultural activities involve merely subsistence agriculture, the economic impact of the disease measures only a small part of the total impact on a family. It should be kept in mind that households are seriously affected in their long-term capacity to produce food as livestock is often sold to cover funeral and treatment expenses, while orphaned children lack the skills to tend the livestock they inherit and thus become impoverished (Piot *et al.*, 2001).

Coovadia and Hadingham (2005) agree that the major economic impact of the disease will be micro-economic. Individual households are primarily responsible for coping with the repercussions of HIV infection and AIDS, such as increased healthcare bills, reduced income, funeral charges and other expenses. In other words, as far as these two authors are concerned, the major economic impact of the disease will be suffered by poor families who would no longer be able to cope and who would lose even more of their precious few resources to the caring for those with the disease.

Piot *et al.* (2001) also predicted that the most severe impact would be on a micro-economic level in the family. They concluded that the impact would be felt most severely by families where one of the members becomes infected with HIV/AIDS. HIV/AIDS not only reverses the capacity of accumulated savings but also reduces the consumption ability of the family. In addition to affecting the income, HIV/AIDS generates higher medical, funeral and legal costs for the family who already has a reduced income; this has a long-term implication for the family's ability to stay together.

The impact of HIV/AIDS on the household is one of the instances where the link between poverty and the HIV/AIDS pandemic is the best illustrated. HIV/AIDS will prolong and intensify poverty in any household where a member or members become infected. In poor households, HIV/AIDS will take up a greater proportion of the disposable income and limit the access to everything, including healthcare and basic necessities like food (Piot *et al.*, 2001).

The impact of HIV/AIDS on economic growth is also discussed by Piot *et al.* (2001). In their global overview of 2001 they mention that there is a direct relationship between the extent of the HIV/AIDS pandemic in a country and the severity of the reduction in the gross domestic product (GDP) of such countries. Furthermore, measures of per capita income underestimate the human impact of HIV/AIDS as the infection kills both the humans and their economy activity, causing an even greater cumulative impact on the total size of the economy. Piot *et al.* (2001) estimate in this discourse that, at around 2010, South Africa would have a 17% smaller GDP than it would have had without HIV/AIDS.

There are, however, other theories on the subject of GDP growth. Natrass (2004) argues that GDP depends on the size of the "pie" and the number of people who need a slice of the pie. She further argues that if mortality rises faster than income growth, the GDP could actually rise, but this would be quite rare. More likely, AIDS will not have a significant impact on GDP or it will reduce the GDP – according to studies quoted by Natrass (2004).

To summarise – although there is significant debate around the exact impacts that will manifest and the exact size of these impacts, there is general agreement that AIDS will have an economic impact.

2.1.2 Some other impacts

Another important impact that might have to be considered would be the *political* impact. "In addition to mortality, infectious diseases have tended historically to play an important role in political change." (Forsythe, 1999). Although political change can seldom be attributed to epidemics alone, they certainly seem to contribute to change in perceptions and political leadership. In modern Africa various examples can be found: The genocide in Rwanda has been blamed partly on the AIDS-induced fatalism within the military.

Together with the political impacts, the *security* impacts should be considered (Forsythe, 1999). The level of infection in the military can affect the stability of certain countries (Piot *et al.*, 2001). The dramatic change in Zambia's attitude towards the pandemic could be ascribed to the death of former President Kaunda's son of HIV/AIDS while he was still in office. It is therefore not unlikely that the pandemic could affect world leaders, specifically in Africa (Forsythe, 1999).

It is clear that the spread of HIV/AIDS has been far greater than expected and everywhere the estimates and predictions have been surpassed. In the same vein the demographic, social and economic impacts of HIV/AIDS have been severely underestimated. The impact seen at the time of this study was only a small and insignificant prelude to the kinds of impacts to follow later. This is due to the fact that the real suffering due to HIV/AIDS and HIV/AIDS-related diseases and symptoms only follow much later, as there is a time lag between infection and severe disease and death. The disease will have a profound effect on future rates of life expectancy and economic growth – even in the light of the very optimistic projections of the scale and impact (Piot *et al*., 2001).

The *demographic* impact of HIV/AIDS is different from that of most other diseases. Firstly, the number of HIV/AIDS-related deaths will continue to rise in the coming years due to infection that have already been incurred. Secondly, the young men and women who become infected during their reproductive years, include those who are economically the most active, best educated and skilled. This will lead to an upside-down population pyramid in a few years, when there will be more people between the ages of 60 and 70 than between the ages of 40 and 50 (Piot *et al*., 2001).

The pandemic also has a very clear impact on *education*. HIV/AIDS has a negative impact on the supply of teachers as well as on the ability for children to remain in school as their families are being devastated by HIV/AIDS infection. Many children will have to drop out of school to care for adults who become ill in the family, and there may not be financial resources left for attending school either (Piot *et al*., 2001).

It is clear that HIV/AIDS affects almost all aspects of the economic and social structures in the countries worst affected. With these impacts in mind, the scientific community have had to set about finding solutions. Many intervention strategies have been tried worldwide and some have had a degree of success. Some of these interventions will be discussed later on, but before that it is important to look at the pandemic in the South Africa context.

The South African context is different even from that of other African countries and strategies that have been successful elsewhere cannot be assumed to work locally. Thus it became crucial to try and test intervention strategies in South Africa to measure success and to develop unique South African strategies to cope with and combat the disease.

2.2 HIV/AIDS in South Africa at the time of this study

According to antenatal clinic data up to the year 2000, the rates of infection in South Africa almost doubled every year in the decade before 2000. This means that the infection rate of 24.7% in the year 2000 (Department of Health, 2000) is judged to have been the highest in the world at that stage. Already in 1997 independent researchers indicated that up to 800 people were infected every day (AIDS Weekly Plus, 1997). It was very clear that major interventions would have to be launched to stem the phenomenal rate of new infections in South Africa. HIV/AIDS could eventually have a severe impact on the whole of South African society. Economically and politically, as well as in many other fields, the pandemic has already affected and will continue to affect all South Africans in many different ways.

In the apartheid years, high-profile media coverage of all issues, including health-related issues, did not occur regularly and even in the post-apartheid South Africa high-profile media coverage is a relatively new phenomenon. One of the biggest problems with the epidemic in South Africa has been silence. Although HIV/AIDS is now beginning to be featured regularly in the media and high-level debates around the issue is starting to take place between government and non-governmental agencies, the epidemic continues to grow rapidly and efforts to combat it have not yielded much success (Gilbert & Walker, 2002).

The following provides brief history of the pandemic in South Africa: AIDS was first reported among homosexual men in South Africa in 1982. Between 1982 and 1985 about 100 blood transfusion-related infections occurred before the development of HIV/AIDS antibody testing. HIV/AIDS testing done on stored blood sera from a community survey in KwaZulu-Natal and donor blood data demonstrated a very low prevalence of HIV/AIDS in the general population in 1985 (Abdool-Karim, 2000).

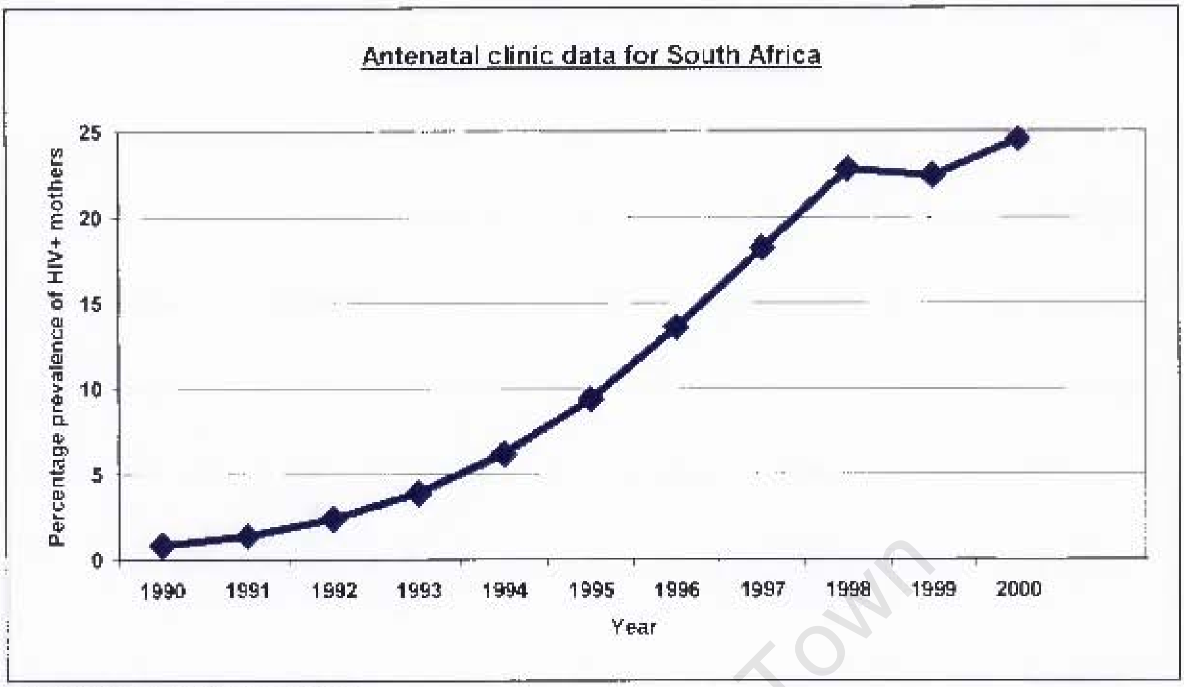
Before 1989 the number of HIV/AIDS cases of hetero-sexual, blood transfusion and pediatric transmission did not exceed 100 per year and were still outnumbered by the reported cases for homosexuals. However, this pattern soon changed as only a year later the number of heterosexual infections outnumbered the homosexual infections and rose steeply to almost 250 cases in 1990 and more than 300 cases in 1991 (Gilbert

& Walker, 2002). The epidemic thus started off in South Africa as in other developed countries, with relatively few infections, but instead of mainly among homosexuals and intravenous drug users, the disease was concentrated among homosexuals as intravenous drug use had very low prevalence. All of this changed rapidly at the beginning of the 1990s. An explanation for this sudden change is given by Abdool-Karim (2000).

In South Africa the dominant strain of the virus is HIV-1, while HIV-2 remains scarce. HIV-1 molecular epidemiology has demonstrated that the clade B virus is predominantly found in gay men while the clade C virus is predominantly associated with heterosexual transmission (Abdool-Karim, 2000). It is possible that these two clades have different patterns of infection. The first started in the early 1980s and was found predominantly in gay men. The second clade started in the late 1980s to early 1990s and was spread mainly through heterosexual contact, as well as by peri-natal transmission. Abdool-Karim (2000) further argues that this in fact means that there are two distinctly independent HIV epidemics unfolding in South Africa.

In 1990 the South African Department of Health first started testing pregnant women in their antenatal clinics. Antenatal clinic data are often used as an estimator of the infection rates across the entire population. However, the publication entitled "AIDS Epidemic Update: December 1999" warned that antenatal estimates generally tend to underestimate actual levels of infection in women, and therefore intimated that there were significantly more infected women than men in sub-Saharan Africa (WHO, 2000a).

Figure 1: Antenatal clinic data for South Africa



(Department of Health, 2000)

Even though there had been major efforts to curb the spread of HIV, the graph in Figure 1 shows that there has not been a slowdown in the incidence of the pandemic in the 1990s and early 2000s.

By 2002 South Africa had been a democracy for eight years and although the country had changed significantly, some imbalances and inequalities were still prevalent. In 1994, under the new dispensation, the country was divided into nine provinces to try and spread resources equally and assist poor areas in development. However, striking differences still exist between the provinces in terms of resources and of course in terms of healthcare. It can be argued that the differences between the rates of infection between the provinces can be attributed to the differences in healthcare and resources available in different provinces (Gilbert & Walker, 2002).

Gilbert and Walker (2002) conclude in their overview of HIV/AIDS in South Africa that the epidemic will have dire social and economic consequences. They reported that in 2002 absenteeism and ill health in the workplace had already increased dramatically; the number of HIV/AIDS orphans was placing a huge burden on the agencies dealing with these; local authorities were having problems in terms of space and infrastructure in dealing with the deceased; healthcare facilities were struggling to cope and the government was at that stage unwilling to provide treatment for all HIV/AIDS-infected people. AIDS was projected to double the infant mortality rate and treble the child mortality rate. Together with the fact that most of the dead will have been in their economically most productive years, the epidemic was set to have a devastating effect on the population structure, the economy and society as a whole (Gilbert & Walker, 2002). In 1997 Prof. Ronald Green-Thompson (an independent researcher) calculated that 16% of South Africa's workers had already been infected with HIV/AIDS and that this figure would rise to 20% by 2000. Thus, the cost of HIV/AIDS to the South African economy was expected to increase from US$25 million to US$2.3 billion (AIDS Weekly Plus, 1997).

South African society displays gross social inequalities between race, class and gender. It can be argued that racial inequalities have had a severe impact on the way health care is provided in South Africa today. Even though all population groups experienced an increase in real income over the past fifty years, the gap between rich and poor is large, compared to other developing countries. Almost 66% of African or black South Africans lived in poverty in 2001, while only 6.7% of whites lived in the same kind of poverty (Gilbert & Walker, 2002). The links and associations between HIV/AIDS and poverty are well documented and described in a number of publications. From the above it is clear that economic factors contribute to risky sexual practices, mostly among women (Natrass, 2004).

In 2001 58% of the total health budget was spent on private health services, catering mostly for higher income groups (mainly white) (Gilbert & Walker, 2002). The impact on health services is further demonstrated by the study done by Pillay *et al.* (2001) at the King Edward Hospital in Durban, South Africa. They found that of the infants who were hospitalised over a period of time, most of those for which an HIV status could be determined were HIV+. Children who were found to be HIV+ were more likely to have been previously hospitalised than those who tested HIV negative. They also noted that none of these infected children were on antiretroviral therapy. The study concluded that the impact of HIV/AIDS on paediatric hospital admissions was higher than previously reported in research in other countries and the authors blamed this fact on the higher seroprevalence of HIV/AIDS in the mothers of children in South Africa.

The Pillay study did conclude that, on the positive side, the most common problems for which children were hospitalised were acute respiratory infection and gastroenteritis. For both of these conditions in children, protocols existed for treatment at primary and secondary healthcare facilities and they would therefore not need to be hospitalised. Treating these children could however increase the workload of primary healthcare clinics (Pillay *et al.*, 2001).

The South African economy was historically and still is, structured around migrant labour. Young men left their "homelands" across the southern African region to work in the industrialised cities, but were not allowed to relocate there with their families. In post-apartheid South Africa rapid and uncontrolled urbanisation led to family breakdown, high levels of rural and urban poverty and a rampant spread of diseases associated with poverty (Gilbert & Walker, 2002).

In some of the economic impacts that were projected by the United Nations Population Fund it was concluded that there was growing evidence that the per-capita economic growth in South Africa would diminish because of increased dependency ratios. Health systems would come under increasing pressure and there would be constraints on investment in productivity and labour forces. The Fund noted that in countries with high HIV/AIDS prevalence the pandemic was killing large numbers of people in their economically productive years, which resulted in an increase of the number of people to be supported by those still working and still economically active (Singh, 2004).

The impact of HIV/AIDS is just starting to show in South Africa. In 2005 Sidley (2005) reported that new statistics released by the South African government indicated that there was a rise of 57% in the number of deaths in the country between 1999 and 2002 – these were attributed to the HIV/AIDS epidemic. In people over the age of 16, deaths increased by 62% over this period, but the largest increase was in the age group 30 to 34 years of age, which would be consistent with an HIV/AIDS pandemic. In this age group the number of deaths increased from 34 779 to 48 572 – a 71.6% increase (Sidley, 2005).

According to Singh, the United Nations Population Fund reported a concrete decline in the South African population growth rate for the first time in 2004, to the level of 0.6%. The report estimated that the population of 45 million would decrease by five million by 2050. In the same time, the world population would grow one third or by 2.5 billion people (Singh, 2004).

More updated data about the epidemic in South Africa are available – among others from the UNAIDS Global HIV report for 2006. According to this report, South Africa's epidemic showed no evidence of decline. This conclusion is based on the Department of Health's antenatal clinic surveillance study, national surveys and mortality data from the civil registration system (UNAIDS, 2006).

One of the few positive signs was that the number of people who indicated that they had been tested for HIV/AIDS increased to almost one third of all respondents, even though respondents still indicated that they would keep their status secret if they found out that they were infected (UNAIDS, 2006).

Although it is clear from this report that prevention strategies have still not been effective in South Africa at all, the treatment of HIV/AIDS infected people seems to be gathering momentum. The report estimates that about 190 000 people were receiving antiretroviral treatment by the end of 2005, even though it still means that only about 20% of the one million South Africans in need of antiretroviral therapy are receiving it (UNAIDS, 2006). It is clear that South Africa is suffering under the burden of an out-of-control epidemic and that few interventions up to the time of this project, or even more recently, have shown any effect. Some of the interventions that were available at the time of the onset of this project are discussed below.

2.3 Overview of interventions and their impact

According to Peter Piot (Executive Director of UNAIDS) and his co-authors – in a review done in 2000 – successful national programmes seem to display at least seven characteristics:

- Ability of all actors to come together under one powerful strategic plan
- Visibility and openness about the epidemic and involving people with HIV/AIDS as a way of reducing stigma and shame
- Addressing core vulnerabilities through social policies
- Recognising the synergy between prevention and care
- Targeting effort to those population groups that are most vulnerable to infection
- Focusing on young people
- Encouraging and supporting strong community participation in the response (Piot, 2000)

In 2004 Siegfried and others (2005) compiled an overview of trials done on HIV/AIDS in Africa. At that stage they managed to find not only 77 different randomised control trials, but also 21 controlled trials that were not randomised, 15 trials that were in their first phase, 14 cross-sectional surveys and 12 cohort studies (among other HIV/AIDS-related studies). This confirms the large amount of research that has been done in the field of HIV/AIDS in Africa.

Of all the trials assessed by Siegfried *et al.* (2005), 42 were prevention trials and 35 were treatment trials. Thirteen of these prevention interventions investigated mother-to-child transmission; 12 studied drugs for the prevention of opportunistic infections; five concentrated on microbicides, five on behavioural interventions and four on drugs for the treatment of STDs; and finally, three studies focused on other preventative measures like nutrients and supplements. The current study is listed under two of these categories, namely behavioural interventions and studies on the prevention of transmission, such as the treatment of STDs.

2.3.1 STD Interventions

Before interventions in Africa started, it was assumed that the presence of other Sexually Transmitted Infections (STDs) would increase susceptibility to HIV/AIDS. This was assumed on the basis that most Sexually Transmitted Infections (STIs) cause broken skin and lesions that would give the HI virus an entry point. It was also assumed that individuals who were infected with other STIs would also be engaging in risky sexual behaviour (that caused them to get infected with an STI in the first place). It was therefore no surprise that in early interventions in Africa the main focus was on the reduction of other STIs.

Many studies were conducted about the role of STIs in the acquiring of HIV/AIDS. One of these was the study done by Cohen (2004), which was done after the completion of this study, but before its findings were available. Cohen (2004) and his study partners also recognised that STIs could increase the risk of acquiring and transmitting HIV via a number of "mechanisms". These mechanisms included breaching of natural protective organs like the skin or membranes, and increased inflammation and higher levels of the type of cells targeted by HIV (like red blood cells) present in the genital area.

According to Cohen (2004), studies of Malawi clinic patients show that the treatment of STIs could reduce levels of HIV virus in the genital area. Work in Africa and India had indicated that genital herpes infection was associated with increased risk of infection by HIV and that the presence of genital ulcer disease was associated with increased risk of transmission of the HI virus. Acute HIV infection was found to be more frequent in individuals with active STIs, and co-transmission of STIs and HIV may well have been a common phenomenon.

Some of the most prominent interventions in Africa that studied the co-variance of other STIs and HIV/AIDS are the Mwanza trial in Tanzania, and the Rakai and Masaka trials in Uganda. The studies in Mwanza and Rakai were randomised control trials of sexually transmitted disease treatment conducted to prevent HIV infections. These trials will be reviewed in the paragraphs that follow.

2.3.1.1 Mwanza STD trial

In Mwanza, a randomised control trial was conducted to test and evaluate the impact that improved case management in the treatment of sexually transmitted disease in primary healthcare settings has on HIV/AIDS infection in this rural district of Tanzania. Twelve communities were compared in this study. Six of them were part of the intervention while the other six constituted a control group, and these communities were pair-matched for the comparison. A random cohort of about 1 000 respondents was surveyed at baseline and at a follow-up two years later. All adults in households between the ages of 15 and 54 years of age were included as eligible (Grosskurth *et al.*, 1995a).

The intervention consisted of four distinct processes. Firstly, an STD reference clinic was established; secondly, staff were trained in the management of STDs; thirdly, care was taken to ensure a regular supply of drugs; and lastly, a programme officer paid regulatory visits to health facilities. During these visits, health education about STDs was updated and a general check of the project was performed (Grosskurth *et al.*, 1995a).

In total, 6 134 and 6 395 people were studied in the cohort in the baseline and the follow-up respectively, with slightly more women in the baseline and in the control. The seroprevalence was 3.4% for males and 4.1 % for females in the intervention group at baseline, and 4.1% and 4.7% respectively for males and females in the comparison group at inclusion. Over the two-year period of the trial 48 seroconversions occurred in the intervention communities and 81 in the comparison group community cohorts. This implies a 1.2% increase for the intervention cohort and a 1.9% increase for the control group (Grosskurth *et al.*, 1995a).

The impact of the intervention on STDs was not that clear. Although declines were reported in the prevalence rates for all tested STDs in the intervention cohorts, there was substantial inter-community variation. When this was taken into account in the analysis, none of the differences were statistically significant (Grosskurth *et al.*, 1995a).

Although the WHO advocates the control and management of STDs as an additional strategy to control the spread of HIV/AIDS, evidence of such a policy is scarce. Many observational studies point to the relationship between STDs and HIV/AIDS, but in an intervention study as the one done in Mwanza the interpretation of the data is difficult, and the trial concluded that the magnitude of such an effect was still largely unknown. The impact of an STD intervention programme on the prevention of HIV/AIDS would depend on the number of HIV/AIDS infections that are attributable to STDs and the extent of STD prevalence reduction that might be achieved by such an intervention. Both of these aspects are clearly very complex to measure and estimate. Even so, the Mwanza trial was the first trial or project that managed to render reliable data on the impact of STD intervention programmes on HIV/AIDS (Grosskurth *et al.*, 1995a).

The Mwanza trial demonstrated that it is possible to achieve an overall reduction in the HIV/AIDS incidence rate of about 42% over two years. This reduction occurred in both sexes and was observed consistently in all matched pairs of communities included in the study (Grosskurth *et al.*, 1995a).

In the Mwanza trial only symptomatic STDs were treated. Due to this fact, it was expected that the results would underestimate the proportion of HIV infection that could be attributed to STI infections (Barnett & Whiteside, 2002). It was revealed that STD intervention did help reduce HIV incidence, but behavioural change was not a factor. This trial apparently proves that STDs play a significant role in the spread of HIV. According to Grosskurth *et al.* (1995a), sexually transmitted diseases would have to be treated effectively and promptly to reduce the HIV infection rates.

The impact of changes in sexual behaviour on the levels of HIV/AIDS prevalence was measured by special surveys of sexual behaviour conducted during baseline and follow-up studies. However, the data from these surveys did not indicate any change in the sexual behaviour of the intervention or the control groups during the two-year follow-up period. Condom use also measured in these special surveys and even here there was no noticeable difference in the behaviour of the intervention and the control groups over the two-year period. Condom use remained low (Grosskurth *et al.*, 1995a).

2.3.1.2 Rakai STD trial

In 1994 the Rakai STD Control for AIDS Prevention Study was launched. It was designed to test the hypothesis that, at population level, STD control could be used to lower the incidence of HIV/AIDS. The study was designed as a home-based and mass treatment study. The decision to use this strategy was based on the fact that in this rural area healthcare facilities are poor or lacking all together. All adults who consented, were given directly observed STD treatment in their home every ten months, irrespective of any laboratory results or tests and irrespective of any current symptoms of STDs. The treatment consisted of one dose of broad-based oral antibiotic. This strategy aimed to ensure that all individuals in all types of relationships, as well as all types of STDs, symptomatic as well as asymptomatic, would be covered (Barnett & Whiteside, 2002; Wawer *et al.*, 1999).

Fifty-six villages were selected amongst the trading villages and villages along secondary roads. Villagers were then aggregated into ten clusters of four to seven contagious villages. Clusters were grouped into three blocks, and were randomly assigned to intervention and control within blocks. Before the analysis, clusters were paired within the randomisation blocks according to HIV/AIDS prevalence at baseline (Wawer *et al.*, 1999). In the intervention arm treatment was provided for the following STDs: gonorrhoea, chlamydial infection, trichomoniasis, bacterial vaginosis and chancroid (WHO, 2000b). The intervention treatment consisted of a dose of azithromycin, ciprofloxacin, and metronidazole. In the control group respondents received mass anthelmintic, vitamin, and iron-folate treatment (Wawer *et al.*, 1999).

Before the onset of every round of intervention a census was conducted to list all the eligible respondents. During the survey visit, the consenting respondents were interviewed by means of an instrument that assessed socio-demographic, behavioural, health and treatment-seeking behaviour. Interviews were conducted by same sex interviewers in the home language of the respondents. Biological samples consisting of a venous blood sample and a urine sample were collected directly after the interview. All women were also asked to self-collect two vaginal swabs (Wawer *et al.*, 1999).

Both intervention and control groups displayed similar STI prevalence rates at baseline (Barnett & Whiteside, 2002). A survey of the entire population aged 15 to 59 showed no effect of the intervention on HIV incidence, even among subgroups like pregnant women (Grosskurth *et al.*, 2000). At baseline, the prevalence of HIV in the intervention and control groups was 16.1% and 15.6% respectively. At rounds two and three the HIV rates were slightly higher in all the groups, but the prevalence of HIV did not differ between the intervention and the control groups even if controlling for different demographic groups like gender, age groups and individuals reporting single or multiple partners (Wawer *et al.*, 1999). Although there was no significant effect of the intervention on the incidence of new syphilis cases (Grosskurth *et al.*, 2000), significant differences occurred between the intervention and the control after the second and third rounds of the intervention. There were significant reductions for trichomoniasis in the intervention group (Wawer *et al.*, 1999).

This study took place in an area in rural Rakai where the infection rates of HIV/AIDS and STDs were very high. The intervention managed to reduce the prevalence of STDs but did not have any effect on HIV/AIDS. The researchers were of the opinion that this finding was not due to methodological problems or design (Wawer *et al.*, 1999).

However, the researchers did note that the findings could perhaps be explained by differences in the stage of the HIV-1 epidemic, in the prevalence of incurable STDs, or by the greater effectiveness of continuously available services than of intermittent mass treatment to help control rapid STD re-infection (Grosskurth *et al.*, 2000). They also stated that the Rakai setting represented a very mature HIV-1 epidemic, and that the high level of HIV-1 exposure, particularly in discordant couples, could have compromised the ability of the STD interventions to make a difference to the HIV infections (Wawer *et al.*, 1999).

The results of this trial contradicted the earlier suggestion that policies on STD control should take into account their role as co-factors in HIV transmission. Thus, STD control once again became a questionable strategy for the reduction of HIV infections. It was suggested that targeted STD control can work best in areas with little funding and rampant commercial sex. Providing basic access to healthcare is also necessary to help reduce STD cases (Grosskurth *et al*., 2000). The investigators in the Rakai study stated their belief that the difference lay in the degree of exposure to HIV-1. They were also of the opinion that in the light of the high background rates of HIV-1, a substantial part of new HIV infections were not due to treatable STD co-factors (Wawer *et al*., 1999).

Many more reasons were given for the differences in the findings of the Rakai and Mwanza trials. Mwanza showed that STD control would reduce the incidence of HIV, while the Rakai trial showed that this was not always the case. The type of intervention was said to have played a role, the stage of the HIV epidemic played a role, and the STD prevalence and profiles influenced the outcomes (WHO, 2000b).

Barnett and Whiteside (2002) offer another possible interpretation of the results of these two trials, namely that the epidemic was at saturation point in the Rakai community. The prevalence was stable at 16%, and the new infection was from people who were not from high-risk groups for contracting STIs. On the other hand, at the time when the Mwanza trial was conducted, the epidemic was still immature. Treating STIs would thus appear to be most effective at the beginning of the epidemic. What these two trials did prove, was that STI is a co-factor to enhance the transmission of HIV/AIDS but the extent to which this was the case, remains a point of debate.

Gray *et al*. (1999) offered other explanations for the differences in the findings of the two trials, but they also suggested that the difference could be attributed to the fact that there is a difference between syndromic management and periodic mass treatment (such as was done in Rakai). Gray *et al*. (1999) subsequently set out to study the explanation offered by the researchers in the Rakai trial. This explanation blamed the differences on the level of background HIV-1 infection in the community and the maturity level of the epidemic.

The observational study that Gray *et al.* (1999) performed showed that STDs made only a very modest contribution to the risk of HIV acquisition or transmission in the Rakai study. Furthermore, a high proportion of the symptoms of STDs reported were associated with non-curable STDs. The differences between the Rakai and Mwanza studies were unlikely to result from differences in epidemiology either, according to these authors. Gray *et al.* (1999) eventually agreed with the Rakai researchers that the differences were probably due to the stage of the epidemic, its maturity and the background seroprevalence, as well as the background untreatable STDs in the population.

The concept of the maturity of the epidemic features in many explanations of the differences between the Mwanza and the Rakai trials. Apparently the following three factors are to be considered with regard to the generation of the epidemic in a susceptible population: the probability of transmission, the duration of the infectiousness and the number of sexual partners. Usually infected persons are very infectious at two stages of their disease – right after infection when the viral load is high and right at the end of their disease, just before death, when the viral load is high again. In between these two stages, the number of infected cells available for exchange between sexual partners is lower and thus the risk of infecting others is also lower. Infection by another STD can increase the shedding of HIV-infected cells and so disturb this pattern where infectiousness is supposed to be low (Hitchcock & Fransen, 1999).

There are two phases to the epidemic that are of interest here. The first is Stage 1, where the epidemic moves rapidly through the high-risk population in a community. High-risk individuals have many STDs and therefore transmission is high due to the increased shedding of HIV-infected cells. A saturation point in the infection of the highly susceptible population subsequently occurs, and an apparent plateau is reached. Here the death rate and new infection rate are similar and the infection is silently moving into the lower-risk but innately susceptible population. At the onset of Stage 2, STDs are no longer required to drive the epidemic as the frequency of sex between individuals in the lower-risk groups is much higher and infection eventually occurs. Low-risk people would for instance be married couples where one of the partners become infected and then, over time, will infect the other partner. In a mature epidemic like the one in Rakai, Uganda, the infection indeed moved from Stage 1 to Stage 2 (Hitchcock & Fransen, 1999). Lower-risk individuals were less likely to change their behaviour precisely because they considered themselves at low risk. Hitchcock and Fransen thus concluded that STD control would have a serious impact at the onset of the epidemic in a large community, but once the disease had moved from Stage 1 to Stage 2, the impact would be minimal (Hitchcock & Fransen, 1999). Although none of this was known at the onset of the Carletonville study,it would seem that the time for STD interventions had come and gone for most sub-Saharan Africans. However, because this was not clear when the Carletonville study started, STD management was included as an intervention in this project. In any event, Hitchcock and Fransen (1999) recommended that STDs should be managed in the long term in Stage 2 epidemics and such management should concentrate on the youth.

2.3.1.3 Masaka trial

The Masaka trial compared different groups who all received information, education and communication (commonly referred to as IEC). A comparison was drawn between a group who received IEC together with improved syndromic treatment of STIs, and another group who had access to a community development intervention but without the improved syndromic treatment of STIs (Grosskurth *et al.*, 2000). The primary objective was to determine the impact of behavioural change brought about by IEC alone compared to IEC together with improved STD management; on HIV incidence in a rural setting like this one in Uganda. A secondary objective was to determine the cost effectiveness of the interventions and to assess whether they could assist in HIV control in other settings (WHO, 2000b). According to Kamali *et al.* (2002) they were not aware of any other trial that had tried to combine an evaluation of behavioural change alone or in combination with STD management to have been undertaken in sub-Saharan general populations at that stage. Therefore the Masaka trial would prove valuable in generating information about its feasibility, effectiveness and cost-effectiveness.

The Masaka trial consisted of three arms with six communities in each arm. In the first arm a behavioural intervention was implemented on its own. In the second arm a behavioural intervention was implemented together with an STD management intervention, while the third arm constituted the control group. There routine government health services were provided with no intervention, although additional community development activities were implemented in these communities (Kamali *et al.*, 2002).

The aim of the behavioural intervention was to give correct knowledge, to correct misconceptions about HIV/AIDS and other STDs, and to promote safer sexual behaviour and practices. The intervention was delivered by means of accepted local approaches like drama groups and paid particular attention to the development of peer-based education systems (Kamali *et al.*, 2002).

Prior to the implementation of the interventions a series of AIDS prevention committees (APC) and community educators (CE) were selected in each community. The APCs were supposed to encourage community participation and play an advisory role in the intervention and in the recruitment of the CEs. There were 24 CEs in each community with 50% more males than females as it was assumed that men would have to be targeted more in the interventions due to the fact that they are the sexual behaviour decision makers. Men were also believed to practise extramarital sex more often than women. The CEs in each community were supervised by a full-time organiser. Dramatic plays on specific HIV/AIDS-related topics were organised and these were staged at regular intervals in each of the communities (Kamali *et al.*, 2002).

The behavioural interventions were thus implemented through various channels. Firstly, through large monthly meetings held in each community and included a play and a subsequent discussion on the topics featured. Secondly through small meetings and one-on-one discussions held as often as possible and thirdly through video showings on a monthly basis. Lastly through the distribution of leaflets that focused on a variety of HIV/AIDS information. To monitor progress staff completed forms listing activities and participation at the end of every session (Kamali *et al.*, 2002).

In the STD intervention the aim was to improve the management of STDs by focusing on the quality of care in both the government and private clinics found in the area. Training was provided to staff of these clinics and based on the syndromic management for STDs described by Hanson. A diagnostic and management manual was developed to guide health workers. All health workers were invited to initial training and then to subsequent annual refresher courses (Kamali *et al.*, 2002).

The impact of the intervention was measured through knowledge, attitude, behaviour and practice (so-called KABP) surveys conducted at 18 to 24-month intervals. There were long and short versions of the KABP surveys, and both included questions on socio demographic factors, sexual behaviour and STDs. However, the long version collected more detailed information. The same samples were used for all the surveys, in other words the same individuals were included in all the different surveys except for those who had not been available with a previous survey. New individuals were also included due to the fact that they became of eligible age or moved into the area (Kamali *et al.*, 2002).

At baseline, the prevalence of HIV/AIDS was 8.8%, 10.1% and 10.4% respectively for arms A, B and C. For STDs no significant differences were reported between the arms at baseline either. The HIV/AIDS epidemic in Uganda was relatively mature at this stage and therefore the risk of infection for low-risk individuals became high (Kamali *et al.*, 2002). (The relationship between maturity of the epidemic and the risk to different individuals was described in more detail above.)

The intervention had no effect on HIV/AIDS prevalence levels in the target communities. The incidence of HIV-1 infections did not differ between arms A and C and neither between arms B and C. Even if the influences of demographical factors like age or sex were controlled for, there were no significant differences between the intervention and the control groups. Further controlling was also done for genital ulcer disease and religion, and still no effect was visible (Kamali *et al.*, 2003). This was once again a very surprising finding. Many possible explanations for the lack of an effect were once again listed. Quigley *et al*. (2004) indicated that there could have been a variety of reasons why the intervention was not successful. They suggested that the intervention might not have been implemented properly, might not have had sufficient coverage, or might have been inappropriate for the setting. Another explanation could be that there were shortcomings in the intervention package that failed to encourage people to change their behaviour. It was also considered possible that the intervention did cause change in behaviour in some individuals but that they did not make up a critical mass to have an effect on the prevalence of the entire community. Quigley *et al*. (2004) then set about trying to explain what they thought was the main reason for the failure of the intervention to reduce the risk of getting infected.

At baseline the researchers detected past syphilis exposure in 23%, 23% and 25% of individuals in arms A, B and C respectively. Active syphilis was detected in 11%, 14% and 15% of these cases. Gonorrhoea and chlamydia infection also did not differ between the three arms in the baseline. After the intervention, a substantial reduction occurred in the incidence of active syphilis and gonorrhoea (Kamali *et al*., 2003).

When the effects of the trial on HIV/AIDS incidence were measured for those individuals who had attended the IEC interventions and meetings only, the difference in infection rates were significant. When adjusted for sexual behaviour, the results were similar. Once again the issue of the stage of the epidemic was mentioned. The authors concluded that, in a mature epidemic stage, having only one partner could still put the individual at high risk (Quigley *et al*., 2004).

Quigley *et al*. (2004) concluded that the intervention resulted in a reduced risk of HIV/AIDS acquisition in women and to a lesser extent in men who attended the intervention. However, they stated that this effect was not large enough to impact on the HIV/AIDS transmission and infection rates in the community as a whole. Their explanation was thus that the intervention caused the desired effect, but failed to reach a critical mass of individuals to make a difference at community level.

One of the important lessons cited by Quigley *et al*. (2004) regarding intervention trials suggested that sexual behaviour data were prone to bias. Therefore evaluations of interventions of this nature needed to have biological markers so as to allow proper evaluations. They also remarked that randomised control trials were important for evaluating behavioural interventions, but that these might not be sufficient to explain all the mechanisms underlying the reasons for success or failure.

The behavioural intervention, alongside syndromic management of STIs in Masaka, showed little or no effect on community-wide new HIV infections. The same was found in Rakai, but the findings were different in Mwanza. A lot of debate and discussion followed as to why the results differed. Some of the explanations offered were mentioned earlier, namely that the epidemics were in different phases in the different places and that the epidemic in Uganda was in a far more mature state than that in Mwanza (Orroth *et al.*, 2003b).

To conclude, Orroth *et al.* (2003a) offered yet another explanation for the differences in the findings of these three trials. They believed that the prevalence of curable STDs in Mwanza was higher than in Masaka and Rakai and therefore it could be expected that STD mass treatment would have a greater impact on HIV/AIDS incidence in this area. Orroth and his fellow researchers felt that this could at least in part explain why STD treatment had such a profound effect on the Mwanza HIV-1 infection, while in Rakai and Masaka no such effect was visible (Orroth *et al.*, 2003a).

The arguments above merely prove that, at the time, the knowledge with regard to STIs and their role in HIV transmission was far from complete and needed further study. Other intervention strategies became prominent in the lead-up to the current project, of which some will be discussed below.

2.3.2 Peer education

In 1997 the Gauteng Department of Health expressed the need to make people more aware of the dangers of the infection. A spokesman said at the time that the attitudes of people needed to change. The spokesman also indicated that the department did not think they had the necessary capacity to be responsible for this change in attitude alone. At the time the Gauteng Department of Health indicated that it was of the opinion that the epidemic should be declared a national disaster (AIDS Weekly Plus, 1997).

From these expressed needs for change in attitude it was clear that the department was going to need help in terms of individuals and organisations that could broker and facilitate the changes in attitude that was required (AIDS Weekly Plus, 1997). Peer education offered such an opportunity.

Peer led educational programmes have been part of the interventions for the prevention of HIV/AIDS infection for some time as well. Sloan and Myers evaluated one such programme in their study. The broad aim of the peer-led educational programmes evaluated by this study were to reduce the HIV/AIDS infection amongst the targeted population by providing educational material on safe sex practices, discussing various sexual behavioural issues like, modes of transmission, sexually transmitted diseases and condom use with peers, as well as supplying free condoms (Sloan & Myers, 2005).

For the intervention being evaluated by this study the same aims and objectives were set and the peer educational programme was designed with same structure as the one studied by Sloan and Myers (2005). These aims and objectives for the peer education programme for this study focused on the following: Partner reduction; condom use; change attitudes towards people living with HIV/AIDS (by measuring if respondents would tell someone if they got infected); personal risk perception; and personal behaviour change to avoid infection with HIV/AIDS.

By 2000 and 2001 very little had been published on evaluations of peer education programmes. The findings reported by various studies were not consistent and most studies were merely descriptive (Sloan & Myers, 2005). One study by Quach *et al.* (2000) reported a 50% increase in knowledge on HIV/AIDS and 27% - 46% increase in condom use but they could not find any change in the attitudes towards HIV/AIDS.

Sloan and Myers (2005) did not find any change in the four objectives of the peer education programme that they were evaluating. The four objectives of the intervention were to: Increase knowledge of HIV/AIDS; change attitudes towards people living with HIV/AIDS; change beliefs, including self perception of risk; change practice, measured by the increase of condom use. Their evaluation study also found that a very high percentage of individuals did not consider themselves at risk of HIV/AIDS infection at all, with 73% indicting that they were at low risk.

It would thus appear that peer based education was a strategy that needed further study at the time as well, as the findings of none of the studies at the time was conclusive. For the sake of prevention attitudes of the general populations still needed to be changed and although not shown to be without problem peer education needed to be included in a total prevention package to achieve success in fighting the disease.

2.3.2.1 Knowing someone with AIDS

One of the theories at the time of this study was that as more and more people became aware of HIV/AIDS through close personal experience like somebody close to them getting infected and possible even dying would change behaviour (Macintyre *et al.*, 2001). This had not been included in the peer education programmes at the time, and is therefore discussed separately here although it formed part of the behavioural evaluation.

Some studies on HIV/AIDS in Africa that suggest that knowing someone with HIV/AIDS or knowing someone who had died of HIV/AIDS may encourage individuals to use more protective strategies like condoms (AIDS Policy Law, 1996; Macintyre *et al.*, 2001). Several other studies also suggested that knowing someone infected with the HIV/AIDS virus or having full blown AIDS may lead to a reduction of risk behaviour (Ijumba *et al.*, 2004). The reasons for this are indicated as a countering of denial and increased personal risk perception.

Contrary to previous findings, analyses by Camlin and Chimbwete (2003) showed no association between condom use and having known a person living with AIDS (PWA). On the contrary condom use was strongly associated with knowledge from the respondents that condoms can prevent HIV/AIDS, having had sex with a non-marital partner, higher education level, a younger age, and urban residency.

This point was being debated at the time of the study and for this reason it was decided to include questions around the issue and to investigate it in this study.

2.3.3 Condom distribution

Condom distribution was already free of charge to all individuals in South Africa at the start of this project. At the time only male condoms were available free of charge at all health facilities and were slowly making their appearance at taxi ranks, public toilets and other government offices. However, the head of the HIV/AIDS and communicable diseases unit, Dr. Liz Floyd said that the supply of condoms at that time was still uneven and unreliable, especially in high density peri-urban settlements and informal settlements (AIDS Weekly Plus, 1997).

From the comment of Dr. Floyd it was clear that condom distribution would have to be part of an intervention strategy to ensure that everyone in the targeted community had unhindered and easy access to condoms. Condom use was thus included in the peer education messages but a separate intervention would be launched to address the condom distribution.

Christiana van der Walt, a public health consultant with the government at the time, believed that condoms were unpopular with people living in South Africa. She noted that they were particularly unpopular with migrant workers and people living in the squatter camps around South Africa. These squatter camps could also be found around the mining hostels in Carletonville (AIDS Weekly Plus, 1997).

This matter needed to be addressed in an intervention to try and encourage high risk groups like mineworkers staying in single sex hostels and commercial sex workers staying in shack communities next to these mining hostels to start using condoms and to make condoms freely available to them. Female condoms were not yet freely available and the focus of this study would be on free male condoms.

2.4 In conclusion

It is important to keep in mind that the most appropriate targeted interventions will not be universal but will have to be prescribed by the situation in which they are to be successful. They could, however, follow globally appropriate principles. Effective responses to HIV need to constitute a variety of community-level interventions that are responsive to particular contexts of risk and vulnerability (Piot *et al.*, 2001). In addition, responses to the pandemic would have to be a combination of different strategies working in unison to fight the spread of the disease. It is unlikely that there will be a so-called "magic bullet" that would solve the problem and stem the tide of infection. Therefore, in view of all the reported literature and all the studies mentioned, this study was designed to include the following three basic strategies:

- STD management and control, including training of healthcare workers across the spectrum of providers – private and public.
- Peer education of the high-risk populations, such as mineworkers and commercial sex workers, including recruitment of peer educators from these groups and assisting them with activities and training.
- Increased distribution of free male condoms in the community.

Later on in the project, a fourth intervention was added, namely preventative periodic treatment (PPT). This treatment was only really operational in the last year of the project and is described in detail elsewhere.

Due to the findings following the baseline survey, the focus of some of the first three strategies changed. A more community-focused approach was followed and although the focus on the high-risk communities did not change, a strong community-based component was added as it became clear that the infection rates were comparable between the high-risk communities and the general population in this area.

3 Research problem and focus of the study

3.1 Research question

The question that emerged from the intervention in Carletonville was: *What was the impact the interventions had on the STDs and on sexual behaviour in the Carletonville area?* The intervention concentrated on the reduction of STD rates, behavioural change and the increase of knowledge on HIV/AIDS. Therefore: the question that this study aims to answer is: *What was the impact of the Carletonville intervention on the progression of the HIV/AIDS pandemic in the community of Carletonville and its mineworkers?*

Together with this, the drivers of the epidemic in such an area can be investigated and an assessment can be made of the appropriateness of the interventions. Thus, a secondary question can be posed: *What were the risk factors for becoming infected with HIV and STDs during the time period of the intervention?*

The current study will focus on the two questions formulated above. The intervention will be discussed and details be given of the surveys that were implemented to measure impacts.

3.2 Theoretical considerations

The research questions can be condensed as follows: *What was the impact of the intervention in Carletonville and what drives the epidemic in such settings?* In order to find answers, the data from the surveys will be analysed.

As stated earlier, the intervention focused on the four strategies of STD management, condom distribution, peer education and preventative periodic treatment (PPT).

To start off, demographic background details were gathered, followed by a set of questions about details of partners and sexual behaviour in relationships. These included regular partners, including spouses, and non-regular partners. Non-regular partners were defined as partners with whom the respondent did not have a stable long-term relationship, but a more casual union. The number of partners and the types of partners were included to assess the behavioural change, if any, with regard to sexual behaviour.

Details about sexually transmitted diseases and the presence of symptoms were gathered, while biomedical tests were also conducted for some of these diseases. STD management and treatment constituted one of the interventions and therefore its impact was measured. The PPT intervention could also be assessed with these biomedical markers, but was not part of this study.

Prior knowledge of HIV was tested to assess its impact on the level of knowledge imparted by the intervention. Evidence in the literature in fact suggested that such knowledge might facilitate sexual behaviour change. Questions around risk perception and behavioural change related to risky sexual behaviour were also included in the analysis to assess the impact of the intervention on these two concepts. The last concept involved the use of condoms as a protective strategy. Interventions were aimed at promoting the use of condoms and the impact of this strategy was measured.

Personal experience of somebody infected with HIV/AIDS was included in the analysis to assess the impact of this aspect during the intervention.

Men from Khutsong, women from Khutsong and mineworkers were studied as three separate groups. Patterns of infection among men and women were considered to be very different and in the statistical analysis males and females were studied separately. At the start of the intervention the mineworkers were considered a high-risk group and therefore it was necessary to study them separately from the men and women in Khutsong.

In order to measure all these concepts over time, the researchers decided to use KAP (Knowledge, Attitude and Practice) survey technology. Some people also refer to this methodology as KAPB surveys, because it includes the measurement of behavioural aspects. Since the author agrees that these are the same, the terms will be used interchangeably in this study. A short review of the KAP methodology and its strong points and weaknesses follows next.

4 Knowledge, Attitude and Practice (KAP) survey methodology

This study is based on KAP surveys that have been performed in the Carletonville area. A theoretical discussion of the kinds of instruments and a review of the methodology of KAP surveys follow below.

Sample surveys are useful in determining what percentage of a given population holds a certain belief or reports engaging in a certain practice. It can be used to examine the relationships between different beliefs. Sample surveys can also be used to represent a target population and they usually make use of quite carefully constructed questionnaires. KAP surveys use the same procedures as sample surveys, but the purpose of this type of survey is to establish the level of knowledge, attitudes and practices of the population being studied. It focuses on the behaviour of the studied population towards dealing with the problem or the issue at hand. A KAP survey includes the perceived consequences to those behaviours and what the studied populations' knowledge and attitudes are toward the desired behaviour. The relationships between all these factors are studied when a KAP survey is conducted (UNICEF, 2000).

KAP surveys have been used in various settings and in different fields of study. They have been used quite often in studies on HIV/AIDS to establish infection rate trends and the relationships between knowledge, attitudes, perceptions, behaviour and infection rates. Many examples are quoted in literature, of which only a few will be discussed briefly here.

In Sierra Leone UNICEF decided to address the imminent HIV/AIDS crisis, as Sierra Leonean society was in denial concerning the epidemic. People refused to consider HIV/AIDS as a major problem and certainly did not think it a priority problem in comparison to the daily struggle to survive. Only limited data were available on the prevalence of HIV (UNICEF, 2000). The parallels with South African society at the time are quite clear.

UNICEF stepped into the Sierra Leone situation and initiated various activities in partnership with many associations and agencies. In order to obtain accurate information so as to target their interventions, UNICEF also undertook a Knowledge, Attitude and Practice (KAP) survey. KAP surveys will be a continuous source of reliable information on how to design new materials for communicating the risk of HIV/AIDS (UNICEF, 2000).

Other interventions and programmes were implemented in Tanzania besides those in Mwanza. A national AIDS control programme was launched in 1988. The main intervention strategy that was promoted then focused on safer sex in the general population, as well as among youths and mobile populations in high transmission areas. The national programme had a monitoring and evaluation component and was therefore able to produce annual reports (Msamanga & Swai, 1999). These reports were based on KAP surveys.

Several national KAP surveys were also conducted in Tanzania. These included a WHO/GPA survey in 1991, a Demographic and Health Survey (DHS) in 1991 and 1996, and another KAP survey on Family Planning and Aids in 1994. All of these suggested a modest but significant change in sexual behaviour in many parts of Tanzania (Msamanga & Swai, 1999).

In Malawi an organisation called "Tilele ife ana Amasiye" set out to mobilise the spiritual and political leadership in villages in rural Malawi to assess the impact of the AIDS crisis in their areas and implement community-based responses. Emmanuel International assisted them with funding to embark on a range of activities to reach their objectives. One of these activities entailed a KAP survey at the beginning of the programme in each village to assess the impact of awareness and prevention initiatives (Emmanuel International, 2001).

In Burkina Faso the national response to HIV/AIDS was limited until 1996. Since then the national efforts have been scaled up significantly. Monitoring and evaluation was incorporated into the national AIDS programme mid-term plans, and included HIV sentinel surveillance in eight antenatal clinics (Meda *et al.*, 1999). The main monitoring and evaluation data collection efforts included an urban KAP survey among pregnant women, truck drivers and commercial sex workers in 1994. During 1996 a nationally representative KAP survey with a sample size of 3 261 respondents was completed. The link between monitoring, evaluation, policy making, programme planning and implementation was weak and therefore the implementation team were not able to utilise the data effectively (Meda *et al.*, 1999).

It is clear from the examples mentioned above that KAP style surveys can be utilised for a number of different purposes. Monitoring and evaluation of national programmes and any intervention programme will always be important and KAP-style surveys often make up an integral part of such evaluation strategies.

However, not everyone agrees that KAP-style surveys are necessary or even useful for interventions on HIV/AIDS. Smith (1993) remarks that KAP-style surveys had limited utility in the practical epidemiology of AIDS, based on his observations with reference to the epidemic in Chile.

Smith's first criticism of the KAP-style surveys was that "[t]he one-shot survey process is not well suited to obtaining valid measures of intimate behaviour, all the more so when some forms of behaviour are normally sanctioned" (Smith, 1993). In his opinion, such surveys would appear to under-report the behaviour that the surveys were studying. He notes an example of the WHO KAP study in Santiago in which the investigators made use of a mirror sample for some intimate questions. In this sample respondents always reported more of the "socially unacceptable" behaviour than when they were reporting for themselves. Even in cases where it was assumed that respondents would over-report (like the sexual activity of young men), the mirror sample still reported more sexual activity for this group. This raises questions about the accuracy of the reporting of sexual behaviour in all KAP surveys.

Smith's (1993) second point of criticism involves that of defined risk behaviours. He agrees that the shift away from risk groups to risk behaviours is a good one, as the former only helped to stigmatise and isolate groups in society. However, identifying risk behaviours might not be that simple. For instance, Smith (1993) points out that most KAP surveys consider multiple sexual partners to constitute risky behaviour. However, having one infected partner obviously constitutes greater risk than having multiple uninfected partners. According to Smith (1993) this type of risk analysis is a confuses the reasons why individuals are at risk. Having several uninfected partners is obviously less risky than having one infected partner. Therefore, measuring the number of partners might be measuring the wrong concept altogether.

A third problem with KAP surveys pointed out by Smith (1993) is that KAP surveys can rarely yield good information on sexual networks, which often constitute the core of the assumptions of risky behaviour.

Although Smith (1993) concedes that well-designed surveys with well-specified measures across relevant populations have their uses, he proposes alternative modes of enquiry. The first is that of in-depth interviews. He concludes that in-depth interviews are useful for addressing the following problems in the field of study.

- "Avenues of infection in the female population".
- "Locus of infection in sexual networks" (which refer to the study of connectedness of people suffering from AIDS).
- "Ability to identify partners and the willingness to notify them" (a form of research that is rare due to, at least in part, the belief that HIV-infected people cannot identify their partners, or if they can, would not be willing to do so).

Smith (1993) indicates that he set out to test the above belief. He and his partners experimented with different methodologies and eventually settled for a focused probing interview as the best method for studying sexual networks.

Smith (1993) remarks that he has "... argued that unfocused inquiry into diffuse behaviours in undifferentiated populations is not a productive line of research in the epidemiology of AIDS and HIV infection, particularly in low-seroprevalence populations and especially when the point is to design some form of intervention that might actually avert further infection". As will become clear in this study, we have in South Africa moved well beyond the point of low-seroprevalence.

Reviewers of Smith's paper in the *Health Transition Review* did not agree with Smith on all the issues raised. Caldwell *et al.* (1993) welcomed the paper, as they believed it to stimulate much-needed debate on raising research standards in the study of sexual networks and the transmission of HIV/AIDS. However, there were three issues on which they disagreed with Smith (1993). These centred on the premise of the possibility to implement better population-based epidemiology in order to understand the epidemic; the extent to which the approach advocated by Smith (1993) can be said to lead to an understanding of the epidemic; and the public health value of population-based research.

According to Caldwell *et al.* (1993) Smith (1993) did not make it clear whether he was attacking poor quality research or whether he felt that population-based inquiries in this area would never secure adequate data (or would secure the wrong data). If the first instance was the case, the studies that were referred to were not meant to be population-based studies to explain the sexual networks and the transmission of HIV/AIDS.

Caldwell *et al.* (1993) stated that "[p]opulation-based survey cum anthropological research is needed to build models of the epidemic, to allow public-health personnel to gauge the potential danger, and to provide data for informational services and the media which may help to bring about behavioural changes."

They further argued that examples of bad research do not disprove the need for good research in the same area (Caldwell *et al.*,(1993). Good research would certainly go further and relate the level of sexual networking to the level of HIV/AIDS in the area. Only good data on sexual networks can show how fast an epidemic is spreading or likely to spread through the population, and whether it is likely to expand or contract. This would surely be an effective weapon in the fight to contain the epidemic. In large areas of sub-Saharan Africa, good information on the extent of sexual networking and the frequency with which high-risk individuals can be found in those networks, is the only factor that will provide governments and the media with information that is disturbing enough to the general population to persuade them to start changing their behaviour. This is certainly the case in South African society, where individuals are still not changing their behaviour due to their low perception of risk. This would make KAP-style surveys of good quality an important tool in the South African fight against the epidemic.

Michael Lane also responded to Smith's paper. Lane (1993) was of the opinion that Smith made two fundamental errors in his perception of the motivation for carrying out KAP surveys. Lane (1993) states that, firstly, Smith (1993) wrongly assumed that surveys were meant to document the modes of transmission occurring in the survey population, and secondly that epidemiologists use surveys as research tools to draw causal conclusions about the risk factors and disease.

According to Lane (1993) the data from surveys are designed to provide information by means of ongoing systematic collection, analysis and interpretation. These data are then used in the planning, implementation and evaluation of public health programmes. This concept has been broadened in recent years to monitor indicators of risk as well as actual disease incidence. Surveillance systems (and KAP surveys with them) are therefore not designed to identify the individuals at risk, provide information on the chain of causation, or to measure disease dynamics.

While Smith (1993) claims that "[t]he one-shot survey process is not well suited to obtaining valid measures of intimate behaviour", Lane (1993) is of the opinion that proponents of the KAP surveys have not made this claim. Instead he admits that, strictly speaking, KAP surveys may not be valid. However, if they are repeated with similar survey instruments and similar samples over time, they would measure the changes in the population's knowledge, attitudes and practices about HIV risk factors. If these trends are not in the desirable direction, scientists and authorities should modify their strategies, regardless of where the starting point was. In the absence of such data, programme managers are "flying without instruments".

In certain instances it is simply more practical and cost effective to measure certain behaviour, even though such behaviour is not causally and directly linked to the transmission of the disease. These are simply measures to indicate in which way public knowledge, perceptions and practices are moving (Lane, 1993).

In this study, the objective of the surveys was clearly to track and monitor the progression on the epidemic amidst an intervention. It was therefore decided that the KAP survey would be relevant and appropriate as a measurement tool to realise this objective.

5 Methodology of the study

5.1 History of the project

This project was conducted in the Carletonville area of South Africa. Carletonville is a relatively small mining community about 80 kilometres west of Johannesburg (see Figure 2 and Figure 3). During the apartheid years, black people were accommodated in townships – usually just outside of the boundaries of a town or city. In the case of Carletonville, the township of Khutsong was established for black people to the northwest of Carletonville, about 20 km from the town centre.

In Khutsong four distinct types of housing can be found. The first and most populous is the so-called council housing. This type of housing originated during the apartheid years and was an attempt by the government to house black people without giving them ownership or title to their housing. Housing provision by the government took the form of a standard design with little variation in size. In fact, the design was so monotonous that this type of housing also became known as "matchbox" houses. All these houses were owned by the state and tenants leased them on a monthly basis (Crankshaw, 2005).

The second type of housing found in Khutsong is private housing. Most of these houses were built after 1994 and were initially inhabited mostly by mine employees who received housing subsidies from the companies that employed them. This type of housing, which had commercial value and was traded, is now mostly inhabited by middle class families and professionals.

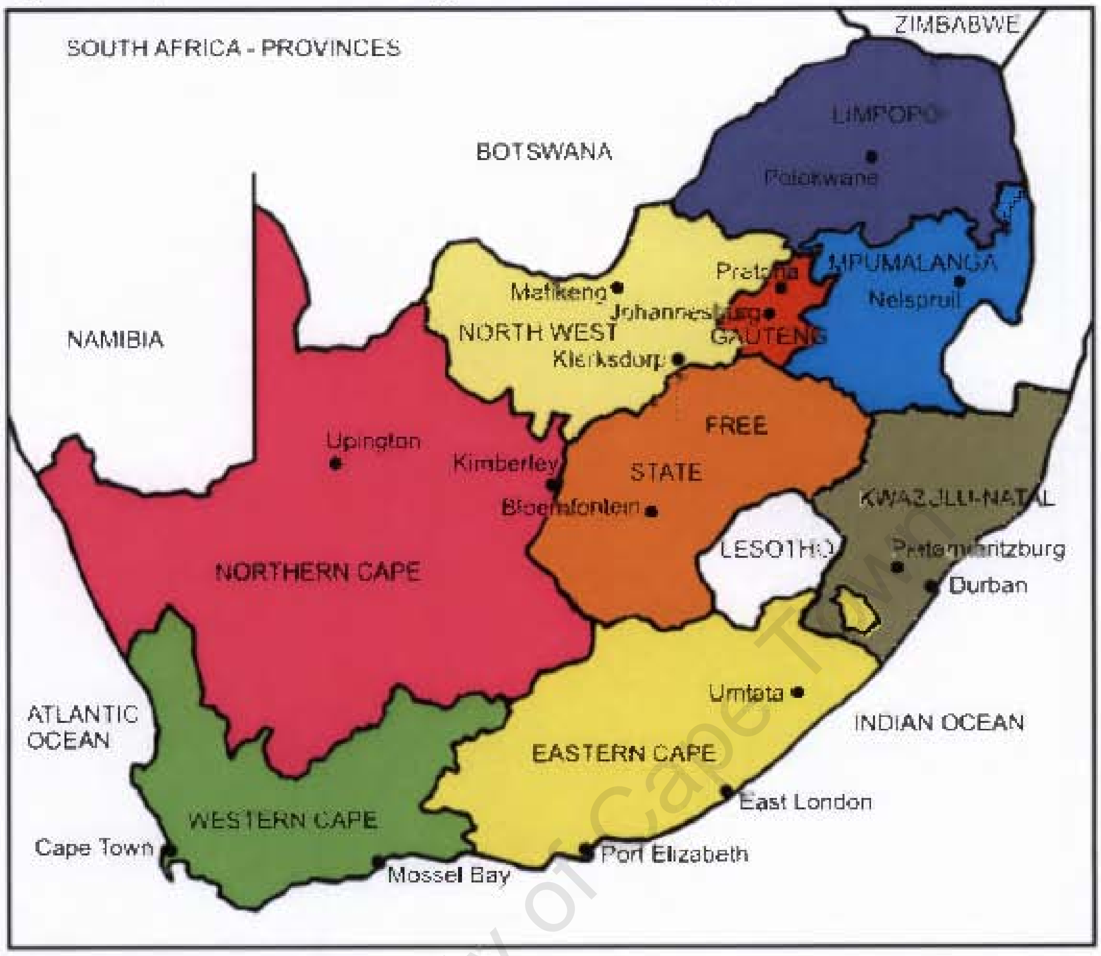
The third type of housing is the so-called 'site-and-services schemes'. Historically this type of housing was born from the inability of the apartheid government to forcibly remove ever-expanding squatter settlements as far back as in 1946. In Johannesburg the solution was to provide cheap land and services to homeless families and the site-and-service schemes were born (Crankshaw, 2005).

The last housing type found in Khutsong comprises illegal squatter settlements. Families in these settlements occupy a piece of land on the perimeter of the township and although they do so illegally, the municipality has not tried to remove them for many years and in some places they are very well established. In the Carletonville study, these different housing types were used as a proxy for socio-economic status (as will be explained later under the sample methodology).

Mineworkers in the Carletonville area are housed mainly in single-sex hostels built within walking distance of the different mine shafts. These hostels consist of many types of constructions, but most of them take the shape of large dormitory rooms, with partitions between beds, shared ablutions and dining halls. Some of the larger hostels can house up to 3 000 mineworkers, and the number of mineworkers living in each hostel is determined by the size of the mine shaft. Mineworkers move freely in and out of the hostel grounds and there are no curfews. Women, however, are not allowed to stay within the hostel grounds overnight.

Near the mine hostels, often on mine-owned property, or alternatively on privately owned property adjacent to the mine hostels, informal squatter settlements can be found. These settlement usually consist of various bars, called Shebeens, and tin shack constructions used for housing as well as for commercial sex by commercial sex workers who live there. Due to the high-risk sexual activities taking place in these settlements, they have become known to the project as "hotspots". Settlements differ greatly in size and it is estimated that the larger settlements housed up to 800 commercial sex workers.

Figure 2 Map of South Africa showing the location of Gauteng Province



Source: images.google.co.za

In 1994 Prof. Brian Williams (the then director of the Johannesburg-based Epidemiology Research Unit) and Dr Catherine Campbell (a social scientist working with Prof Williams) realised that the impact HIV/AIDS would have on South Africa and the mining industry in particular would be severe. They launched a fund-raising exercise to address the problem. During this time they met with members of the Carletonville AIDS Action Committee (CAAC). Mr Solly Moema and Sr Zodwa Mzaidume (later the Project Manager and the Community Outreach Co-ordinator respectively) were trying to gather support for the development of an HIV intervention programme in the Carletonville area. The CAAC was established by local community groups in Carletonville when they realised the severity of the impact that HIV/AIDS was beginning to have on their community.

Prof. Williams and Dr Campbell spent three years (1994 to 1997) raising funds from donors for the project. During this time negotiations took place with the gold mines, trade unions, state health services, local community organisations and other interested parties on implementation of the project. Initial funding for the project was provided by the Department for International Development, United Kingdom (DFID, UK). The main aim of the project was to develop ways to reduce the spread of HIV in a community at high risk. The project also set out to evaluate and research the impacts and risk factors for HIV infection in the community. Later on, the Population Council, Old Mutual in South Africa and the *Agence Nationale de Recherches contre le SIDA (ANRS)* from France made financial contributions as well. The Population Council provided funding specifically for some of the surveys. The ANRS also sponsored some of the survey activities, in particular the 1999 youth survey.

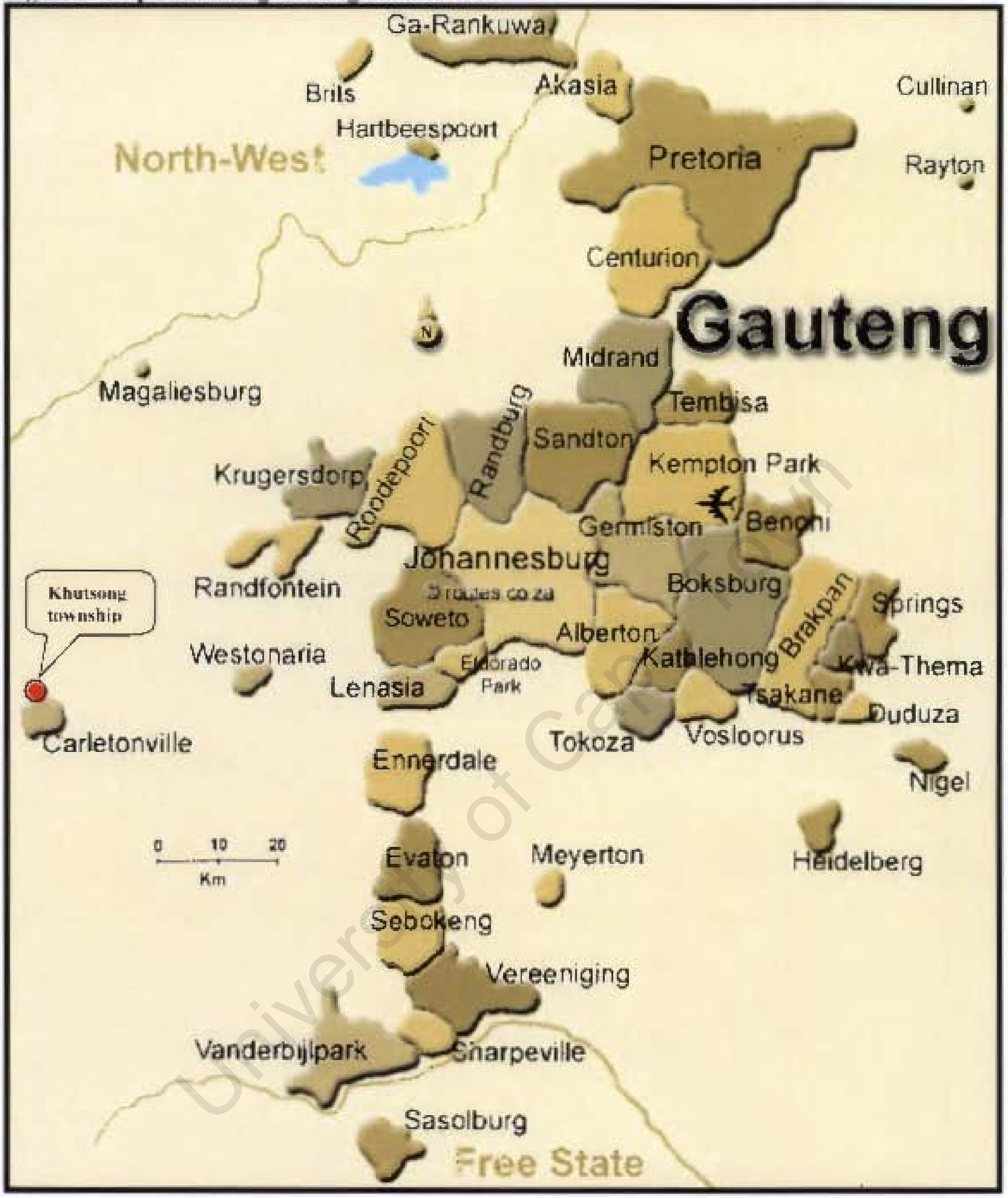
5.2 The intervention in Carletonville

In the light of previous interventions that had been implemented to prevent the spread of HIV/AIDS (as discussed earlier), the team putting together the Carletonville study decided to use the experience, but to use a more ecological approach. The following three interventions were planned and implemented from the very start of the project in 1998:

- Increased condom distribution
- Improvement of healthcare treatment together with the syndromic treatment of STIs
- Peer education strategies in high-risk populations

High-risk populations were defined as migrant workers living in single-sex accommodation for the majority of the year, as well as commercial sex workers who frequented areas around these living quarters. However, the initial intervention was modified slightly after it came to light that the residents from the nearby township of Khutsong were also highly infected. The intervention was therefore extended to include the whole of Khutsong and to focus on the youth. Khutsong is about 35 to 40 km away from the mines, but with a well-developed transport system between the mines and the township there was obviously regular contact between the mineworkers and residents of Khutsong.

Figure 3 Map of Gauteng showing Carletonville



Source: © routes.co.za

Later on at the end of 2000, a Preventive Periodic Treatment (PPT) component was added for commercial sex workers working close to the mines. This intervention comprised of a mobile clinic with a professional nurse, which visited the hotspots on a monthly basis and treated commercial sex workers for STDs. In addition, all commercial sex workers were given a broad-spectrum antibiotic, Azithromyzin®, to eliminate any asymptomatic STD infections (Williams *et al*., 2000a).

The impact of the interventions was measured on a number of occasions. In the spring of 1997 Progressus (a research organisation) conducted a demographic survey to establish the demographic structure of the population in order to decide on stratification of the sample in future studies. Some KAP surveys followed. Early in 1998 Progressus did the first biomedical cross-sectional survey and this was referred to as a pilot study. This survey included respondents between the ages of 15 and 59 in Khutsong, a small number of commercial sex workers (CSWs) and mineworkers. The interventions started during the middle of 1998, except for the PPT intervention that was added later on. In August of the same year Progressus conducted a baseline survey, which again included a sample of mineworkers and respondents from Khutsong in the age group 15 to 59. A year later (August 1999) Progressus conducted another biomedical cross-sectional survey, but this sample was based on Khutsong residents between the ages of 15 to 25 years. The mineworkers were sampled again, regardless of their age, and a small number of CSWs were also included. In 2000 Progressus conducted a third cross-sectional biomedical survey. On this occasion respondents from Khutsong between the ages of 15 and 59, as well as mineworkers and CSWs were again included as before. Progressus did a final survey from August to October 2001 where the respondents from Khutsong, mineworkers and CSWs were sampled in the same way as in 2000.

This was not a cohort study and the respondents who participated were recruited in the same way every year, though a randomly selected sample which will be described later. People who had participated before were not excluded. This left the researchers with five data points for the project, namely the pilot survey, the baseline, the youth survey and the 2000 and 2001 surveys. Of these, the pilot survey sampling strategy for the residents of Khutsong was different, in this first survey members of a household were only included if all the members of the household agreed to participate. In subsequent surveys members of a household were included even if not all the members of the household agreed to participate, this fact should therefore be kept in mind the data are considered. The youth survey consisted of a different sample of residents of Khutsong compared to the baseline, 2000, as well as 2001 surveys. For the residents of Khutsong, therefore, we can only compare the baseline in 1998, the 2000 and 2001 surveys. For mineworkers and commercial sex workers, a comparison can be drawn between the pilot survey, baseline survey, youth survey and the 2000 and 2001 surveys.

The interventions in Carletonville started in February 1998. For the duration of the project a number of peer educators in high risk groups, mineworkers and CSWs, were trained. Later, during 1999, school peer educators were trained as well. For the improvement of STI treatment services nurses and General practitioners were trained. Traditional healers in the community were also trained in the recognition of STI symptoms. The STI training was done throughout the duration of the intervention. A full time professional nurse supported all health facilities in the area on STI treatment.

Condoms were distributed to health facilities where they were not available at the time, and points in the community where people gather on a regular basis, like taxi ranks and shebeens. Data on condom distribution during the intervention project showed that 1.48 million condoms were distributed in the first year. In the subsequent years 4.66 million and 4.81 millions condoms were distributed in 1999 and 2000 respectively (Williams *et al.*, 2003). No condom distribution data was available for 2001. The delivery of all interventions was consistent over the period of the study as far as could be established.

5.3 Organisations, stakeholders and funding bodies

From its inception the project was directed by Prof. Brian Williams, director of the Epidemiology Research Unit (ERU) in Johannesburg. At the beginning of 1999 Williams moved to the Council for Scientific and Industrial Research (CSIR) (also in Johannesburg), which then took over responsibility for the project. Williams convened a committee of stakeholders to oversee the project and members included representatives from the following stakeholder groups:

- Anglo-American Corporation (now Anglo-Gold)
- Gold Fields of South Africa (now GFL Mining Services)
- RandGold
- The Carletonville AIDS Action Committee (CAAC)
- The Carletonville Local Health Authority

- The Epidemiology Research Unit (ERU; succeeded by the Council for Scientific and Industrial Research (CSIR)
- The Gauteng Provincial Department of Health
- The National Department of Health
- The National Union of Mineworkers
- The North-West Provincial Department of Health
- The Society for Family Health (SFH)
- The South African Institute of Medical Research (SAIMR)

Funding for the project came from a variety of sources (Williams *et al.*, 2000a):

- The ERU
- The Department for International Development (UK)
- The Population Council (USA)
- The Provincial Department of Health (SA)
- The ANRS (France)
- The Old Mutual Assurance Company (SA)

5.4 Ethical approval

The protocol for the project was submitted to the committee for Research on Human Subjects (Medical) of the University of Witwatersrand, Johannesburg, and was approved on 10 March 1997 (Protocol M 970235).

5.5 The pilot survey

Fieldwork for the pilot survey was carried out in January 1998 among 1 597 residents of the Carletonville mining region. During this survey, respondents completed a questionnaire based on the UNAIDS multi-site HIV survey. The questionnaire was reworked and amended by Prof. Williams, Catherine MacPhail and myself to suit the conditions and circumstances of the community of Carletonville. My role was to align the questions to the experience I had working with people in low income and low educational level areas, to make sure that the language and explanation used was appropriate for the whole community. The questionnaire included sections on the following:

- Background characteristics
- Demographic and socio-economic issues
- Measures of social capital
- Sexual relationships and sexual networking with both regular and casual partners
- Knowledge and perceptions of HIV/AIDS
- Attitudes towards people who are HIV positive
- Condom use and reported behavioural change
- Experience of STIs

The biomedical component included tests for HIV, syphilis, gonorrhoea and chlamydia. Later on, ethical clearance was obtained and testing for HSV-2 was included in the biomedical component.

5.5.1 Sample design of the pilot survey

For the residents of Khutsong the sample design was again a collective effort of a number of people. The researcher assisted in the final design for which a stratified, two-stage cluster sample was used. In the first stage of the sample, the primary sampling units were clusters of stands in the township. In the second stage the secondary sampling units were residential stands in the township.

The clusters were drawn using stand maps of the Khutsong township. The entire township was divided into clusters; the clusters decided upon were usually a few street blocks put together with roughly equal numbers of stands per cluster. In the the squatter settlements, blocks were drawn where no clear street blocks were visible to divide the area in roughly equal-sized clusters. The sample was stratified in the first stage of the sample according to housing type. This was done proportional to population size and for each housing type the proportional number of clusters was sampled. For instance, council houses far outnumbered all other forms of housing, so more council house clusters were selected in the first stage of the sample. The exact number of clusters per stratum was based on the expected number of respondents that each cluster would produce to achieve a final sample size of about 1 200 respondents from Khutsong. All clusters were numbered and selected randomly by using a random number generator.

For the second stage of the sample, a systematic sample of stands was drawn. In each cluster the stands were sampled systematically using a sampling interval. This interval was calculated by dividing the number of stands to be selected by the number of stands in the cluster. Every eligible person living on a selected stand was interviewed; this was done to ensure that households who shared dwellings or stands with other households, for instance backyard shack dwellers, would be included in the sample. A systematic start was used to start the counting in each cluster. The counting would start from the top left-hand corner of the map of the cluster, which was the northwest corner of each cluster, and proceeded in a clockwise direction. Obviously, slight variations in the direction occurred in some cases, as not all clusters were rectangular and nor were the stands always arranged in neat rows.

There are at least two good reasons for using a cluster sample in the kind of surveying used in the Carletonville study. Firstly, using a cluster sample reduced the fieldwork costs as the sampled stands were not spread across the entire township, but close to each other in clusters, which cut fieldwork transport and time. Secondly, since no sampling frame was available for the population, a cluster sample was ideal because a sampling frame had to be drawn up for the clusters only and not for the entire population (Moser & Kalton, 1979). It was important to be sure that all households in Khutsong had an equal chance of being included in the sample for it to be considered as a random sample (Kish, 1995; Moser & Kalton, 1979). Cluster sampling gave each household in Khutsong an equal chance to be included the study and once in the cluster, it gave each household an equal chance of being selected into the sample.

Stratification is used in sampling strategies to make the sample more accurate without having to increase its size (Moser & Kalton, 1979). The sample was self-weighting, in other words housing groups were included in the proportions that they are present in the population and stratified according to housing types, to ensure that all housing types were included in sufficient numbers. Housing type was used as a proxy for socio-economic status. Given the substantial differences in socio-economic status and also in the place of origin of residents in the various housing sectors, it was important to ensure that all were represented approximately in proportion to their numbers in the overall population. Housing type served as a good proxy for socio-economic status, with informal squatter camps at the bottom of the socio-economic scale and people in private housing at the top (Crankshaw, 2005). The residents of council houses were employed mostly as unskilled labourers and semi-skilled operators. They slotted in below the private housing where residents were employed as professionals and as technically skilled employees. The site-and-service area was populated by people who were only slightly better off than those in informal squatter areas, as they tended to be more settled and engaged in subsistence economic activities.

The number of dwellings and the number of eligible individuals in each of the housing types were known before the sampling process began. Therefore the number of clusters and the number of stands required in each cluster to render the targets for each stratum could be calculated.

For the pilot survey, the number of respondents included from each housing type was slightly different than for the later surveys and it was less representative of the proportions in the population. This was due to the fact that the response rates were low in some of the housing type domains during the pilot survey. Private housing and council housing were over-represented, while squatter camps and site-and-service schemes were under-represented. The number of respondents per housing type for the baseline survey was more representative of the proportions of the housing types in the sampling frame, with private housing and squatter settlements slightly under-represented and council houses and site-and-service schemes slightly over-represented.

Once a household was selected, the selection team was not allowed to substitute it, as no replacement sampling was done. Attempts were made to contact selected households over a period of five weekdays in the afternoon and evening at various times. An over-sample of 15% was used to ensure a sufficient sample realisation, and to account for refusals and households not found at home during the five days of sampling in each cluster.

Once a household had been selected, the recruiters (called selectors in this study) were sent out and they recruited each household to take part in the study. Households were only included in the pilot study if everyone in the household agreed to take part in the study. This was done to ensure that the age distributions were representative of the population.

For both the sample of mineworkers and of people living in council hostels, a systematic sampling technique was used. The sampling interval was different for different hostels as they differed greatly in size. Sampling in the hotspot squatter camps were also done systematically and no clusters were used because these were fairly small villages.

5.5.2 Lessons from and problems of the pilot survey

The pilot survey provided useful information about the state of the epidemic as well as a number of important lessons concerning the logistics of the survey (Williams *et al.*, 1999). The pilot survey revealed two problems – concerning language and participation respectively.

The questionnaire was translated from English into five African languages: Zulu, Xhosa, Tswana, Sotho and Shangaan. However, the interviewers experienced problems due to the fact that, although the translations were formally correct, the wording sometimes differed significantly from the language used by people in the area. It was clear that the local dialects of the languages differed significantly from the formal academically accepted versions. The questionnaires thus had to be retranslated by local people.

The second and more important problem was to get residents to participate, particularly in the higher-income sections of the township. As far as the private housing areas were concerned, it was estimated that about 90% of the people were at home when visited, but only about 10% of them agreed to participate. The reasons given by selected households for not wanting to participate in the research included the following:

- The household already had a medical aid fund.
- They would go to their own doctor if they had a problem.
- They were not at risk of contracting HIV/AIDS.
- Their blood would be taken and sold.
- The study was concerned only with black and not with white people.

According to (Williams *et al.*, 1999) one of the other common reasons for households refusing to participate is their lack of understanding that the research project has been designed to understand the scale and nature of the problem.

The research organisation which had been recruiting respondents felt that there would be little point in organising a community meeting in the private housing sector for future surveys as the people living there did not have a strong sense of community. It was decided that when future surveys were conducted extensive leafleting of the area would be done prior to the survey.

Among people living in the council houses the response rate was better. It was estimated that 80% of them were at home when visited and of these, 80% agreed to participate. The most common reason given for refusal to participate was that the head of the household was not present and that he would have to decide if the family should participate.

In two adjacent sections, visited on consecutive days, there was very poor response on day one in the first section, and a very good response on day two in the second section. The recruiters felt that this was partly due to the fact that once word got around that the process was perfectly acceptable, the news was passed to neighbours who were then happy to participate. It was also clear that to reach the middle-aged women, recruiters should visit before 11:00 in the morning, but to find the middle-aged men they needed to visit in the late afternoon. It was decided that in future surveys, council houses would be visited on the first night between 16:00 and 18:00 and arrangements would then be made for respondents to attend on the following day.

This would give families time to discuss their participation with fathers or heads of the households. In practice, families were visited between 15:00 and 19:30.

In the site-and-service areas it was estimated that 80% of the people were home when visited, but in about 20% of households no-one was eligible because of the age criteria. For example, many families consisted of grandparents living with grandchildren. Among those who were eligible but refused to participate, the main reason given was fear of the pain involved in giving a blood sample.

In the squatter settlements people were far more likely to be found at home and it was estimated that over 95% of the people were in fact home when visited. However, in Shangaan-speaking areas almost everyone refused to participate, while in the sections known as 'Chris Hani', 'Joe Slovo' and 'New Mandela', the refusal rate was about 30%. In the remaining areas about 10% refused to participate. The reason given by Shangaan speakers was that it was 'against their religion' to give blood samples. Their refusal may have been compounded by the fact that many of them were probably illegal immigrants. In the three named areas there were also many illegal immigrants and this would account for the high refusal rate in those areas. In fact, it seemed that people were afraid that the minibus that transported them to the central point was in fact going to take them away for deportation. This situation was aggravated by the fact that the police were known to use unmarked cars to round up illegal immigrants in the area (Williams *et al*., 1999).

There was a significant problem in explaining the difference between HIV and STDs, plus a fear of the results. Almost all respondents did not want to know their HIV status. This could be explained by the social stigma that was still attached to the disease. For future surveys it was decided that interviewers and selectors (fieldworkers responsible for recruitment of respondents) should receive explicit training in this regard. A decision was also made to work closely with the street committees, at least one month prior to the survey, to help educate the community about the reasons for and the importance of the survey.

The participation rates for mineworkers varied substantially among the various mine shafts. Mineworkers were approached during mealtimes in the dining halls and in their rooms. The survey was conducted at the following shafts:

- Elandsrand
- Deelkraal
- Western Deep Levels Shafts 1, 2, 3, and 9
- East Driefontein Shafts 1 and 2
- West Driefontein Shafts 2, 4 and 5

For the pilot survey, the refusal rates varied greatly. At the Elandsrand shaft the refusal rate was estimated at 70%; at Western Deep Levels Number 1 Shaft 40% refused; at its Number 2 Shaft no-one refused; and at its Number 3 Shaft 50% refused. At Deelkraal as well as at East and West Driefontein no-one refused to participate. The problems on the mines were varied. The union was suspicious of the process and was concerned that management would get access to the results – this was responsible for at least some of the variation in refusal rates (Williams *et al.*, 1999).

Furthermore, the mine management was not overly supportive in some instances. Little or no information about the research had been given to the hostel residents, making them suspicious of the research despite negotiations with their union and management representatives, which took place well in advance. On the day of the fieldwork the members of the hostel committees were very unco-operative. The difficulties around access centred on the unions' suspicions about the motives of management for allowing the survey and about the availability of data to the mine management. At some of the mine hostels, for example East and West Driefontein, the union created a list of people who were nominated to take part in the survey and all of them agreed to participate (of course this kind of a strategy could introduce a bias in the sample). It was decided to negotiate with the union not to select people in future surveys, but to ensure that respondents would be selected by the research team.

It was clear that future surveys would have to ensure much higher levels of support from management, much closer co-operation with the local union representatives and much greater involvement of the hostel residents' committees. If all of these precautions were to be taken, persuading mineworkers to participate would not seem to pose a great problem.

5.5.3 After the pilot survey

As is clear from the discussion above, there were many issues that had to be resolved for future surveys. All of these matters were addressed and solutions found. In the discussions to follow on the cross-sectional baseline surveys, some of the changes and solutions will be pointed out. Overall, it was decided to continue with the cross-sectional surveys.

5.6 The cross-sectional surveys

The main aim of the baseline survey was to assess the prevalence of HIV and STDs among the residents of Khutsong, the mineworkers and the commercial sex workers living in informal settlements around the mine hostels. From this basis, the subsequent surveys were done to study the impact of the interventions that had been put in place.

5.6.1 Recruitment and training of field assistants

Advertisements were placed in churches, local clinics and community buildings in Carletonville, Khutsong and the neighbouring township of Wedela, in which positions in a community project were offered to young people over the age of 23 years who had some tertiary education experience and fluency in English. Suitable applicants were interviewed and a total of 42 field assistants (20 selectors for the recruitment of study respondents and 22 interviewers to conduct interviews) were recruited. The number of fieldworkers used in the different surveys differed from year to year, but were very similar. All selected assistants were fluent in at least one local language and were familiar with the Carletonville area.

The 20 selectors met the trainers from Progressus for three-day training sessions where they were taught how to:

- find the selected households;
- visit them one by one;
- inform household members about the study;
- motivate them to participate, staying within the prescribed guidelines from the ethics committee;
- collect basic demographic data; and
- conduct a basic interview (Williams *et al.*, 1999).

A special training programme was developed by the research organisation to train inexperienced fieldworkers with low academic qualifications in techniques for interviewing and recruitment of respondents. The training programme was designed on the basis of outcome-based techniques.

Training the approximately 22 interviewers for each of the surveys took one week. Trainee interviewers were given the opportunity to look through the questionnaire and discuss each section in-depth. Discussions focused on the structure of the questionnaire and on words and concepts that were difficult to understand. Trainees used role-plays to practise interviewing techniques. Practice interview sessions with both a friend or family member and a stranger were followed by further in-depth discussion of problems and difficulties encountered. Questions on sexual behaviour and the vocabulary used by interviewees generated the most discussion. Question-and-answer sessions, exercises and role-plays were used until all trainees felt comfortable administering the questionnaire to a stranger. The training also provided information on HIV transmission, symptoms of AIDS and places to which to refer people who were in need of counselling (Williams *et al.*, 1999).

5.6.2 Sampling and stratification

Mineworkers living in single-sex hostels at the mine shafts where they were employed, commercial sex workers living in the hotspots and the population of Khutsong were all sampled separately. Within Khutsong, the population was stratified according to housing type. The housing types were council houses, informal squatter housing, site-and-service schemes and private housing. Given the substantial differences in socio-economic status and also in place of origin of people living in the various housing sectors, it was important to ensure that all were represented approximately in proportion to their numbers in the overall community. Housing type served as a good proxy for socio-economic status, with informal squatter housing at the bottom of the socio-economic scale and people in the private houses the most affluent (Crankshaw, 2005). The council houses housed people who would be working – as labourers and in semi-skilled jobs – and they slotted in below the private housing professionals and technically employed people would be found. The site-and-service area was populated by people who were only slightly better off than the people in informal squatter areas, as they tended to be more settled and engaged in subsistence economic activities.

It was decided to include approximately 1 000 mineworkers, 1 500 people from Khutsong and a further 100 commercial sex workers living in the hotspots, to complement the qualitative, in-depth studies that were planned as part of the project. Hotspots were defined as areas of informal settlement within walking distance of the single-sex mineworker hostels close to the mines. These were small communities consisting of a varied number of shacks mainly functioning as bars and places where mineworkers met sex workers. It was populated mainly by women with a high turnover of residents (Williams *et al*., 1999).

The sampling strategy used in Khutsong was the same for the cross-sectional surveys and for the pilot survey and is described above. However, there was one important difference. In the pilot survey individuals were only included in the survey if everyone from a selected household agreed to take part. In the cross-sectional surveys that followed, individuals from selected households were included even if all the members of the household could not be found or if some members of the household refused.

Different sampling strategies and ways of preparing communities for recruitment were used for the residents of Khutsong, the mineworkers, and the commercial sex workers. A full-time person was recruited locally to work with the mines as well as with the residents in Khutsong. His job was to promote and market the project, and to provide information to organisations and individuals. Street associations, churches and other community organisations in Khutsong were contacted to gain support for the project. In addition, pamphlets were distributed in the private housing sector to facilitate communication with people living in this area. All these were strategies that were implemented after the pilot survey to increase participation in the areas where participation was problematic during the pilot survey.

The sample was stratified by housing type, using the results of the demographic survey done in 1997. For the cross-sectional survey, individual dwellings on aerial photographs were counted, the aerial photograph was 'ground-truthed' to estimate the degree to which the settlements had increased in size since the photographs were taken, and the number of inhabitants per housing type was estimated. The number of people sampled per housing type included those living in the backyard shacks. The number of respondents needed from each housing type was calculated in proportion to the total sample size and the number of clusters chosen to give 25 to 30 people per cluster (Table 1) (Williams *et al*., 1999). The sampling was again a two-stage cluster sample, stratified by housing type. The first stage comprised a random sample of clusters selected proportional to population size. Clusters were numbered and selected randomly using a random number table. Within the selected clusters, stands were selected systematically by using a systematic starting point. Once again the stand was the sampling unit . Every eligible person living on a selected stand was interviewed. This ensured that residents living in backyard rental units were included in the sample.

Table 1 Number of people required per housing type for the baseline survey

	Number of respondents per housing type	Number of clusters	Number of respondents per cluster
Private houses	100	4	25
Council houses	200	4	50
Site-and-service schemes	300	8	38
Council hostels	50	2	25
Informal sector	400	14	29
Khutsong South	100	3	34
Mine hostels	900	9	100
Hotspots	150	25	6

The large number of people per cluster in the council houses was due to the high number of backyard shacks in this area. Maps of all the areas, including the squatter areas, were obtained from the local authority and these were used to draw the sample. The index houses were chosen systematically by starting in the top left-hand corner of cluster maps or the northwest corner of each cluster and identified on the ground. Other houses in each cluster were identified by moving to the right of the index house, with a sampling interval determined by the target for the cluster divided by the number of dwelling in the cluster, including respondents from the backyard shacks and everyone who slept on that stand the night before. Some of the backyard residents were part of the main household and some were tenants. Both groups were included. If the selected plot did not have a house, then the sampling continued with the same sampling interval until a stand with eligible residents was found. The same applied if the plot had a church, shop or any building other than a house. In council hostels, an index room was chosen at random, a sample interval was used and all inhabitants of every n^{th} room to the right of this room were sampled. Once the dwelling units within a cluster had been identified, all people aged 13 to 59 years were invited to participate. Every effort was made to ensure that all members of the selected households took part in the survey (Williams *et al.*, 1999). The selectors introduced the project and themselves, after which they explained the procedure for participation and answered questions that the residents of the dwelling might have. Under-age respondents were required to get consent from their parents or guardian before they could take part.

5.6.3 Recruitment of respondents

Recruitment in the area began each day in the late afternoon, when people finished work and were most likely at home. The selectors covered a specified area of the township according to a pre-arranged sampling plan. They approached the head of the household in the selected households and provided information on the study. The whole family, including those living in backyard shacks, was then invited to participate. Once the family had agreed to participate, the selectors completed a household form, recording the number of people in the house, their first names (family names were not recorded), gender and age. Selectors returned to a selected house three times if there was no-one present at the first visit or if some household members had not presented themselves to be interviewed. If people were not present or still refused to participate after three visits, the house or the person was dropped and the household replaced. Fieldworkers did not replace households – this was done by the monitoring staff, who used the same sampling interval. They merely added more houses to the selected list for each cluster.

Based on the experience gained from the pilot survey, it was considered important to involve both the mine management and the National Union of Mineworkers in the selection of mineworkers. Before the recruitment of mineworkers commenced, all mines in the area were visited and at each one all hostel supervisors were informed about the project, and were asked to give their support. Ten hostels in the Carletonville area were occupied by migrant mineworkers and from these, 900 mineworkers were recruited. In each hostel all the occupants of every n^{th} room to the right of a randomly-selected index room were invited to participate. Sampling was continued in this way until a total of 90 men had been recruited in each hostel.

Recruitment began at one o'clock in the afternoon, when the men from the evening shift were available, and continued throughout the afternoon with the men from the other shifts.

5.6.4 Refusal rates

In Khutsong, 173 people refused to participate and a further 135 apparently lived in the selected houses but could not be found during the first survey in 1998. In the following surveys the refusal and not-at-home rates were very similar to that in the first survey. Neither the sex ratio nor the age distribution of those who refused to participate differed from those who did participate, so that the refusals are unlikely to have caused any bias to the results. It should be pointed out, however, that the refusal rate did vary by housing type, with higher refusal rates among those living in private houses.

5.6.5 Ethical considerations

A consent form was available in English and translated into the respondent's language of choice so that all respondents were informed in their own language that they would be interviewed about issues relating to their health and their sexual behaviour and that they would be asked to provide a sample of blood and urine for HIV and STD testing.

Respondents were told that they would be given their STD test results and provided with treatment if they so wished. All STD tests were therefore done, and the results made available to the study respondents anonymously through a card system. Respondents were treated in local community clinics or mine clinics before the HIV tests were carried out. All individual identifiers were then destroyed and the blood samples tested for HIV. Study respondents were all offered a separate, free HIV test with pre- and post-test counselling, but the uptake was nil.

The first name, age, sex and identifying number of each study participant, as well as the identification number of the house were recorded when people were recruited. All information that could lead to the identification of an individual participant was destroyed after data collection had been completed. The behavioural and biomedical data were connected by an individual identification number only; this ensured that no survey information could be traced back to a particular person. For those who returned for the results of their STD tests, the project kept only the identification number. Respondents had to produce their identification number, based on which their STD test results could be ascertained and treatment be given.

5.7 Data collection

The baseline survey was carried out during four weeks in July and August 1998. Subsequent surveys were carried out at the same time of the year, every year around July, August and September.

During the surveying process the recruiters gave each household member a card which stated the time and place at which to attend an interview and give blood and urine samples. The respondents were accompanied by selectors to a specified street corner from where they were transported to their interview venues at local schools.

5.7.1 The questionnaire

The questionnaire was based on the questionnaire used in the UNAIDS Multi-centre Study which was carried out in two West African cities (Cotonou and Yaounde) and in two East African cities (Kisumu and Ndola) (Buve *et al.*, 2001). Some of the questions in the UNAIDS questionnaire were changed to make them relevant to the situation in Carletonville and other questions were added to cover issues of migration (central to the social structure of Carletonville) and social capital. Once again, the changes to the questionnaire were made by the research team of which the author was a member. It was once again my role, using my experience in populations similar to the target population in this study, to make sure that the terms used and explanations given were appropriate. The questionnaire was first translated into Sotho, Tswana, Zulu and Xhosa, and then translated back into English to check the accuracy of the translation. Due to the low number of Shangaan people and the fact that all of them also spoke another local language, the questionnaires were not translated into

Shangaan again after the pilot survey. Final adjustments to the questionnaire were made during the process of training the interviewers in order to ensure that the questions were translated into the local dialects.

5.7.2 *The interview*

At the interview venues, the interviewers introduced themselves and again explained what was expected of the respondent. The consent form was read out in the language of the respondent, who was asked if he/she would consent to be part of the study. Once the respondent agreed to participate, he/she signed the consent form. The interviewers completed the questionnaire during a one-to-one discussion in the language of the interviewee. Whenever possible, an interviewer of the same sex as the respondent was used to obtain data on socio-economic characteristics, medical and sexual history, knowledge and attitudes about HIV/AIDS. It was made clear to the interviewees that, in order to maintain confidentiality, their names were not being recorded on the questionnaire and they had the right not to answer questions if they so wished. Two teams of ten selectors and eleven interviewers each worked simultaneously and were supervised by two language supervisors and four project supervisors.

5.7.3 Blood and urine collection

The interviewee took the completed questionnaire to an assistant nurse who explained the procedures for collecting blood and urine samples to the participant. The assistant nurse labelled the questionnaire, the household card, two tubes for blood collection, and a urine container. All of these were labelled with a common identification number. A fully qualified nursing sister then drew venous blood, and the subject was asked to deliver approximately ten milliliters of first-stream urine. The blood tubes, urine container, questionnaire and household card were next presented to the assistant nurse who checked that everything had been done. Each participant was given a card with his or her identification number, to be presented when collecting STD results at the nearest clinic or healthcare facility. Once the whole process had been completed, the respondents were given R10,00 (approximately US$1.50) as a token of appreciation and to cover the transport costs for the collection of their STD results. (In the subsequent surveys respondents were given more money, but in the final survey this increase was only up to R20-00, approximately US$3.00). While the interviewee was still present and blood and urine samples were being taken, the completed questionnaire was checked by the supervisors for completeness and for internal consistencies. When the supervisor had completed the checking of the questionnaires and the anomalies had been solved, a taxi service was arranged to transport respondents home again, because data collection often finished after nightfall (Williams *et al.*, 1999).

5.8 Analyses of laboratory tests

Once the blood and urine samples had been collected, they were stored overnight at a temperature of 4°C and transported to Johannesburg the following morning. Staff at the Reference Centre for STDs at the South African Institute for Medical Research were responsible for processing and analysing the samples. Both tubes of blood samples were spun down and the serum was collected in two separate sterile tubes; one was refrigerated for use in syphilis serology and the other was stored at -20°C. All tests were performed once and the results recorded on pre-prepared record sheets (Williams *et al.*, 1999).

5.8.1 HIV

The serum samples were defrosted and a Capillus® HIV-1/HIV-2 Latex Aggregation Test was performed according to the instruction manual (Cambridge Diagnostics, Galway, Ireland Ltd). Only a single test was done because the sensitivity and the specificity of the test are both greater than 99%, and the results of the test were strictly anonymous. All respondents were offered a separate HIV test with full counselling, but none took up the offer (Williams *et al.*, 1999).

5.8.2 Syphilis

Serological tests are the most frequently used method for diagnosing syphilis. Although non-treponemal tests are very sensitive yet not absolutely specific, they are known to yield false positive reactions. However, they are easy to perform, inexpensive, and suitable for large-scale screening. Moreover, they can be used to monitor responses to treatment. In contrast, while treponemal tests are highly specific, people continue to test positive once they have been infected, even if they are subsequently treated and cured (Williams *et al*., 1999). In this analysis the serological RPR tests were used as the indicator of syphilis infection. RPR+ or RPR>= 1:8 were considered to be infected with syphilis.

5.8.3 Gonorrhoea

The LCx® *Neisseria gonorrhoea* assay uses the nucleic acid amplification method (Ligase Chain Reaction) to detect a specific target nucleic acid sequence in the Opa gene of *Neisseria gonorrhoea* in urine specimens from symptomatic and asymptomatic men and women. All tests for the presence of *Neisseria gonorrhoea* DNA were performed according to the instruction manual of the *Neisseria gonorrhoea* assay. The specificity of the assay is greater than 99% in all cases, the sensitivity varies from 85.7% in asymptomatic men to 99.4% in symptomatic men, with the sensitivity for women falling in between (Williams *et al*., 1999).

5.8.4 Chlamydia

All tests for the presence of *Chlamydia trachomatis* plasmid DNA were performed according to the instruction manual of the LCx® *Chlamydia trachomatis* assay. The specificity of the test is in excess of 96% in all cases, while the sensitivity varies from 92% in asymptomatic men to 97% in symptomatic women (Williams *et al*., 1999).

5.8.5 Collection of STD results

Participants in the surveys from Khutsong were told that they could collect their STD results from the clinic closest to their home. No names were recorded. Upon presentation of the blue card with an identification number that could be matched to the test results, each person was either told that he or she was free of STDs or given a referral letter and asked to present at a municipal clinic for free treatment. Mineworkers who participated in the surveys were given their STD results and treatment, if necessary, at mine clinics.

5.9 Data management

All information collected was recorded on standard forms and checked daily. Laboratory results and all data from the behavioural survey were entered twice into a database by different people (Microsoft Access). The two entries were then compared and any differences noted and corrected. The data were next checked extensively for inconsistencies (ages in the correct range, men answering only questions relating to men, etc.). The files were finally imported into the Statistical Package for Social Sciences (SPSS 9.0 for Windows) and prepared for statistical analysis.

5.10 Data Analysis

Frequency distributions and cross tabulations were performed to verify the data and to check the sample. After this, a first logistic regression was performed to check the comparability of the samples. This first regression was done to analyse the difference between the samples of the different surveys. This was important for further regression analysis and data analysis as the research team had to ensure that changes observed were due to real changes and not to changes in the sample.

Logistic regression is a statistical model that belongs to a generalised linear group of models. This group of models includes statistical models such as ordinary regression, ANOVA, ANCOVA and loglinear regression (The Measurement Group, 2006). Logistic regression allows one to predict a dichotomous outcome by using independent variables that may be continuous, categorical, dichotomous, or a mix of any of these types. Generally, the dependent or response variable is dichotomous, such as the presence of a specific outcome (San Francisco State University, 2006) or, in the case of our study, the presence of an STD, HIV or a behavioural outcome. Discriminant analysis is another technique that can be used to predict group membership in dichotomous dependent variables. Discriminant analysis can however be used only if the independent variables are continuous and not categorical. In studies where the independent variables are categorical, such as in this study, or in studies where there is a mix of continuous and categorical variables, logistic regression rather than discriminant analysis should be used (San Francisco State University, 2006).

Logistic regression is a method for determining whether each of a set of independent variables has a unique predictive relationship to a dichotomous dependent variable (The Measurement Group, 2006). For example, in our analysis, the outcome (HIV-infected or not) is a dichotomous dependent variable and was tested for the influence that independent variables like gender, age and number of sexual partners had on this outcome. All other dependent variables that were studied in the logistic analysis were coded into dichotomous variables and treated in the same way.

Logistic regression is by far the most widely used model for binary outcomes (dichotomous variables) in clinical and epidemiological studies (Vittinghoff, 2004). Clinical and epidemiological studies often have binary outcomes: a person is either infected with the disease or not. A disease such as HIV/AIDS often has multiple predictors like age, gender and the number of sexual partners. When some of the predictors are continuous variables, or when you have a larger number of predictors, then this logistic regression method has a number of advantages. All the independent variables might contribute to the outcome risk (whether the respondent is infected or not), but they are also potentially associated with each other (Vittinghoff, 2004). For example, the number of lifetime sexual partners a respondent had will be associated with the age of the respondent. In this study, most of the variables (dependent and independent) entered into the model as predictors of the outcome also influenced one another. When the risk factors for HIV infection are studied and the age of the respondent and number of sexual partners that person had in his/her life are entered as independent variables, these variables clearly will affect one another. To isolate the variable being studied, it is therefore necessary to control for these covariates and they are added to the model in a multi-variate analysis.

Linear trends were used in the regression analysis. They represent a straight line that can be drawn through the data points and that can best describe the pattern of the data, in other words to best represent the different data points being studied (Lutz, 1983). In the current case there could be three data points or more. However, if there are three data points, the linear trend would represent the best straight line that can be drawn to describe the pattern that these three data points form. The linear trend is often described as "the line of the best fit" (Lutz, 1983).

All variables were considered in a linear trend fashion. This means that a straight trend line was calculated for the three data points, namely those from the 1998 baseline survey, the 2000 and the 2001 surveys. The trend line runs in between the 2000 and the 2001 data points, starting from the 1998 data point. It was next calculated whether this trend line was increasing or decreasing. The differences between the 1998 and 2000 surveys and the difference between the 2000 survey and the 2001 survey were thus not considered separately, but instead a trend was established using both the 2000 and 2001 findings. This trend was tested for statistical significance. In order to produce a linear trend across years, the variable of the year of each survey was entered into the model as a co-variate and not as a categorical variable.

If a variable increased from 1998 to 2000 and decreased below the 1998 mark in 2001, then a linear trend is not a good fit for this variation, but in these cases the probability would be low, the p-value high and the result would be inconclusive as there was no clear linear trend. This strategy would therefore not lead to incorrect interpretations, but would rather lead to an inconclusive result which might underestimate an influence. An alternative way to treat variables that have this type variance was to treat year as a categorical variable. However the aim of the study was to look for trends, if a variable clearly did not show a trend the analysis was not pursued any further, for instance by entering the time of the survey as a categorical variable into the model.[1]

The linear trends were used in all the regression analyses. Logistic regression does not require linear relationships between the independent variables or covariates and the dependent variables, but it does assume a linear relationship between the independent variables and the log odds (logit) of the dependent variables. The log odds (logit) is the natural log of the odds ratio. In most studies to interpret a logit is to convert it to an odds ratio. When linearity is not assumed in the logit, and therefore not in the odds ratio, then logistic regression will underestimate the influence of the independent variables on the dependent variables and will lack power of analysis (Garson, 2006).

It was the aim of this study to establish the changes that occurred over time in a number of indictors. The values of the indicators at the beginning of the study in 1998 were compared to the values at the end of the study in 2001. Therefore the trend, or the changes over time was studied. The middle point, 2000 survey, was used to give more power to the data. To be able to use the trends in the data as an analysis medium it was necessary to assume a linear trend, due to the description above that linear trends make the regression analysis more accurate. It is not likely that the result would have been totally different if linearity was not assumed, rather the findings might have been more inconclusive. Therefore it was most appropriate to use a linear trend for the logistic regression in this study.

This linear trend was next tested through the logistic regression to see what the Odds Ratio was – in other words, what the size of the variance from the first to the last data point was. The statistical significance of the odds ratio was tested through the p value and if this value was smaller than 0.05, the trend was considered to be significant and therefore not attributable to chance. The odds ratio is a measure of the size of the effect. This ratio indicates the relative importance of the independent variables in terms of their effect or influence on the dependent variable's odds (Garson, 2006). The Odds Ratio was considered only when the p value showed significance. If this

[1] Personal communication with Dr. Mike Bergh, Statistical advisor and Co-director for SPSS-South Africa, Steenberg Office Park Westlake, Cape Town.

was not done, the research team could not be sure that the observed trends were not due to chance variance in the data. If the p value was larger than 0.05, the null hypothesis could not be rejected and this finding would then represent an inconclusive result. The closer an odds ratio was to 1.0, the more the independent variable's categories (for example "used a condom", "not used a condom") had no effect on the dependent variable (for example HIV+, or HIV-). An odds ratio of 1.0 would thus be the lowest possible outcome and would mean no statistical influence at all, whereas anything greater than 1.0 would indicate an effect of the independent on the dependent variable (Garson, 2006). Before the odds ratio can be considered, the p value will first have to be checked to make sure that the trend is statistically significant. It is quite easy to convert the odds ratio to a percentage: if the odds ratio is 1.65, it would mean that there is a 65% better chance of the outcome and therefore the independent variable has a 65% influence on the dependent variable (Garson, 2006). When we compared our data for the qualifications of the women in the sample with the different samples, it showed a p value of 0.0016 for the qualifications variable (the categories were "secondary schooling completed", "secondary schooling not completed"). Thus, we had to consider the odds ratio. The odds ratio was 1.1432, which means that in the later samples the female respondents were 14% more likely to have completed secondary schooling.

For a logistic regression, variables are entered into the model being tested. Independent and dependent variables are added. To do a uni-variate analysis, only one independent variable that might influence the dependent variable and the dependent variable are entered into the model. In this way the model shows the individual effect of each independent variable on the dependent variable. This is then reported under the odds ratio column in the tables. To do a multi-variate analysis, all the independent variables that have shown a significant effect on the dependent variable and the dependent variable are entered into the model. This then results in the measure of the effect on the dependent variable being studied, taking into account the co-variance of other influencing independent variables. This effect is subsequently reported as the adjusted odds ratio. Some independent variables did not show significant differences for the different samples, but were still used as independent variables in the further logistic regression. The reasons for these inclusions will be discussed where the findings are reported.

The next logistical regression done was a risk factor analysis. In the preceding analysis the aim was to try and establish or prove if the indicator, for instance Syphilis infection had changed over time during the study, taking into consideration the independent variables and also in this case the influence of the other biomedical dependent variables. In the behavioural analysis, the independent variables and the behavioural dependent variables were entered, to track the changes in a behaviour marker, controlling for the independent variables and the co-varying behavioural variables. In the risk factor analysis we remove the time factor and try to establish or prove that the changes seen during the previous analysis could be attributed to factors directly altered by the intervention. In other words, was the movement that is observed in the STI indicator, directly attributable to the movement observed in the sexual behaviour for instance?

The risk factor analysis was planned for women of the Khutsong community, for men of the Khutsong community and for mineworkers – each group separately, and on two dependent variables only. The first variable was the risk of getting infected with HIV/AIDS during the study and the second the risk of having self-reported symptoms of STIs in the last 12 months. Eventually, the risk of being infected with HIV during the study was not analysed for men from Khutsong. The reason for this decision will be explained where the findings are reported. The risk factor analysis was also not done for biomedical indicators of STIs for any of the groups and the reason for this decision will also become clear from the analysis.

All the variables that were included in the behavioural analysis for women were entered into the model for testing for risk factors that contributed to the risk of getting infected with HIV during the study. This was done through the multi-variate analysis and produced an adjusted Odds Ratio (aOR). All the behavioural risk factors were also entered into the model on their own, but were controlled for the background variables. This produced the unadjusted Odds Ratio (OR) value. The same procedure was followed for the data on the mineworkers.

The statistical procedure used in this study can be found in many similar studies (Auvert *et al*., 2001; Buve *et al*., 2001; Williams *et al*., 2003).

6 Sample comparison between different surveys

The analysis of the results was done as follows: First, the demographic variables as independent variables were analysed to make sure that the samples were comparable. This analysis included the description of the variables in graphs and tables. A comparison was drawn between the characteristics of the samples and the selected independent variables in order to check for significant differences between the samples of different years. A logistic regression was next conducted, first in a uni-variate and then in a multi-variate analysis.

Before analysing the behavioural and biomedical changes that were observed in the different surveys, and before making any risk factor analysis, the team first needed to study the samples of the different years to see if there had been any changes in the samples between the different surveys. If any significant changes occurred within these variables, they would have to be controlled for during the further analyses. For instance, if the age profile of the respondent changed from one survey to the next, age would have to be controlled for during further analyses to make sure that the changes observed were not due to the changes in age profiles of the different samples.

For this logistic regression analysis the author decided to use only three data points: the baseline survey of 1998, and the surveys of 2000 and 2001. The pilot survey was not included in this analysis due to the fact that it had used a slightly different sample strategy than the rest of the surveys and would thus not be appropriate to use in a regression analysis. The 1999 survey was also not included because the sample for that year was different. In 1999 respondents who were included from Khutsong were all under the age of 25. So, although the data could be compared to the same age groups for other samples, it was not possible to include the 1999 survey in the regression analysis due to the difference in samples.

The analysis was done separately for Khutsong men, Khutsong women and mineworkers in the surveys, due to the fact that the analysis of sexual behaviour and sexually transmitted diseases is so different for the different genders and also very different for mineworkers.

6.1 Analysis of independent variables for Khutsong women

As has been described in the methods chapter under data analysis (5.10 Data Analysis), all variables were considered in a linear trend fashion. This means that a straight trend line was calculated for the three data points, namely the 1998 baseline, 2000 and 2001 surveys. The trend line was thus always a line that runs in between the 2000 and the 2001 data points, starting from the 1998 data point. Calculations were next made to determine whether this trend line increased or decreased. The differences between the 1998 and 2000 surveys and those between the 2000 survey and the 2001 survey were not considered separately. Instead, a trend was established using both the 2000 and 2001 findings, and this trend was tested for significance.

In the analysis of the Odds Ratio (indicated by the "OR" in the tables), the variables are entered into the regression model on their own and then reported as the unadjusted Odds Ratio. Next the adjusted Odds Ratio (indicated by the "aOR" in the tables) is calculated by entering the variables into the model one by one, but every time controlling for all the other independent variables. This is done to ensure that the variables are studied one by one and that the variance in the variable is not due to the changing of other variables. This strategy eliminates the covariance effect for each variable in the comparison between the samples of the three surveys. For instance, if the age profile of the sample should change, one cannot be sure of this change if you do not control for housing type, since people living in one housing type might not have the same age profile as other housing types.

For this first analysis of the independent variables only women from Khutsong of all ages categories were included. The women from the mines and the commercial sex workers from the hotspots were excluded.

As can be seen from Table 2, there were quite a few independent variables for women that changed significantly between the surveys of 1998, 2000 and 2001. Age changed significantly from 1998 to 2001. In 1998, 44% of the females in the sample were under 30 years of age, while in 2001 45.5% of females were under the age of 30. This was not a huge change (the aOR was 0.9249) and it was barely significant (p=0.0497). The educational qualifications of the females in the sample also changed significantly from 1998 to 2001 (p=0.0016). In 1998, 76.2% of the sampled females had completed secondary school, while only 69.9% of the sample had achieved secondary school qualifications in 2001. The number of females who had made trips outside of the greater Carletonville area differed significantly between the different surveys as well – 58.7%, 56.2% and 71.8% of females in the sample had not made trips outside of the greater Carletonville area in 1998, 2000 and 2001 respectively. This change was indeed very significant (p=0.0000). Marital status also differed very significantly between the three samples. In 1998, 50% were not married, in 2000 53.4% were not married and in 2001 58.9% were not married. The last variable, which was barely significant (p=0.0335), concerned having had an alcoholic drink in the last month. In the 1998 survey only 65.5% had had no alcoholic drink in the last month and this percentage rose to 70.3% in 2001 while it was steady at 65% in 2000. The values for some variables went up from 1998 to 2000 and then down from 2000 to 2001, while others first went down and then up over the three years. In these and all other cases, the linear trend was used for the analysis.

Table 2 Linear trend of independent variables over the three years for women

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Housing type	Formal housing	430	619	520	62.2	69.3	59.2	1.0233 (.5110)	1.0196 (.5973)
	Informal housing	261	274	358	37.7	30.7	40.8		
Age	Over 30	304	418	398	44	46.8	45.4	0.9776 (.5033)	0.9249 **(.0497)**
	30 and under	387	475	479	56	53.2	54.6		
Qualification	Secondary	523	618	577	76.2	75.3	69.9	1.1074 **(.0097)**	1.1432 **(.0016)**
	Primary	163	203	249	23.8	24.7	30.1		
Made trips	No trips	402	502	630	58.7	56.2	71.8	0.8520 **(.0000)**	0.8588 **(.0000)**
	Have made trips	283	391	248	41.3	43.8	28.2		
Marital status	Not married	352	477	517	50.9	53.4	58.9	0.9041 **(.0028)**	0.8287 **(.0000)**
	Married	339	416	361	49.1	46.6	41.1		
Lifetime partners	Low number	297	344	385	43	38.5	43.8	0.9988 (.9719)	1.0430 (.2927)
	3+ lifetime partners	394	549	493	57	61.5	56.2		
Ever had sex	Yes	600	828	778	90.0	92.9	88.6	1.0314 (.5988)	1.0377 (.6627)
	No	67	63	100	10.0	7.1	11.4		
Had alcohol	No alcohol	451	581	617	65.5	65.1	70.3	0.9382 (.0727)	0.9205 **(.0335)**
	Have had alcohol	238	312	261	34.5	34.9	29.7		

n – the sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **P value – the level of significance**
'Formal housing' includes private and council housing; 'informal housing' includes squatter settlements and site-and-service schemes. 'Qualification' specifies only the highest qualification achieved; 'secondary' includes matric and 'primary' includes no education at all. 'Made trips' includes all trips outside of the greater Carletonville area, 'Have made trips' includes only trips that were made in the last 12 months. 'Lifetime partners' refers to the number of lifetime sexual partners individuals have had; a 'low number' implies those who have had fewer than 3 partners. 'Ever had sex' refers to individuals who have had penetrative sex in their lives. 'Have had alcohol' refers to individuals who have had alcoholic drinks in the last month.

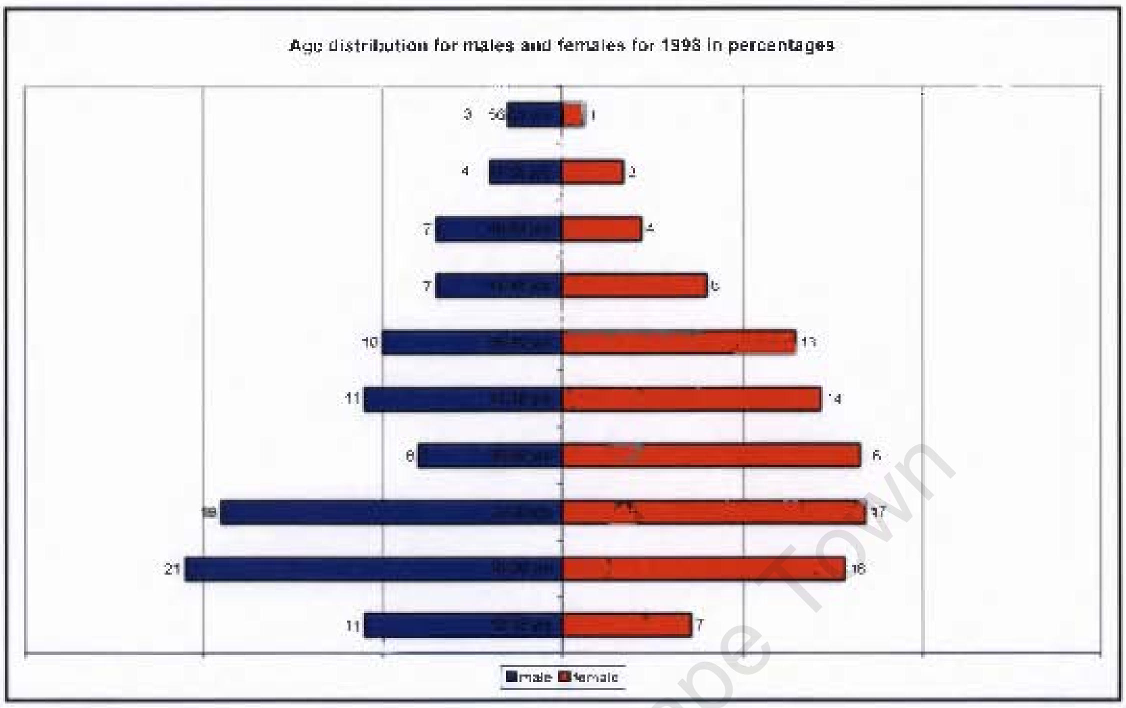
Some variables changed significantly in a uni-variate analysis, as well as in the multi-variate analysis where the research team controlled for the influence of the other independent variables. This multi-variate analysis was used to decide which variables should be controlled for in the subsequent analysis of the risk factors. If a variable differed significantly between the three surveys in the multi-variate analysis, it was controlled for in the further analysis. In the case of females from Khutsong these variables were age; qualifications; whether they had made trips outside of Carletonville; marital status; whether respondents had had an alcoholic drink in the last month. These variables were controlled for during the subsequent analysis due to the fact that the sample had changed significantly from one survey to the next. If not controlled for, the differences in the dependent variables being studied might have been due to these changes in the sample and not to changes in the dependent variable under study.

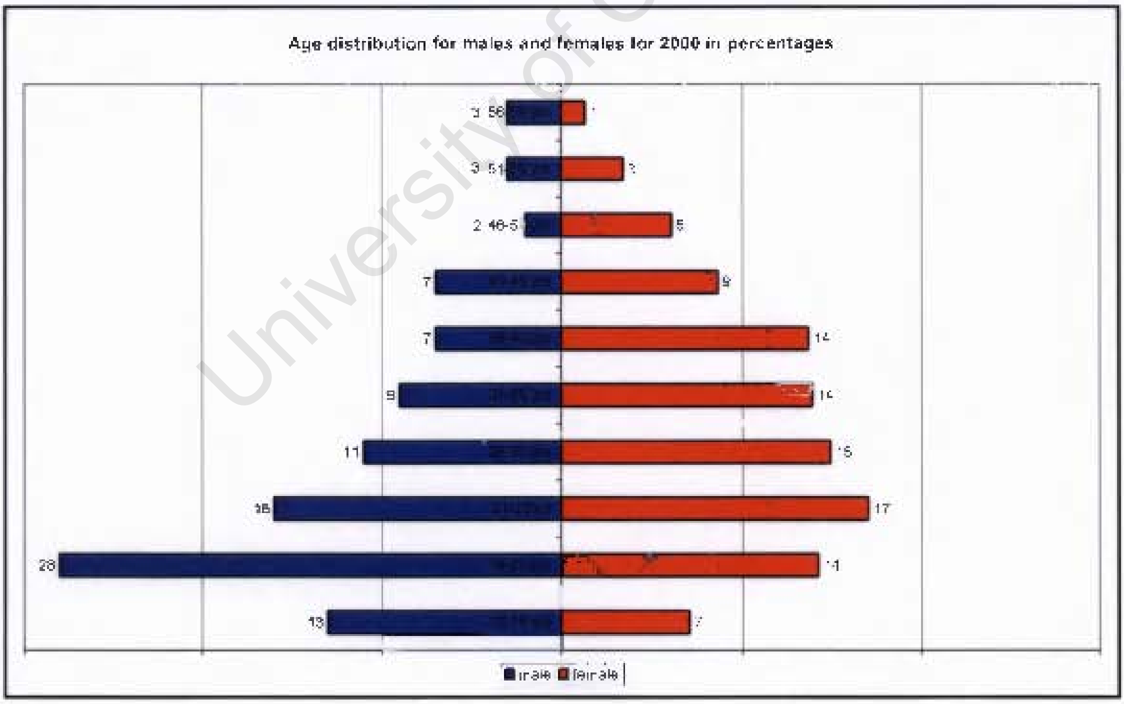
Some variables were included despite not having changed significantly according to Table 2. They were nevertheless included, because of their potential to differentiate between the individuals in the sample. Housing type was one of these variables. As was mentioned before, this was a self-weighting sample and housing type could always be seen as a proxy for socio-economic status.

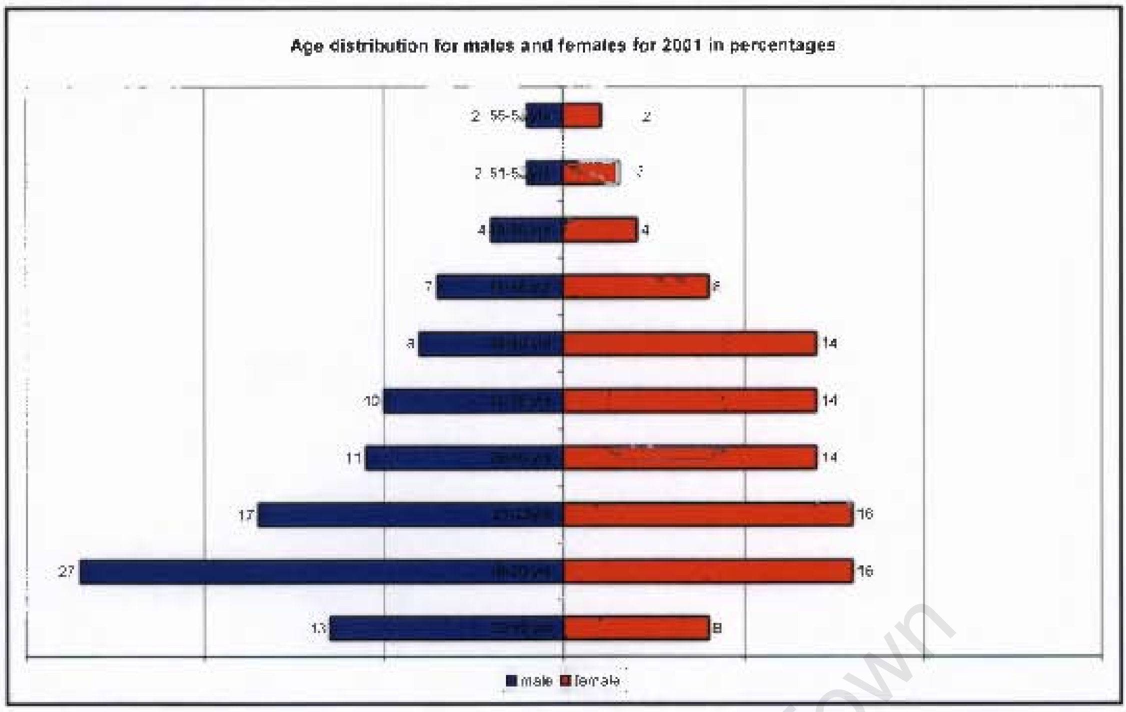
Age proved to be a very interesting variable in women and men. The age distribution for women and men in all the surveys combined is clear from Figure 4. There is a huge difference in the number of men in Khutsong in the age category of 21 to 25 years of age and in the age group 26 to 30 years of age, compared to the age group less than 20 years of age. After the age of 25, women outnumber men by quite a substantial margin until the late 40s age categories. It is possible that the age distributions in the sample could be have been due to a sampling bias, however the consistency within gender groups from one survey to another suggests that sample bias was not the cause of this observation.

It could have been an interesting study to analyse age in much smaller bands, like 16 to 20 year olds and 21 to 25 year olds separately. However, this study was simply not powered to do that and the sample size did not allow these fine distinctions.

Figure 4 Age distribution of the samples







The school qualifications of the female sample for the three years were lower in the later samples than in the earlier samples. In other words, the number of people having completed secondary school qualifications goes down from 76.2% in 1998 to 69.9% in 2001. This trend was significant.

The number of females who indicated that they had travelled out of the greater Carletonville in the last 12 months changed significantly as well. Fewer women went on trips in 2001 than had left the greater Carletonville for at least one overnight stay in 1998.

Marital status of the female sample was also quite interesting. More women were not married in 2001 than were married in the 1998 sample. In 1998, 49.1% of female respondents were married. In 2001 only 41.1% of females in the sample were married. The possibility that these changes might not reflect a change in the population, but rather an error in the sample, will be investigated further elsewhere.

The differences between the surveys with regard to the number of lifetime sexual partners of a respondent and whether someone had ever had sex in his/her life were not statistically significant. Due to the fact that this variable was not measured in the same way for the three surveys, the number of casual sexual partners that respondents had had in the last 12 months was not included in the risk factor analysis to follow. Other than that, all the significant variables were included in the analysis.

In the later surveys, 2000 and 2001, there was no significant change in the number of respondents who had had sex in their lives. In the further risk analysis, the sexually non-active respondents were sometimes excluded if the variables being studied were clearly not applicable to those who had never had sex in their lives.

To summarise: The variables that were considered to be controlled for during the risk factor analysis were the following:

- Housing type
- Age of the individual respondents
- Highest school qualification achieved
- Having made a trip out of Carletonville in the last 12 months or not
- Current marital status
- Had/Did not have an alcoholic drink in the last month

Some of these variables were originally included in the questionnaires because of their previously shown association with sexual behaviour. For instance, the fact that people travel outside of their area means that they come into contact with a lot of other people – this is believed to put them into a different category of risk than those who do not travel.

For the male sample, the same procedure was followed to identify the variables to be included in the further risk factor analysis.

6.2 Analysis of independent variables for Khutsong men

Table 3, which shows the independent variables, uni-variate and multi-variate analysis, indicates the linear trend over the three years (as in the case of the female sample). Although the data point for 1998 might be lower than the data point for 2000 for a specific variable, and although the data point for 2001 might also be lower than the 2000 data point (i.e. the variable increased and then decreased again), the linear trend is reported as the Odds Ratio (OR). The adjusted Odds Ratio (aOR) is the linear trend emerging from the multi-variate analysis, controlling for the other independent variables.

For the current analysis only men of all ages from Khutsong were included. Men from the mines and men living in the hotspots were excluded from this analysis.

As can be seen from Table 3, an extra variable enquiring about the circumcision status of the individual was added (this did not feature in the independent variable analysis for women). This factor did not change significantly over the three surveys. As it was shown to be a very important variable (see studies like the "Dynamics of HIV infection and AIDS in central African cities" by(Auvert *et al.*, 1990; Auvert *et al.*, 2005; Rain-Taljaard *et al.*, 2003), this variable was included in the further analysis of the risk factors.

Table 3 Linear trend of independent variables for men

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Housing	Formal	252	308	275	56.9	50.8	51.7	1.0790 (.0744)	1.0755 (.1170)
	Informal	191	298	257	43.1	49.2	48.3		
Age of the sample	Over 30	182	195	175	41.1	32.2	33.0	1.1358 **(.0039)**	1.0363 (.5665)
	30 and under	261	411	356	58.9	67.8	67.0		
Qualification	Secondary	322	390	330	72.9	69.1	65.1	1.1256 **(.0121)**	1.1364 **(.0165)**
	Primary	120	174	177	27.1	30.9	34.9		
Made trips	No trips	218	304	377	49.8	50.2	70.9	0.7758 **(.0000)**	0.7622 **(.0000)**
	Made trips	220	302	155	50.2	49.8	29.1		
Marital status	Not married	290	464	409	65.5	76.6	76.9	0.8170 **(.0000)**	0.8590 **(.0158)**
	Married	153	142	123	34.5	23.4	23.1		
Lifetime partners	Low number	140	224	230	31.6	37.0	43.2	0.8504 **(.0003)**	0.8500 **(.0137)**
	3+ partners	303	382	302	68.4	63.0	56.8		
Ever had sex	Yes	356	518	399	82.0	85.6	75	1.1324 **(.0270)**	1.1624 (.0995)
	No	78	87	75	18.0	14.4	25		
Alcoholic drink	No alcohol	227	287	280	51.4	47.4	52.6	0.9948 (.9024)	1.1111 **(.0421)**
	Had alcohol	215	319	252	48.6	52.6	47.4		
Are you circumcised	Yes	111	125	118	26.2	20.9	22.4	1.0838 (.1120)	0.9603 (.4777)
	No	312	472	409	73.8	79.1	77.6		

n – the sample size in each category **OR – unadjusted Odds Ratio**

aOR – adjusted Odds Ratio **P value – the level of significance**

'Formal housing' includes private and council housing; 'informal housing' includes squatter settlements and site-and-service schemes. 'Qualification' specifies only the highest qualification achieved, 'secondary' includes matric and 'primary' includes no education at all. 'Made trips' includes all trips outside of the greater Carletonville area; 'Have made trips' includes only trips that were made in the last 12 months. 'Lifetime partners' refers to the number of lifetime sexual partners individuals have had; a 'low number' included only those who had fewer than 3 partners. 'Ever had sex' refers to individuals who have had penetrative sex in their lives. 'Have had alcohol' refers to individuals who have had alcoholic drinks in the last month.

It is clear from Table 3 that housing type and age of the respondents did not change significantly for the three years. Housing type, however (as in the case of the female analysis), was included in the risk factor analysis due to its importance for the sampling strategy.

What also emerged, as in the female sample, was the decline in the highest educational level achieved by men, and this trend is also significant.

The same observation that was made in the female sample about the number of females who had travelled out of the greater Carletonville area in the last 12 months occurred in the male sample. In the case of the males the trend was also significant. Table 3 shows that in 1998, 49.8% of men had not made a trip out of Carletonville, and this percentage rises to 70.9% in 2001. Certainly for the members of this area there was not a lot of travelling around.

The marital status of men also changed significantly. Fewer men were married in the 2001 sample than were married in 1998. In 1998, 34.5% of men in the sample were married as opposed to only 23.1% in 2001.

Since the number of lifetime sexual partners was not measured in the same way for the three surveys, this variable was not included in the risk factor analysis to follow. Besides that, all the significant variables were included.

The variables that changed significantly for the three years in the case of men were the following:

- Educational level
- Having made a trip out of the greater Carletonville in the last 12 months or not
- Current marital status
- Number of lifetime sexual partners
- Had/Did not have an alcoholic drink in the last month

If we controlled for the rest of the independent variables, the fact that someone had had an alcoholic drink in the last month became significant, while in the uni-variate analysis where we did not control for the rest of the independent variables, the changes were not significant. The opposite can be seen with regard to the age of the sample. If examined on its own, is the changes are clearly significant for the three years, but when controlling for the rest of the independent variables, the changes for the three years are not significant anymore.

The following independent variables or demographic variables of the sample were controlled for in the subsequent analysis of the risk factors for HIV and STIs:

- Qualifications
- Whether or not someone made a trip out of the greater Carletonville area
- Marital status
- Whether or not someone had an alcoholic drink in the last month
- Circumcision status
- Type of housing occupied by the respondent

The last two variables did not differ significantly between the surveys, but were included due to the relative importance of the issue of circumcision and the importance of the role of the housing type in the sample.

6.3 Analysis of independent variables for mineworkers

The same process that was followed for the analysis of the independent variables for women and men from Khutsong was also followed for the mineworkers. First, all of the independent variables were tested for significant changes on their own in a uni-variate analysis and then they were all entered together in a multi-variate analysis to establish the adjusted Odds Ratio for changes in each of the independent variables.

The research team decided to include the samples for 1997 and 1999 in the analysis of the independent variables for the mineworkers, as their samples were the same for all the different years that the surveys were done. The samples were therefore directly comparable to each other. All five surveys were included in all the logistical regression analyses made for mineworkers. In this instance the linear trend was calculated using all five data points available and afterwards the trends were again tested for significance. Trends with five data points should obviously be more accurate than trends with three data points only. Since five data points instead of three were available for the mineworkers' data, the team decided to do the analysis differently than that for the residents of Khutsong – they included all five data points. This should be remembered when comparisons are made between the residents of Khutsong and the mineworker data, despite the fact that this particular comparison was not one of the aims of the project.

Men from Khutsong and men living in the hotspot squatter areas were of course excluded from the data to be analysed in respect of the mineworkers,.

The results of the analysis of the independent variables can be seen in Table 4 below. In the table it is clear that the age of the mineworker sample changed. Mineworkers from the later surveys were significantly older than in the earlier samples. The fact that the under-30 category decreased from 33.5% in 1997 to 21.7% in 2001 should be kept in mind when the data are analysed. It is also necessary to control for age in all of the further analyses to make the samples comparable, as they differ significantly in age.

The educational qualifications of the respondents in the samples stayed basically the same. There was no significant difference in the samples as far as educational level was concerned. For the further analyses educational level was not controlled for, as this variable did not impact on the comparability of the sample.

Data about whether or not the respondents made trips outside of the greater Carletonville area changed significantly between the samples. A significantly larger number of men reported that they had made trips out of Carletonville in the last 12 months. This was not affected by the annual leave that all mineworkers are forced to take, as the time period that was enquired about always covered the December break, regardless of when the survey was done.

The marital status of the mineworkers had changed over the five surveys, and more of those in the sample were married in 2001 than had been in 1997. This should be seen together with the fact that the mineworkers in later samples were also significantly older, as already emerged from this discussion.

The number of lifetime sexual partners decreased for mineworkers. In 2001 mineworkers had significantly fewer lifetime sexual partners than they had in 1997. This is always a difficult finding to explain, but in this case it should probably be seen together with the fact the mineworkers were older, and therefore more likely to be married.

The number of mineworkers who had not had penetrative sex was so small that this variable was not considered in any further analysis.

The number of mineworkers who indicated that they had an alcoholic drink in the last month declined as well. In 1997, 48% indicated that they had used alcohol in the last month; in 2001 only 44.5% indicated that they had used alcohol in the last month. This linear trend was significant.

Table 4 Linear regression of independent variables for mineworkers

		1997	1998	1999	2000	2001	1997	1998	1999	2000	2001		
		n	n	n	n	n	%	%	%	%	%	OR (P)	aOR (P)
Age	30 =<	84	292	218	184	215	33.5	32.5	26	23.9	21.7	1.1864 (.0000)	1.1025 (.0125)
	30 +	167	607	619	585	778	66.5	67.5	74	76.1	78.3		
Qualification	Primary	176	692	549	501	176	80	77.3	65.7	75.7	77.9	0.9838 (.5960)	0.9728 (.4474)
	Secondary	44	203	287	161	190	20	22.7	34.3	24.3	22.1		
Made trips	No trips	77	307	219	122	427	30.6	34.8	26.2	15.9	43	0.9285 (.0075)	0.9226 (.0168)
	Made trips	175	586	618	646	567	69.4	65.2	73.8	84.1	69.2		
Marital	Not	64	300	172	163	207	25.4	33.4	20.5	21.2	20.8	1.1708 (.0000)	1.1305 (.0021)
	Married	188	599	665	606	787	74.6	66.6	79.5	78.8	79.2		
n Lifetime	Low		63	101.0	76	128		7.0	12.1	9.9	12.9	0.8441 (.0005)	0.8662 (.0048)
	3+		836	736.0	693	866		93.0	87.9	90.1	87.1		
Ever sex	Yes	250	883	833.0	765	990	99.2	99.9	99.8	99.6	99.6	1.0858 (.7181)	1.2827 (.4678)
	No	2	1	2	3	4	0.8	0.1	0.2	0.4	0.4		
Alcoholic	No alcohol	131	422	439.0	429	552	52	47.2	52.6	55.8	55.5	0.9165 (.0007)	0.8938 (.0003)
	Had alcohol	121	473	396.0	340	442	48	52.8	47.4	44.2	44.5		
Circumcised	Yes	97	449	463.0	407	541	40.9	50.1	56.1	53.1	54.5	0.9249 **(.0024)**	0.9438 (.0638)
	No	140	447	362.0	360	452	59.1	49.9	43.9	46.9	45.5		

n – sample size in each category
% – percentage of the sample for that category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
(P) – p value and level of significance
'Made trips' means having travelled out of the greater Carletonville area in the last 12 months. 'n Lifetime' refers to the number of sexual partners the mineworker has had in his lifetime, and 'Low' implies 3 and less. 'Ever sex' refers to a participant admitting that he has had sex before. 'Alcohol' refers to having consumed an alcoholic drink in the last month. 'Circumcised' refers to having been circumcised.

The last of the independent variables studied for the mineworkers was circumcision status. Although there was not a significant linear trend and the number of mineworkers who were circumcised did not vary significantly over the time period, this variable was nevertheless included in the further analysis. At the time of analysis there was great interest in this factor as other studies in the field had shown that circumcision could probably have a protective effect (Auvert *et al.*, 2005).

In respect of the mineworkers it would thus seem that the age of the sample, marital status, whether or not they had made trips out of Carletonville, the number of lifetime sexual partners and the use of alcohol changed significantly. All of these significant factors were controlled for in the further logistic regression analysis. Some of the factors that were not significant were included as well, either because they have been shown to be significant in one of the other two samples (i.e. men or women in Khutsong), or because they were considered to have had an important influence on the sample.

6.4 Summary of the independent variable analysis

In summary, the analysis of the independent variables was made separately for mineworkers, men and women in Khutsong. Independent variables were considered to be any variable that could explain differences in the findings when the outcome variables, such as infection rates, were studied. Most of these variables were of a demographic nature. For women the 1998, 2000 and 2001 surveys were taken into consideration and it was found that the samples differed significantly on age, qualifications, whether they had made a trip out of the greater Carletonville area in the last year, marital status and whether they had had an alcoholic drink in the last month. All of these variables, plus housing type (due to the importance of this variable in the sample) were therefore included in the risk factor analysis for the Khutsong women.

For the Khutsong men, the independent variables that differed significantly between the surveys were the following: qualifications; whether they had taken trip outside of the greater Carletonville area in the last year; marital status; the number of sexual partners in their lives, and whether they had had an alcoholic drink in the last year. Of these, the number of sexual partners was not included in the risk factor analysis due to the fact that this variable was not measured in the same way in all the surveys. Instead, circumcision status was included in the risk factor analysis due to the relative importance of this factor.

For mineworkers, the analysis could be done on the basis of five data points instead of the three that were available for the respondents in Khutsong. From this linear trend analysis it was clear that for mineworkers the following variables differed significantly over the various years: age; whether they had travelled out of the greater Carletonville area; marital status; number of sexual partners in their life time, and whether they had had an alcoholic drink in the last month. These variables as well as the circumcision status of the respondents were included, while the number of sexual partners a respondent had in his life was excluded from the risk factor analysis. The decision to include circumcision status was once again based on its relative importance in the literature of the time.

Thus is concluded the discussion on the characteristics of the sample. The above independent variables will not only be used for control during the further analysis, they should also be kept in mind when the findings are interpreted in the sections to come.

7 Analysis of the behavioural factor changes

This chapter deals with the findings around the first part of the research question. The question posed for this study was to assess the impact of the intervention on behavioural change and rates of infection. In the discussion above the model for the study of such impact was described in detail. In short, a four-pronged intervention was launched:

- The first intervention made use of peer education to try and change the high-risk sexual behaviour of the targeted populations, namely the residents of Khutsong, mineworkers and commercial sex workers.
- The second intervention focused on the widest possible distribution of condoms as well as a constant flow by making sure that all condom distribution points were always stocked and new points were introduced.
- The third intervention involved the intensified management of STD treatment, which included training of healthcare staff and the syndromic treatment of all STDs.
- The fourth intervention was the Periodic Preventative Treatment (PPT) of all individuals in high-risk groups. In this instance all the commercial sex workers in the hotspots were treated with STD treatment drugs on a monthly basis.

In the analysis that follows below, the effect of the peer education intervention and consequently the changes in behaviour were measured by the following variables: The number of casual sexual partners a respondent has had; a respondent's risk perception (namely if he/she thought he/she was at risk of being infected with HIV); whether sexual behaviour has been changed to avoid infection with HIV; perceptions of stigma around infection with HIV/AIDS; willingness to tell anybody if he/she got infected with HIV; and lastly, being acquainted with anybody who was infected with HIV/AIDS. (The latter variable showed up in the literature to be of value as a deterrent against high-risk sexual practices.) The second intervention, the distribution of condoms, was assessed by asking if respondents had ever used a condom and if they had used a condom with their casual sexual partners in the last 12 months.

The third intervention involving the treatment of STDs was measured by the number of infections of HIV, chlamydia, gonorrhoea and syphilis in the targeted populations (which were again the men and women in Khutsong, and the mineworkers). Since the impacts of the intervention on the commercial sex workers in the hotspots are well documented elsewhere, they are not reported here.

The fourth intervention – PPT – occurred indirectly through measurement of the prevalence of STDs among the mineworkers at workplaces geographically close to where the intervention took place. (It was actually not the aim of this study to assess this last intervention.)

In the first analysis to follow here, the author made use of logistic regression to analyse the changes in the behavioural variables.

In this analysis the dependent variables were entered into the model one by one and the following were included for the behavioural analysis:

- Number of casual sexual partners in the last 12 months
- Respondents' perception of risk
- Changes to sexual behaviour to avoid HIV infection
- Perceptions around the stigma associated with HIV infection
- Acquaintance with somebody who was infected with HIV/AIDS

Condom use as a behavioural change was also included in this analysis. Here the dependent variables entered into the model involved whether the respondent had ever used a condom during sexual intercourse and whether he/she had used a condom with a casual sexual partner in the last 12 months.

The significance of trends between the surveys and the Odds Ratios are reported. Initially the dependent behavioural variables were entered into the logistic regression one by one. They were subsequently entered into the model again, but this time the research team controlled for all the independent variables that have shown significant changes over the period covered by the three surveys. The independent variables were housing type, age of the individual respondents, highest school qualification achieved, whether or not they had travelled out of Carletonville in the last 12 months, current marital status and whether or not they had had an alcoholic drink in the last month. Some variables that were included as controlling variables were not significant in the independent variable logistic regression, but the reason for these inclusions has been discussed above.

The results of the current analysis of behavioural variables in Khutsong women can be seen in Table 5 - 11.

7.1 Analysis of changes in behavioural variables for Khutsong women

From Table 5 it is clear that the number of respondents who had had casual sexual partners decreased from 47.3% in 2000 to 41.1% in 2001. Unfortunately no data were available for the 1998 survey for this variable. This change is significant on the 5% level of significance in both the uni-variate (unadjusted Odds Ratio: OR) and the multi-variate (adjusted Odds Ratio: aOR) analyses for this variable. This is odd in view of the fact that fewer women were married in 2001 than in 2000. The figures could hint at a change in behaviour, with women having fewer casual sexual partners – however, it should be kept in mind that this finding was based on just two data points.

Table 6 shows that the use of condoms with casual partners had increased from 6.2% in 1998 to 18.9% in 2000 and declined to 16.9% in 2001. The linear trend, however, increased significantly, which means females in the sample were significantly more likely to use condoms with casual sexual partners in the later survey. Although this result suggests that the intervention had the effect of increasing condom use among women in Khutsong, the use of condoms with casual sexual partners was still below 20%.

A growing number of theories state that behavioural change is related to personal experience (AIDS Policy Law, 1996; Ijumba *et al.*, 2004; Macintyre *et al.*, 2001).

The figures in Table 7 also indicate that significantly more people knew someone who was infected with HIV, and the relevant percentages increased from 8.6% in 1998 to 17.6% in 2001. In an area where the prevalence levels are such as they are, this result could have been predicted and was statistically significant.

From Table 8 it is clear that the number of people who thought they had a good chance of getting infected with HIV increased from 1998 to 2000 and decreased from 2000 to 2001, as is the case with many variables that have been studied so far. The percentage rose from 28.2% in 1998 to well over one third of the female sample (38.2%) in 2001, having peaked at 45.3% in 2000. The linear trend in this case is also very significant if controlled for independent variables, but it is not significant on its own. Thus, if the dependent variable was studied on its own, no statistically significant difference is evident, but when the influence of the covariates was considered, the number of respondents who considered themselves to be at high risk increased statistically significantly. In any prevention programme or intervention, one of the most difficult and most important aspects is the perception of personal risk. This variable clearly measures the personal risk experience of females in the sample. Although in reality a higher number of females in their 20s would be exposed to risk than the ones who indicated that they might be at risk here, the trend was increasing and a growing number of respondents perceived themselves to be at risk.

Table 9 shows that the respondents did not significantly report that they had changed their behaviour to avoid getting infected with HIV. This is surprising in the light of the fact they were significantly more likely to use condoms with their casual partners. They were also significantly less likely to have casual partners, so one would expect that they had in fact made these changes to avoid getting infected with HIV. For the multi-variate analysis, where all the controlling variables were taken into account, this factor was almost significant with a p value of 0.0749. Just over a third of respondents indicated that they had changed their behaviour in order to avoid getting infected with HIV.

Table 5 Linear trend of behavioural variables for women: Number of casual sexual partners in the last 12 months

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Number of casual sexual partners	No casual partners	*	426	517	*	52.7	58.9	0.7787 **(.0110)**	0.6891 **(.0046)**
	Had casual partners	*	382	361	*	47.3	41.1		

n – sample size in each category
aOR – adjusted Odds Ratio
*** No data available for this year**
OR – unadjusted Odds Ratio
P value – level of significance
'Number of casual sexual partners' refers to the number of casual sexual partners with whom the individual had sex in the last 12 months. 'Had casual partners' includes having had only one or many casual sexual partners. 'Casual partners' were defined as any partners with whom the respondent might have had sex and whom they were not married to or committed to in a relationship.

Table 6 Linear trend of behavioural variables for women: Used condoms with casual sexual partners in the last 12 months

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Used condoms with casual sexual partners	Never used	648	724	730	93.7	81.1	83.1		
	Used condoms	43	169	148	6.2	18.9	16.9	1.4115 **(.0000)**	1.4853 **(.0000)**

n – sample size in each category
aOR – adjusted Odds Ratio
OR – unadjusted Odds Ratio
p value – level of significance
'Used condoms with casual sexual partner' refers to individuals who have used condoms with their casual sexual partners in the last 12 months and includes those who always and sometimes used condoms with these partners.

Table 7 Linear trend of behavioural variables for women: Know someone who is infected with HIV

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Know someone infected with HIV	Do not know someone	609	679	693	91.4	80.2	82.4	1.3065 **(.0000)**	1.3486 **(.0000)**
	Know someone	57	168	148	8.6	19.8	17.6		

n – sample size in each category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
p value – level of significance
'Know someone infected with HIV' refers to being acquainted with someone who might be infected with HIV. 'Do not know someone' refers to not knowing anybody who might be infected with HIV, while 'Know someone' refers to individuals who knew someone who was infected with HIV.

Table 8 Linear trend of behavioural variables for women: Chances of being infected with HIV

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Chances of being infected	Small chance	298	240	301	71.8	54.7	61.8	1.1851 (.0798)	1.1927 **(.0003)**
	Good chance	117	199	186	28.2	45.3	38.2		

n – sample size in each category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
p value – level of significance
Sample sizes in this table are lower due to 'Don't know' and 'Refused' responses
'Chances of being infected' refers to the individual's own assessment of his/her risk to get infected with HIV, 'Small chance' includes 'No chance' and 'Moderate chance', while 'Good chance' includes 'Good chance only'. There were many 'Don't know' and 'Refused' responses on this variable.

Table 9 Linear trend of behavioural variables for women: Changed behaviour to avoid HIV

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Changed behaviour to avoid HIV	Yes	231	339	309	33.5	38.0	35.2	0.9679 (.3550)	0.9358 **(.0749)**
	No	459	553	569	66.5	62.0	64.8		

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Changed behaviour to avoid HIV' refers to individuals who indicated that they had changed their behaviour in order to avoid getting infected with HIV. 'Yes' means that they had adjusted their behaviour and 'No' means that individuals have not made any personal changes to avoid getting infected with HIV.

Table 10 Linear trend of behavioural variables for women: Willingness to reveal HIV status

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Tell somebody if infected with HIV	Tell somebody	464	748	694	67.1	83.8	79.0	0.7830 **(.0000)**	0.7770 **(.0000)**
	Keep it secret	227	145	184	32.9	16.2	20.8		

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Tell somebody if infected' refers to women being prepared to reveal their HIV infection. 'Tell someone' includes those females who would tell somebody, and 'Keep it secret' includes those who indicated that they would keep their HIV status a secret.

Table 10 shows a significantly increasing trend in the likelihood of someone telling somebody else about his/her own infection with HIV. In 1998, 67.1% of respondents said they would tell somebody; in 2000, 83.8% and in 2001, 79.0% of respondents would tell somebody. One of the major challenges of the HIV pandemic is to rid the infection and disease of the stigma associated with it. If one considered the fact that respondents were significantly more likely to tell somebody else if they were infected, it would seem to indicate that the stigma was slowly disappearing. This finding should also be seen in the light of the fact that in 2001 there was still no treatment available for people who were infected with HIV and the trend here would thus not be linked to the hope of access to treatment. It would rather seem to be linked to the need for support from family or friends.

From Table 11 it is clear that there was a significant increase in the number of female respondents, who had had sex with a partner using a male condom, in their lives. The percentages rose from 29.7% indicating that they had used male condoms in their lives before in 1998 to 40.7% indicating that they had used male condoms in their lives before in 2001. This finding ties in with a previous finding that significantly more female respondents indicated that they had used condoms with their casual partners. The increase in the number of respondents who indicated that they had used a condom before was quite dramatic (the aOR was 0.8485) and very significant with a p value of less than 0.000. As explained in Section 5.10 "Data Analysis", the Odds Ratio is not directly equal to the Relative Risk but this finding would mean that women were roughly 16% more likely to have used a condom in their lives up to that point.

Table 11 Linear trend of behavioural variables for women: Condom use

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Have used a condom	Yes	201	352	357	29.7	39.4	40.7	0.8485 **(.0000)**	0.8040 **(.0000)**
	No	475	541	521	70.3	60.6	59.3		

n – sample size in each category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
p value – level of significance
'Have used a condom' refers to the women who admitted to having used a male condom in their lives before.

In conclusion, the behavioural variables included in this analysis for women show that

- female respondents had significantly fewer casual sexual partners;
- significantly more women knew someone infected with HIV;
- significantly more women experienced themselves to be at risk;
- significantly more females would tell somebody if they were infected with HIV;
- significantly more females used condoms with casual sexual partners, and
- significantly more females had used a male condom at least once in their lives.

We also saw that, across the three surveys, roughly one third of respondents indicated that they had changed their behaviour to avoid becoming infected with HIV/AIDS.

7.2 Analysis of changes in behavioural variables for Khutsong men

Logistic regression was also used to analyse the changes in the behavioural variable for the Khutsong male sample. This sub-sample included only men from all age groups who were resident in Khutsong. Men from the mines and men from the hotspots were excluded.

In this analysis the dependent variables were first entered into the model on their own (as was done in the analysis of the female sample). The dependent variables used in this analysis were the following:

- Number of casual sexual partners
- Respondent's perception of the risk of getting infected with HIV
- Change in sexual behaviour
- Perceptions of stigma
- Knowing anybody who was infected with HIV/AIDS

Behavioural change with regard to condom use was also included in this analysis and here the dependent variables that were entered into the model involved whether the respondent had ever used a condom in his life and whether he had used a condom with his casual sexual partners in the last 12 months. The significance of the changes was subsequently reported in the unadjusted Odds Ratio. The dependent behavioural variables were then entered into the logistic regression again, but controlling for all the independent variables that have shown significant changes over the time period of the three surveys. These were qualifications, whether or not the respondent had travelled out of the greater Carletonville area, marital status, whether he had had an alcoholic drink in the last month, circumcision status and housing type of the respondent. The last two variables that were included as controlling variables were not significant in the independent variable logistic regression, but the reason for these inclusions has been discussed above. The results of this analysis can be seen in Table 12 to Table 18.

It is clear from Table 12 that the number of men reporting to have had casual sexual partners in the last 12 months decreased dramatically from 62.9% in 2000 to 44.7% in 2001. This change was significant and could not be attributed to the differences in the sample. The null hypothesis, namely that there would be no change in the number of casual sexual partners Khutsong men had over the duration of the study, can be rejected with confidence. As for the analysis of the female sample, there were no data for this variable in the 1998 sample. However, this trend is very similar for men and women and significant in both groups – a substantial and significant reduction for women was also observed.

The next table, Table 13, shows an increase in the use of condoms with casual sexual partners in the last 12 months. This was again a very significant linear trend. In 1998 only 11.3% of men reported using condoms with their casual sexual partners, and this percentage rose dramatically to 25.7% in the year 2000. In 2001 some of these gains were given back, but the linear trend still showed a significant increase. For women we saw a similar significant trend, but the percentage of women who used condoms with casual partners was still lower than the number of men who reported using condoms with casual partners. In 1998 only 6.2% of women reported using condoms with casual partners as opposed to the 11.3% of men in the same year. The figure for women increased to 16.9% in 2001, while that for men increased to 23.3% in the same year.

Table 12 Linear trend of behavioural variables for men: Casual sexual partners in the last 12 months

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Had casual sexual partners	None	*	183	294	*	37.1	55.3	.4779 **(.0000)**	.4565 **(0.000)**
	Had partners	*	310	238	*	62.9	44.7		

*** No data available for this year**
n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Had casual sexual partners' refers to men who indicated that they had had casual partners in the last 12 months. 'None' includes men who indicated that they had no casual sexual partners in the last 12 months, while 'Had partners' indicates that men in the sample reported to have had one or more casual sexual partners in the last 12 months.

Table 13 Linear trend of behavioural variables for men: Condom use with casual sexual partners

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Used condoms with casual sexual partners	Never used	393	450	408	88.7	74.3	76.7		
	Used	50	156	124	11.3	25.7	23.3	1.3329 **(.0000)**	1.3673 **(.0000)**

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Used condoms with casual sexual partners' refers to men having used condoms with their casual sexual partners of the last 12 months. 'Never used' includes men who never used a condom with their casual sexual partners, while 'Used' includes men who always or sometimes used condoms with their casual sexual partners in the last 12 months.

According to Table 14, the percentage of men who knew someone who was infected with HIV grew dramatically from 8.4%, to 16.4% and 19% in 1998, 2000 and 2001 respectively. Although this is sad testimony of a rapidly spreading disease, it will hopefully eventually assist in a greater awareness of risk for people who gain firsthand experience of friends and family getting infected. This linear trend was also significant, the same as in the female sample. There was hardly any difference between the levels and increase of this variable in the male and the female samples.

For the next table, men were questioned on their perception of risk, or what they felt their chances were of getting infected with HIV. Table 15 shows that this risk perception for men grew from 37.4% in 1998 to 54.8% in 2000; some of these gains were lost again in 2001 as the percentage decreased again to a level of 45.7%. Unlike for women though, where the linear trend for this variable was significant, the linear trend for men on this variable was not significant but close to the significance level (p=0.0777). It would seem that men were slowly gaining a greater risk awareness, but not significantly so and in quite stark contrast to women whose risk perception had increased significantly. However, the overall percentage of men who indicated that they were at risk was higher for men in all three surveys than for women.

Table 16 displays the same odd finding that was seen in the female sample with regard to the variable that investigates whether respondents had changed their sexual behaviour in order to avoid getting infected with HIV. There was also no significant increase in the men's reporting on changes in their sexual behaviour, despite the changes that they reported for condom use, number of sexual partners and risk perception. Although the number of men who reported a change in their sexual behaviour increased from 54.9% to 59.6% in 1998 and 2001 respectively, this trend was not significant on the 5% level of significance. It would seem that the changes that men and women had made with regard to risky behaviour were not necessarily seen as changes they had made to avoid HIV infection.

Table 14 Linear trend of behavioural variables for men: Know somebody who is infected with HIV

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Know someone infected with HIV	Do'nt know anyone infected with HIV	394	478	413	91.6	83.6	81.0	1.3656 **(.0000)**	1.4701 **(.0000)**
	Know somebody infected with HIV	36	94	97	8.4	16.4	19.0		

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Know someone infected with HIV' refers to male respondents who indicated that they knew somebody who was infected with HIV. 'Don't know' includes all those males in the sample who indicated that they did not know anyone infected with HIV; 'Know sombody' refers to those men who indicated that they knew someone infected with HIV.

Table 15 Linear trend of behavioural variables for men: Risk of getting infected with HIV

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Chances of being infected with HIV	Small chance	139	113	151	62.6	45.2	54.3	1.1453 **(.0243)**	1.1235 (.0777)
	Good chance	83	137	127	37.4	54.8	45.7		

Sample sizes in this table are lower due to "Don't know" and "Refused" responses
n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Chances of being infected with HIV' refers to the risk men perceived for themselves, what they thought their chances were of getting infected with HIV. 'Small chance' implies that they felt they had no, or moderate risk of getting infected, while 'Good chance' refers to men who felt that they ran a high risk of getting infected with HIV.

Table 16 Linear trend of behavioural variables for men: Reported changes in behaviour to avoid getting infected with HIV

		1998 n	2000 n	2001 n	1998 % of total	2000 % of total	2001 % of total	OR (P value)	aOR (P value)
Changed behaviour to avoid infection with HIV	Yes	200	306	220	45.1	50.7	41.4	1.0317 (.4635)	1.0338 (.4827)
	No	243	298	312	54.9	49.3	58.6		

n – sample size in each category
aOR – adjusted Odds Ratio
OR – unadjusted Odds Ratio
p value – level of significance
'Changed behaviour to avoid infection with HIV' refers to men indicating that they have changed their sexual behaviour to avoid getting infected with HIV. 'Yes' includes those men who indicated that they had made changes and 'No' includes men who reported having made no changes in an attempt to avoid getting infected with HIV.

Table 17 Linear trend of behavioural variables for men: Willingness to reveal HIV status

		1998 n	2000 n	2001 n	1998 % of total	2000 % of total	2001 % of total	OR (P value)	aOR (P value)
Tell somebody if infected with HIV	Tell somebody	305	504	425	68.8	83.2	79.9	0.7926 **(.0000)**	0.7860 **(.0000)**
	Keep it secret	138	102	107	31.2	16.8	20.1		

n – sample size in each category
aOR – adjusted Odds Ratio
OR – unadjusted Odds Ratio
p value – level of significance
'Tell somebody if infected with HIV' refers to men who indicated that they would tell somebody if they got infected with HIV. 'Tell somebody' includes those men who indicated that they would tell somebody and 'Keep it secret' includes men who reported that they would keep their status a secret.

Table 18 Linear trend of behavioural variables for men: Condom use

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
Have used a condom	Yes	169	285	221	39.4	47.0	41.5	0.9570 (.3110)	0.9692 (.5341)
	No	260	321	311	60.6	53.0	58.5		

n – sample size in each category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
p value – level of significance
'Have used a condom' refers to whether men have ever used a condom in their lives. 'Yes' means that men have used condoms before, while 'No' means that the male respondents have never used a male condom in their lives.

The next table, Table 17, reveals that there was a significant increase in the number of men who indicated that they would tell somebody if they were infected with HIV. In 1998, 68.8% of men indicated that they would reveal their HIV status, while in 2001 79.9% of men indicated that they would tell somebody if they were infected. The percentages for men and women are very similar for this variable. For women the 1998 percentage was 67.1% and for 2001 it was 79%. For both male and females this was a significant increase.

The last table in this section, Table 18, shows an increase in the number of men who have used a male condom in their lives, but this is not a significant change. For the female sample the same change in trend was observed, but unlike for men, the change in the female sample was very significant.

When we consider the linear trend, these uni-variate and multi-variate analyses show that most of the behavioural variables included in the analyses changed significantly. Variables that changed significantly were the number of casual sexual partners, use of condoms with casual sexual partners, whether the participant knew somebody who was infected with HIV and whether men would reveal to somebody if they were infected with HIV.

The main differences between the male and the female samples involved a significant increase in the number of females who indicated that their chances for getting infected with HIV were good; in other words, although females used to have a lower risk perception than men, this changed significantly for females only. Significantly more females in the later surveys also indicated that they had used a male condom in their lives.

The variable that questioned respondents on whether they had made changes to their behaviour to avoid HIV showed no significant changes for males and females.

7.3 Analysis of the behavioural variables for mineworkers

Logistic regression was used to analyse the changes in the behavioural variables for the mineworker sample as well. More data points were available for this analysis. The data for the 1997, 1998, 1999, 2000 and 2001 surveys could all be used because the samples had not changed between the different surveys for mineworkers.

First, the dependent variables were again entered into the model on their own as was done in the analysis of the two samples from the Khutsong residents. The dependent variables used in this analysis were the following:

- Number of casual sexual partners
- Respondents' perception of risk of being infected with HIV
- Changes to sexual behaviour to avoid being infected with HIV
- Perceptions of stigma
- Acquainted with someone who was infected with HIV/AIDS

The behavioural change with regard to condom use was also included in this analysis and here the dependent variables entered into the model involved whether the respondent had ever used a condom and whether he had used a condom with his casual sexual partners in the last 12 months.

The significance of the changes was reported next, after which the dependent behavioural variables were entered into the logistic regression again. Controlling was done for all the independent variables that showed significant changes over the period covered by the five surveys. The independent variables that were controlled for in the analysis of the behavioural analysis for mineworkers were age; having made trips outside of the greater Carletonville area; marital status; the number of lifetime sexual partners; having had an alcoholic drink in the last month, and circumcision status. The last variable, which was included as a controlling variable, was not significant in the independent variable logistic regression (however, the reason for these inclusions was discussed earlier). The results of this analysis can be seen in Table 19 to Table 25.

Table 19 Linear trend of behavioural variables for mineworkers: Number of casual sexual partners

		1999	2000	2001	1999	2000	2001		
		n	n	n	%	%	%	OR (P value)	aOR (P value)
Casual sexual partners	None	273	356	562	32.9	46.5	56.5	0.6166 **(.0000)**	0.5938 **(.0000)**
	Had one/ some	556	410	432	67.1	53.5	43.5		

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Casual sexual partners' refers to whether the respondent had casual sexual partners in the last 12 months. 'Had one/some' includes one or more casual sexual partners and 'None' refers to not having had any casual sexual partners.
No data for this variable were available for 1997 and 1998.

Table 20 Linear trend of behavioural variables for mineworkers: Condom use with casual sexual partners

		1997	1998	1999	2000	2001	1997	1998	1999	2000	2001		
		n	n	n	n	n	%	%	%	%	%	OR (P value)	aOR (P value)
Used condoms with casual sexual partners	Never	226	761	692	585	827	89.7	84.6	82.7	76.1	83.2		
	Used	26	138	145	184	167	10.3	15.4	17.3	23.9	16.8	1.1065 **(.0027)**	1.1573 **(.0000)**

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Used condoms with casual sexual partners' refers to whether the respondent used a condoms with his casual sexual partners. 'Used' includes having always and sometimes used condoms.

In Table 19 there were no data available for 1997 and 1998, as this question was only added after 1998. In 1999, 67.1% of mineworkers indicated that they had had casual sexual partners, and in 2000 this figure decreased to 53.5% and to 43.5% in 2001. The linear trend for this decrease in the number of casual sexual partners was significant and the adjusted Odds Ratio was 0.5938, which means that mineworkers were roughly 40% less likely to have casual sexual partners at the end of the intervention than in the beginning. From one of the previous analyses done here we know that there is a ratio of about two women for every man in Khutsong in the age category 20 to about 35. This makes the fact that fewer mineworkers have had casual sexual partners in the last 12 months even more interesting. Mineworkers are considered a high-risk group, because they stay in single-sex hostels while they are working at the mines. It is therefore to be expected that they will have casual sexual partners while they are at the mines. The fact that fewer of them reported to have had casual partners is therefore very positive, as this would reduce their own risk and simultaneously the risk of their families and regular partners.

The linear trend of condom use with casual partners was significant for all the groups studied – women in Khutsong, men in Khutsong and mineworkers. It would thus seem that there is a significantly growing use of male condoms, especially with casual sexual partners. One of the aims of the interventions was to increase the awareness and use of male condoms. It would seem that it was successful.

Table 21 shows that there was not a significant linear trend of the variable associated with the respondent's acquaintance with somebody infected with HIV. In other words, there was not a larger number of mineworkers who knew someone who was infected with HIV in the later surveys compared to the earlier surveys. It has to be kept in mind that the respondents here were all employees of mining houses and were therefore probably a little more careful in stating up front that they knew someone infected with HIV. For the men and the women in Khutsong, this variable changed significantly. The percentage of respondents who indicated that they knew someone infected with HIV was quite low for all the surveys, around 10% to 12%. However, the figure in Khutsong rose from 8.6% to 19.8% in respect of females, and from 8.4% to 19.0% in respect of males who knew someone who was infected with HIV. The levels of acquaintance for all three groups, women of Khutsong, men of Khutsong and mineworkers, started off quite similar, but the significant increases were reported only for men and women of Khutsong.

From Table 22 it is clear that the number of mineworkers who considered themselves to be at high risk of contracting HIV decreased from 70.1% in 1997 to 56.8% in 2001. This linear trend was significant. This was the exact opposite of the findings made for the male and female residents of Khutsong. In Khutsong more women saw themselves as being at risk of getting infected with HIV and the men of Khutsong this figure stayed the same – though on a higher level than for women. This finding could probably be linked to the increased condom use of mineworkers, and the fact that they were having fewer casual sexual partners. However, this finding needs to be explored further as this survey was not able to answer these secondary questions.

It is clear from Table 23 that there was a significant trend among mineworkers to change their behaviour in order to avoid being infected with HIV. This should be seen together with the fact that mineworkers reported a lower risk perception. Despite other behavioural changes this was a variable that in Khutsong did not show a significant increase. In mineworkers the increase was quite dramatic and significant, from 30.5% in 1997 to 40.5% in 2001, but with an adjusted Odds Ratio of 0.9440. Therefore mineworkers were roughly 6% more likely to make changes in their behaviour so as to avoid HIV.

Table 21 Linear trend of behavioural variables for mineworkers: Know someone who is infected with HIV

		1997	1998	1999	2000	2001	1997	1998	1999	2000	2001		
		n	n	n	n	n	%	%	%	%	%	OR (P value)	aOR (P value)
Know someone infected with HIV	Do not know	205	758	699	598	837	89.5	90.2	87.9	83.8	88.4	1.0798 (.0587)	1.0844 (.0563)
	Know	24	82	96	116	110	10.5	9.8	12.1	16.2	11.6		

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Know someone infected with HIV' refers to mineworkers indicating that they knew somebody who was infected with HIV. 'Knows' implies knowing at least one person who is infected with HIV.

Table 22 Linear trend of behavioural variables for mineworkers: Risk of getting infected with HIV

		1997	1998	1999	2000	2001	1997	1998	1999	2000	2001		
		n	n	n	n	n	%	%	%	%	%	OR (P value)	aOR (P value)
Chances of being infected with HIV	Good	96	385	273	224	312	70.1	65	60.1	56.1	56.8		
	No chance	41	207	181	175	237	29.9	35	39.9	43.9	43.2	1.1405 **(.0001)**	1.1531 **(.0001)**

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
'Chances of being infected with HIV' refers to the perception of risk and what the respondent considers as his chances of getting infected with HIV. 'None' implies no chance and a moderate chance.

Table 23 Linear trend of behavioural variables for mineworkers: Reported changes in behaviour to avoid getting infected with HIV

		1997	1998	1999	2000	2001	1997	1998	1999	2000	2001		
		n	n	n	n	n	%	%	%	%	%	OR (P value)	aOR (P value)
Changed behaviour to avoid infection with HIV	Yes	74	329	493	370	403	30.5	36.6	59	48.1	40.5	0.9440 **(.0254)**	0.9286 **(.0063)**
	No	169	570	343	399	591	69.5	63.4	41	51.9	59.5		

n – sample size in each category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
p value – level of significance
'Changed behaviour to avoid infection with HIV' refers to indications from the respondents that they had adjusted their sexual behaviour to avoid getting infected with HIV.

Table 24 Linear trend of behavioural variables for mineworkers: Willingness to reveal HIV status

		1997	1998	1999	2000	2001	1997	1998	1999	2000	2001		
		n	n	n	n	n	%	%	%	%	%	OR (P value)	aOR (P value)
Tell somebody if infected with HIV	Tell	*	663	619	591	737	*	73.7	74	76.9	74.1	0.9824 (.5978)	1.0056 (.8713)
	Secret	*	236	217	178	257	*	26.3	26	23.1	25.6		

n – sample size in each category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
p value – level of significance
'Tell somebody if infected with HIV' refers to the respondents who indicated that they would tell somebody if they were infected with HIV. 'Secret' includes those who would not reveal their HI status.
*** This variable was no included in the 1999 survey.**

Table 25 Linear trend of behavioural variables for mineworkers: Condom use

		1997	1998	1999	2000	2001	1997	1998	1999	2000	2001		
		n	n	n	n	n	%	%	%	%	%	OR (P value)	aOR (P value)
Have used condoms	Used	72	324	*	392	474	29	39	*	51.3	47.9	0.8448 **(.0000)**	0.8048 **(.0000)**
	Not used	176	506	*	372	516	71	61	*	48.7	52.1		

n – sample size in each category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
p value – level of significance
'Have used condoms' refers to whether respondents have ever used a male condom in their lives.
No data were available for this variable for the 1999 survey.

Table 24 in this analysis explored whether respondents would tell someone if they became infected with HIV. This question was not included in the 1997 survey. From the other surveys it is clear that the number of respondents who indicated that they would tell someone if they were infected with HIV stayed around 73% to 76%, and this change was clearly not significant. Even though the trend was not significant, the number of people who indicated that they would tell somebody is quite high. In fact, around three-quarters of the mineworkers indicated that they would tell somebody if they were infected with HIV. If we consider who they would tell, only one person indicated in one of the five surveys that he would inform his employer. At the stage that this survey was done, there was no treatment available for employees yet and respondents were clearly careful of informing the employer about their status. It is also to be expected that respondents would rather tell their families and partners of HIV infection.

In the last table reporting on the behavioural analysis for mineworkers, Table 25, it is very clear that, according to the linear trend, the number of mineworkers who have used condoms in their lives has increased significantly. Condom use started from a low base of 29% in 1997 and increased steadily and significantly to almost half of the sample in 2001, with an adjusted Odds Ratio of 0.8048. Therefore mineworkers were roughly 20% more likely to have used condoms in their lives before. This can be linked to the fact that there was also a significant increase in the number of mineworkers who indicated that they had used condoms with their casual partners in the last 12 months. If all of these observations of condom use were combined, it would seem that behavioural change indeed took place and that there was a considerable increase in reported condom use. The research team observed this increase in the use of condoms in Khutsong. Although this was a significant change only for women in Khutsong, there were significant increases in the use of condoms with casual sexual partners among men and women in Khutsong. The question is whether this change in behaviour led to the decrease in sexually transmitted diseases and HIV.

7.4 Summary of behavioural change

In this section we have seen a number of significant behavioural changes that the intervention was designed to achieve. In the analysis the dependent variables were entered into a logistic regression analysis on their own and in the next step all the independent variables that have shown to differ significantly between the samples of the different years were controlled for. The analysis was performed separately for men and women of Khutsong and then for the mineworkers.

The following dependent variables were considered in this analysis of the behavioural changes that took place:

- Number of casual sexual partners in a 12-month period
- Use of condoms with casual sexual partners
- Knowing someone infected with HIV
- Perception of personal risk of getting infected with HIV
- Changes to sexual behaviour in the last 12 months to avoid getting infected with HIV
- Willingness to tell someone about own infection with HIV
- Previous use of a condom

In all three groups the number of respondents who indicated that they had had casual sexual partners decreased significantly, since having many casual sexual partners is a high-risk factor for getting infected with HIV/AIDS and STDs. This was a success for the intervention. The second trend that we observed was that in all three groups the respondents significantly increased their use of male condoms with casual sexual partners. The use of condoms with casual sexual partners of whom the sexual history is not known, is important. These two behavioural components suggest that the intervention had the desired effect, as both of these were intended outcomes of the intervention.

In the next analysis it became clear that male and female residents of Khutsong were more likely to know someone who was infected with HIV/AIDS than were the mineworkers. However, the trend was positive for mineworkers as well, indicating that the number of mineworkers who knew someone who was infected with HIV/AIDS had also increased. The trend was nevertheless significant for men and women in Khutsong, but not for the mineworkers.

The next trend we observed was a significantly increased risk perception by women from Khutsong and the mineworkers. Although more men from Khutsong also reported that they considered themselves to be at risk, the trend for these men was not significant. Only among mineworkers was observed a significant increase in the number of respondents who had changed their behaviour in the last 12 months to avoid getting infected with HIV/AIDS. Among the residents of Khutsong an increased number of men and women also reported having changed their behaviour, but for them the trend was not significant.

The number of men and women from Khutsong who would tell somebody if they became infected increased significantly. Among the mineworkers there were also more men who would tell somebody, but the trend was not significant yet. It should be noted, however, that for all the surveys around 75% of men in the mines indicated that they would tell somebody, while in Khutsong this percentage increased from around 67-68% for men and women respectively in 1998 to around 79-80% for both groups in the 2001 survey.

Lastly, it became clear that there was a significant increase in the number of men in Khutsong as well as mineworkers who had already used a condom. For females in Khutsong, the number of respondents who had used a condom remained under 50% and did not increase significantly. Changes in risky sexual behaviour by all three groups on most of the behavioural indicators suggest that the intervention to change behaviour was indeed successful.

8 The impact of the intervention on the prevalence of STDs and HIV

In the analysis of the biomedical indicators (the outcome of the tests for STDs and HIV infection) for women of Khutsong the same procedure was followed as with the independent variables and the behavioural variables. The biomedical tests were first examined one by one in a uni-variate analysis to calculate an unadjusted Odds Ratio (OR) and then all the independent variables controlled for were entered into the model to calculate the adjusted Odds Ratio (aOR).

The analysis of the STDs and HIV infections was done to measure the impact of the intervention on the prevalence of STDs and HIV. The first analysis dealt with the changes in the sample and was done to make sure that the samples across the three different surveys considered were comparable. The analysis of the behavioural factors followed and was aimed at establishing whether the intervention to change behaviour had had an impact. In this third analysis the impact of the intervention on the infection rates of STD and HIV was assessed.

8.1 Analysis of changes in STD and HIV prevalence in Khutsong women

Once again the research team examined women separately from men and also filtered out women who were not resident in Khutsong. We included data from the 1998, 2000 and 2001 surveys, except in the case of HIV where no data were available for the 2000 survey.

The findings of this analysis are described below and reported in Table 26.

The most striking result of the linear trend analysis was that all of the changes in the biomedical test were significant in the multi-variate analysis. Even in the uni-variate analysis, all of the changes were significant. The levels of infection for all the STDs and HIV have thus changed significantly in the female population of Khutsong.

All of the trends, except for one, were not in the direction that the intervention had aimed to impact. In other words, the HIV infection rate (HIV prevalence) increased significantly for women, even when controlling for independent variables that were significantly different when comparing the samples (e.g. age, housing type and marital status). The infection rates for gonorrhoea and chlamydia infections increased as well, in contrast to the infection rate for syphilis, which declined significantly. There was a huge drop in the number of females infected with syphilis. In 1998, 9.7% of respondents were infected with syphilis, in 2000 this figure increased to 18.7% and then declined dramatically to 2.1% in 2001. In discussion with Prof. David Lewis of the Sexually Transmitted Disease reference Laboratory of the National Institute for Communicable Diseases, where the tests were conducted, he indicated that such high variability in syphilis prevalence is unlikely and suggested that this could have been due to testing errors.

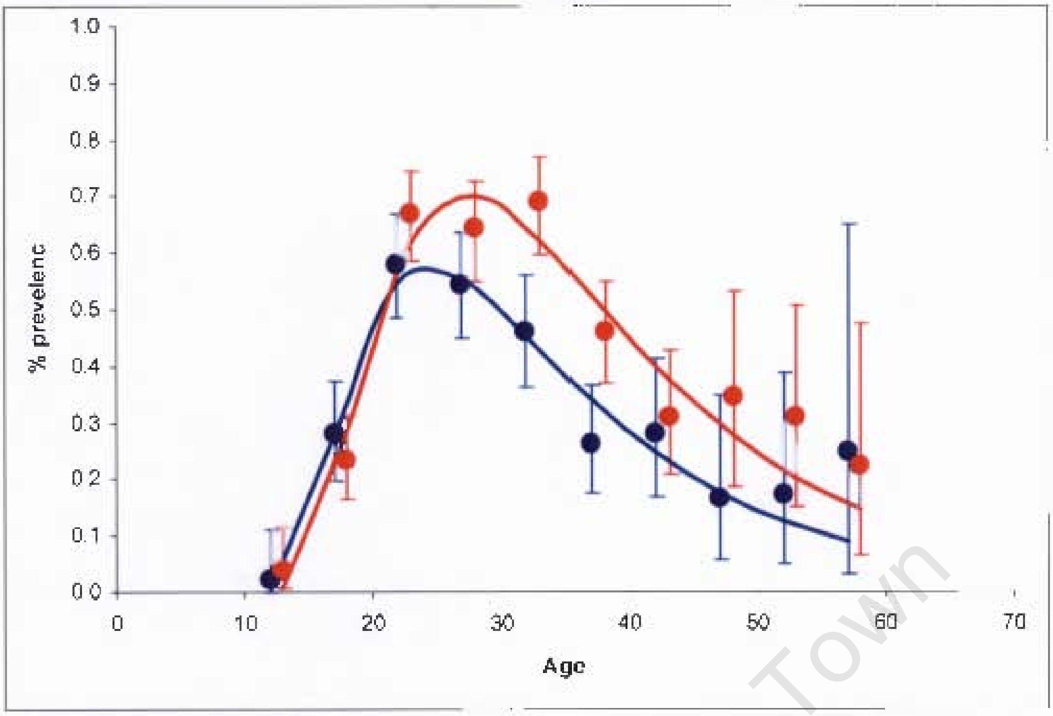
For HIV, we only had two data points. It would have been very interesting to compare the prevalence over three years instead of two, but indications were that the rate increased gradually, and statistically significantly so. It is therefore fair to assume that the data point for 2000 would have been somewhere between the 1998 and 2001 data anyway. This increase in prevalence should be comparable to the antenatal clinic data released by the South African National Department of Health on an annual basis. According to these data, the national rates of infection for women attending ante-natal clinics increased from 22.8% in 1998 to 24.8% in 2001 (Makubalo *et al*., 2004; Williams *et al*., 2000b), compared to 37.2% in 1998 and 45.3% for 2001 in this study. The intervention thus does not seem to have had any impact on the rate of infection for HIV in women in Khutsong, as the prevalence of HIV infection increased dramatically more than the national prevalence over the same period. If one compares the prevalence of HIV in women in Khutsong to the prevalence in Gauteng (24.4% for 1998 and 29.5% for 2001) and North West (20.7% for 1998 and 25.8% for 2001), the rates are closer to the provincial prevalence (Makubalo *et al*., 2004). Carletonville lies on the provincial border between Gauteng and North West. If we look at the proportional increase for Gauteng and the proportional increase for North West, both are almost exactly the same as the proportional increase for Carletonville.

Table 26 Linear trend analysis of biomedical results for women

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
HIV	Negative	438	*	481	63.4	*	54.8		
	Positive	253	*	397	36.6	*	45.2	1.1263 **(.0006)**	1.1873 **(.0000)**
Gonorrhoea	Negative	644	816	785	93.2	91.3	89.4		
	Positive	47	77	93	6.8	8.6	10.6	1.1747 **(.0104)**	1.1477 **(.0329)**
Chlamydia	Negative	637	770	770	92.2	86.2	87.7		
	Positive	54	123	108	7.8	13.8	12.3	1.1852 **(.0023)**	1.1850 **(.0029)**
Syphilis	Negative	624	726	860	90.3	81.3	97.9		
	Positive	67	167	18	9.7	18.7	2.1	0.8269 **(.0004)**	0.8231 **(.0006)**
Symptoms of STIs	None	316	523	552	50.9	64.2	70.8		
	Had symptoms	305	292	228	49.1	35.8	29.2	0.7546 **(.0000)**	0.7615 **(.0000)**

n – sample size in each category
OR – unadjusted Odds Ratio
aOR – adjusted Odds Ratio
p value – level of significance
No data were available for the 2000 survey for HIV
'Symptoms of STIs' refers to self-reported symptoms of STIs in the last 12 months and includes pain in the genital area, unusual discharges and sores in the genital area.

Figure 5 **HIV prevalence as a function of age among women in 1998 and 2001 against data**



• 1998
• 2001

The points on the X axis have been adjusted by 0.5 of a year in each case for display purposes.
The whisker plots indicate the 95% confidence level.

Table 27 HIV prevalence among women of different ages in 1998 and 2001

	1998		2001	
		% HIV+		% HIV+
Age category	n	in each age category	n	in each age category
12-15 yrs	48	2.1	73.0	4.1
16-20 yrs	107	28.0	141.0	23.4
21-25 yrs	119	58.0	142.0	66.9
26-30 yrs	116	54.3	123.0	64.2
31-35 yrs	102	46.1	119.0	68.9
36-40 yrs	91	26.4	126.0	46.0
41-45 yrs	57	28.1	74.0	31.1
46-50 yrs	30	16.7	32.0	34.4
51-55 yrs	23	17.4	29.0	31.0
56+ yrs	8	25.0	18.0	22.2

n is the number of females in each age category. % HIV+ is the percentage of females in each category who have tested positive for HIV

HIV data needed to be compared by age groups though; there is huge variance in the rates of infection of different age categories of respondents. In Figure 5 we can see the prevalence rate for women distributed according to age. The multivariate analysis indicated that the change in the HIV rate for women between 1998 and 2001 was significant. From the graph it is clear that the rate of increase of HIV prevalence or the incidence in the younger categories were very similar between the different years. The prevalence then rose sharply in the age categories 21-25 and 26-30 between 1998 and 2001 and stayed well above the 1998 prevalence rate in the older categories. The rising HIV prevalence rate among women in these young age categories cannot be explained by the ageing of the sample from the previous year alone – it can only be explained by new infections.

There was a steady but significant rise in the prevalence of gonorrhoea (Table 26). It increased from 6.8% to 8.6% and then to 10.6% in 1998, 2000 and 2001 respectively. It is generally accepted that gonorrhoea is a much more sensitive indicator of sexual behaviour change than HIV would be. In view of the behavioural change that was observed so far, one would have expected the incidence of gonorrhoea to be on the decline and not on the rise.

The same conclusion can be drawn in respect of chlamydia, which increased even more strikingly from 7.8% to 13.8% and then dropped slightly to 12.3% in 1998, 2000 and 2001 respectively. The intervention for the control of STIs did not result in lower rates of infection for gonorrhoea and chlamydia, and therefore cannot be considered to have been successful.

For syphilis however, we do see a sharp drop in the prevalence from 2000 to 2001 (Table 26). In fact, the rate dropped from 18.7% to 2.1% (after having gone up from 9.7% in 1998) for the other sexually transmitted diseases studied here. The dramatic drop in 2001 creates a significant linear trend of decrease for this disease.

Another factor that has decreased significantly (according to the linear trend observed from the uni- as well as the multi-variate analysis of sexually transmitted diseases) was the drop in self-reported symptoms of STIs by female respondents. These self reported symptoms were pain in the genital area, unusual discharges and sores in the genital area. The number of respondents who reported symptoms in the last 12 months fell from 49.1% in 1998 to 39.8% in 2000 and even further to only 29.2% in

2001. This ties in with the behavioural changes reported by female respondents. It is, however, not clear why there was such a significant and substantial drop in the number of self-reported infections, but not in the biomedically tested infections.

8.2 Analysis of changes in STD and HIV prevalence for Khutsong men

For men the same process was followed for this analysis as was followed for the female respondents of Khutsong. First, the variables were entered into the model on their own for the uni-variate analysis coefficients and then the influence of the independent variables was controlled for in the multi-variate analysis. The findings of this analysis can be seen in Table 28.

Unlike in the female Khutsong sample where the movement of all the biomedical indicators were significant, the analysis for men shows that for HIV and gonorrhoea there were no statistically significant changes.

The difference for HIV between men and women is quite striking. The rate for all Khutsong males was 20.1% in 1998 and 19.7% in 2001. The change in the estimate for the HIV infection rate is small and also not statistically significant (p=0.8879). This means that we cannot reject the null hypothesis, namely that there was no change in the HIV prevalence based on this statistic. By contrast, the rate for women in Khutsong increased from 36% in 1998 to 45% in 2001. Thus, the prevalence of HIV did not increase for men in Khutsong over the time of the intervention, while in the women it did. A stable prevalence of HIV, however, might be a desirable outcome for this project due to the fact that even if the incidence of HIV infection was stopped altogether (i.e. not one infection occurred during the time of the study), the prevalence would not be expected to drop by much, as the number of infected people who would die or move out of the area in one year would be low. The measures used in this analysis could not detect any reduction or increase in HIV prevalence for the men in Khutsong and this result might indicate the success of the intervention. However, the p value was very high and therefore the changes that occurred in the male sample cannot be detected by this sample. According to the confidence intervals the 1998 figure were between 16.35% and 23.85% and in 2001 between 16.30% and 23.10%

prevalence of HIV in men of Khutsong. This means that the actual prevalence figure in 1998 could have been 16.35% and in 2001 it could have been 23.10%, which would have been a 6.25% increase, of course this is the maximum that the prevalence could have changed for men and it was therefore still a much smaller change than for women if indeed the prevalence did change.

The adjusted p value for the change in HIV prevalence is $p=0.8879$, which is far from statistically significant. In fact, the prevalence for the two years is very similar, as is also clear from Figure 6. This is an important finding in the study of the impact that this intervention had on HIV prevalence. It is quite complex to try and understand why there was no increase in the prevalence for men, but a definite increase in prevalence for women in the Khutsong community. Causality could not be concluded from this type of study. A possible explanation to consider would be that fewer men in Khutsong had casual sexual partners and more had used condoms with those casual partners. However, these behavioural changes took place among the women of Khutsong as well and yet the HIV prevalence for women increased – so it would be difficult to conclude that these behavioural changes alone made the difference. It is not sure why there was not an increase in the prevalence for men and it seems that this fact cannot be attributed to a behavioural change.

In the older age categories for men there are considerable differences between the HIV prevalence for the different age categories. Since the sampling error here was large (as can be seen in Figure 6), the changes are not significant.

From Table 28 it is also clear that – as for the women of Khutsong – gonorrhoea and chlamydia prevalence among male Khutsong residents increased, but for men this was only a significant linear trend for chlamydia. Here the intervention did not have the intended impact. There was an increase in the prevalence of all the sexually transmitted diseases, but the prevalence of HIV remained unchanged, which was a desired outcome.

As with Khutsong females, the Khutsong male sample also recorded a very significant drop in the prevalence of syphilis from 2000 to 2001 (8.1% to 0.2%). For the men this figure initially also rose from 6.1% in 1998. Although the prevalence levels for men and women differed, both showed a significant drop in syphilis prevalence levels between 1998 and 2001.

Another trend that was clear from the analysis for Khutsong females is also replicated here for the men. There was a drop in the number of women who reported symptoms of STIs in the last 12 months and this linear trend was also significant in the men. For men these symptoms were pain in the genital area, unusual discharges and sores in the genital area. Although not as dramatic in men as in women, STI symptom prevalence dropped from 28.8% to 20.6% to 16.2% in 1998, 2000 and 2001 respectively. The adjusted Odds Ratio was 0.7888, which means that men in Khutsong were roughly 22% less likely to have reported symptoms of STIs in 2001, compared to earlier surveys.

These trends were the same for men and women from Khutsong. It tied in with the observation earlier that there were some significant changes in behaviour, more so for women than for men, and there was a significant reduction in the number of reported symptoms of the STIs – again more so for men than for women.

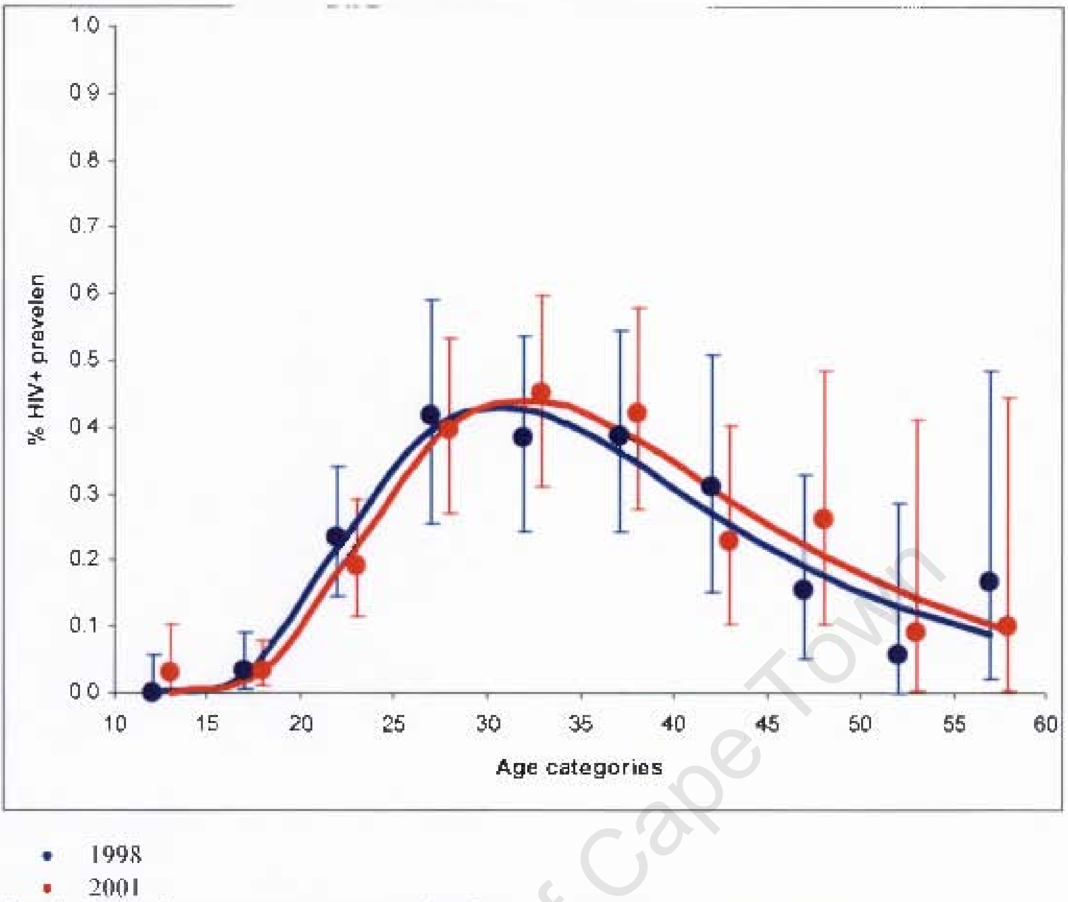
As in the case of the Khutsong female sample, the self-reported symptoms of STDs decreased significantly. In 1998, 28.8% of men reported symptoms in the last 12 months, while in 2001 only 16.2% of men indicated having had such symptoms. It is not clear why the self-reported symptoms for STDs decreased while the biomedical indicators showed a significant increase for chlamydia and an increase, though not significant, for gonorrhoea.

Table 28 Linear trend analysis of biomedical results for men

		1998	2000	2001	1998	2000	2001		
		n	n	n	% of total	% of total	% of total	OR (P value)	aOR (P value)
HIV	Negative	354	*	427	79.9		80.3		
	Positive	89	*	105	20.1		19.7	0.9926 (.8905)	1.0090 (.8879)
Gonorrhoea	Negative	430	586	510	97.1	96.7	95.9		
	Positive	13	20	22	2.9	3.3	4.1	1.1228 (.3374)	1.1321 (.3306)
Chlamydia	Negative	427	531	496	96.4	87.6	93.2		
	Positive	16	75	36	3.6	12.4	6.8	1.2361 **(.0121)**	1.2366 **(.0180)**
Syphilis	Negative	416	557	531	93.9	92	99.8		
	Positive	27	49	1	6.1	8.1	0.2	0.7219 **(.0006)**	0.7191 **(.0015)**
Symptoms of STIs	None	262	381	331	71.2	79.4	83.8		
	Had symptoms	106	99	64	28.8	20.6	16.2	0.7864 **(.0000)**	0.7888 **(.0001)**

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
No data were available for the 2000 survey for HIV
'Symptoms of STIs' refers to self-reported symptoms of STIs in the last 12 months and includes pain in the genital area, unusual discharges and sores in the genital area.

Figure 6 HIV prevalence as a function of age among men in 1998 and 2001 against data



The points on the X axis have been adjusted by 0.5 of a year in each case for display purposes.
The whisker plots indicate the 95% confidence level.

Table 29 HIV prevalence among men of different ages 1998 and 2001

	1998		2001	
	n	% HIV+	n	% HIV+
12-15 yrs	50	0.0	67	3.0
16-20 yrs	93	3.2	143	3.5
21-25 yrs	81	23.5	88	19.3
26-30 yrs	36	41.7	58	39.7
31-35 yrs	47	38.3	51	45.1
36-40 yrs	44	38.6	45	42.2
41-45 yrs	29	31.0	35	22.9
46-50 yrs	32	15.6	23	26.1
51-55 yrs	17	5.9	11	9.1
56+ yrs	12	16.7	10	10.0

n is the number of males in each age category

% HIV+ is the percentage of males in each category who have tested positive for HIV

8.3 Analysis of changes in STD and HIV prevalence for mineworkers

For mineworkers the same process was again followed as for the female and male respondents from Khutsong. First of all the dependent variables (in this case the test results for HIV, gonorrhoea, chlamydia and syphilis, as well as the self-reported symptoms of STDs) were entered into the analysis one by one, the Odds Ratio was reported and then the independent variables that needed to be controlled for were entered into the model and the adjusted Odds Ratio was calculated. Once again all the surveys from 1997 to 2001 were included in the mineworker analysis, due to the fact that the mineworker samples were comparable. The findings of this analysis can be seen in Table 30.

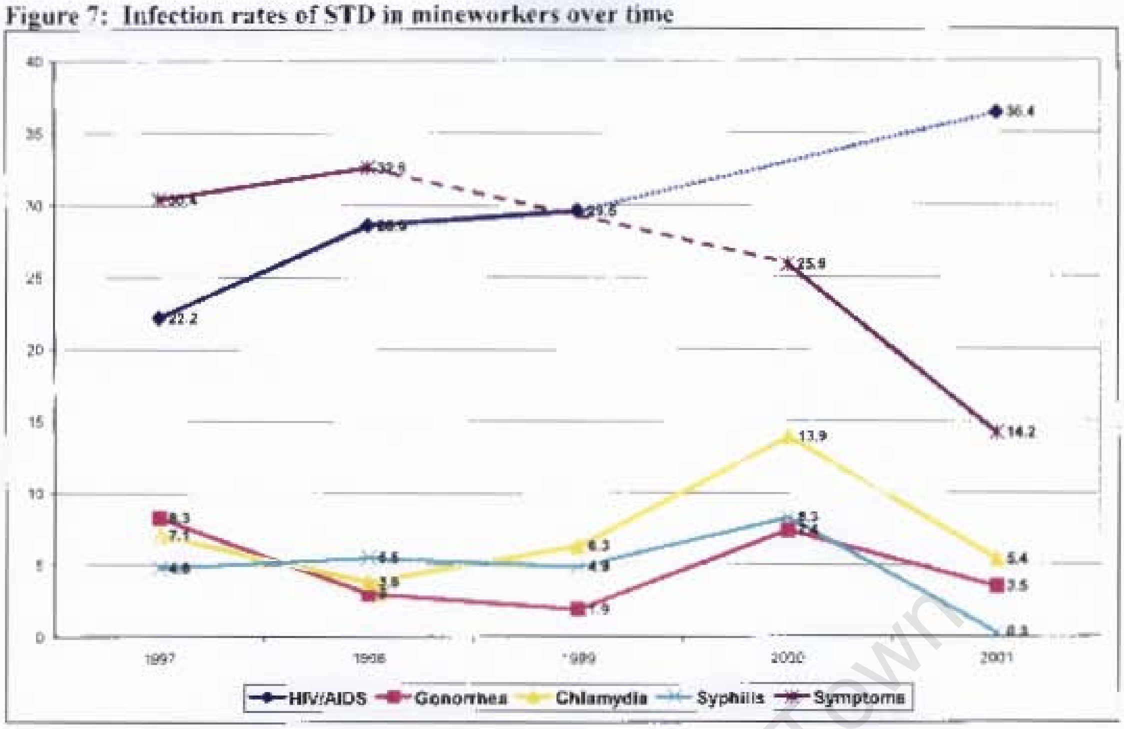
Firstly, all the biomedical indicators except for gonorrhoea showed statistically significant increasing trends for mineworkers. In the sample for Khutsong we saw that all the biomedical results showed an increase for women, while for men only HIV and gonorrhoea did not show an increase.

As in the case of the residents of Khutsong, the findings for the mineworkers also did not seem to indicate any success emerging from the STD intervention. However, the PPT intervention was launched in the hotspot communities close to the mines during the latter part of the project and therefore some of the effect on the prevalence of STDs in mineworkers is evident. It was expected that there would be greatly reduced rates of STD infection among the mineworkers by 2001. Table 30 shows that levels of gonorrhoea infection increased and decreased throughout the project and steadied in 2001 at a level of 3.5% of respondents who tested positive for gonorrhoea. However, the rate of infection with gonorrhoea had decreased from 7.5% in 2000 to 3.5% in 2001. Chlamydia did decrease among the mineworker respondents from 13.9% in 2000 to 5.4% in 2001. A similar trend can be seen for syphilis where the rate of infection decreased from 8.3% in 2000 to 0.3% in 2001. It is clear from Figure 7 that all the STDs and even the self-reported symptoms of STD declined from 2000 to 2001. Only HIV rates did not decline and instead increased from 22.2% to 36.4%. This could be an indication that the PPT intervention had a substantial impact, but just using two data points could not provide reliable trends and this change can therefore not be attributed to the PPT intervention. It is possible that the populations have changed from survey to survey, but this is unlikely because of what is understood to be common practice by the mines in terms of staff continuity. Mineworkers' contracts are usually extended from one year to the next.

Specific trends are evident from Figure 8 in the prevalence of mineworkers of different ages. There was a substantial decrease in prevalence of HIV in young mineworkers, between the ages of 21 to 25 years in the 2001 survey. In 1997 the infection rate was 22.2%, this went up to 26.5% in 1998, and dropped to 22.2% in 1999 and then finally to just 11.9% in 2001. The age distribution of mineworkers showed that mineworkers were statistically significantly older in the later surveys than in the earlier ones. So, although there seemed to be fewer mineworkers of the age group 21 to 25, a reduction in prevalence was noticed for this group. In an age distribution of HIV one would expect to see a substantial drop in incidence after about 30 years of age when respondents are usually expected to have less risky sex. However, this did not seem to be the case for mineworkers, in the age group 26 to 30 year-olds the prevalence went up from 19.2% in 1997 to 42% in 2001 and in 36 to 40 year-olds from 32% in 1997 to 39% in 2001. Even 41 to 45 year-olds were still highly infected with HIV/AIDS, and prevalence for this group went from 18.8% in 1997 to 31.3% in 2001, which could indicate that mineworkers were still being infected at higher ages.

There was also a reduction in the reported symptoms of sexually transmitted diseases and this trend was significant as well. Once again, the research team was confronted by the same apparently opposing findings that behaviour changed and self-reported STI symptoms declined, but this was not confirmed by the biomedical test – except between the 2000 and the 2001 measurements and in the case of syphilis.

Figure 7: Infection rates of STD in mineworkers over time



Both HIV and chlamydia increased statistically significantly on a linear trend. Only syphilis prevalence decreased with statistical significance.

Figure 8: HIV infection of mineworkers by age

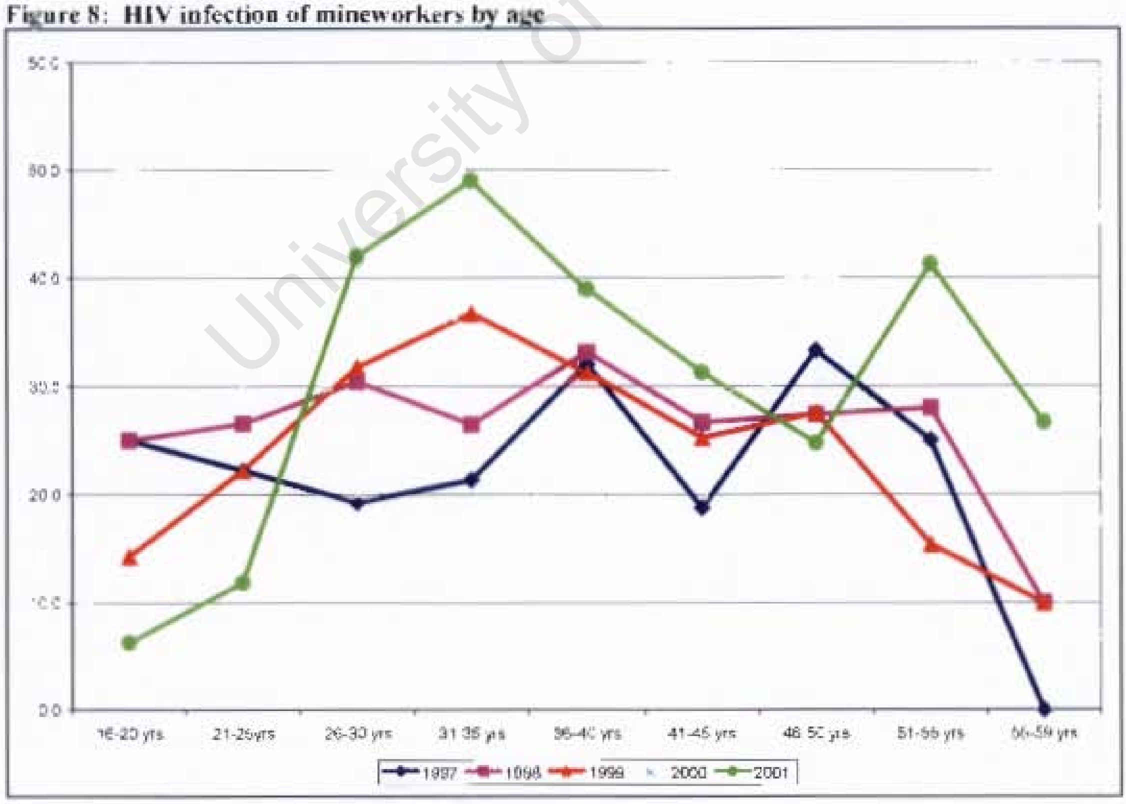


Table 30 Linear trend for mineworkers: Biomedical indicator analysis

		1997	1998	1999	2000	2001	1997	1998	1999	2000	2001		
		n	n	n	n	n	%	%	%	%	%	OR (P value)	aOR (P value)
HIV	Negative	196	642	589	*	632	77.7	71.4	70.4	*	63.6		
	Positive	56	257	248	*	362	22.2	28.6	29.6	*	36.4	1.1512 **(.0000)**	1.1878 **(.0000)**
Gonorrhoea	Negative	231	872	821	712	959	91.7	97	98.1	92.6	96.5		
	Positive	21	27	16	57	35	8.3	3	1.9	7.4	3.5	1.0069 (.9142)	1.0428 (.5559)
Chlamydia	Negative	234	865	784	662	940	92.9	96.2	93.7	86.1	94.6		
	Positive	18	34	53	107	54	7.1	3.8	6.3	13.9	5.4	1.1298 **(.0449)**	1.1695 **(.0046)**
Syphilis	Negative	240	850	796	705	991	95.2	94.5	95.1	91.7	99.7		
	Positive	12	49	41	64	3	4.8	5.5	4.9	8.3	0.3	0.7856 **(.0001)**	0.7721 **(.0001)**
Symptoms	None	174	603	**	483	849	69.6	67.4	**	74.1	85.8		
	Had	76	291	**	169	141	30.4	32.6	**	25.9	14.2	0.7664 **(.0000)**	0.7825 **(.0000)**

n – sample size in each category **OR – unadjusted Odds Ratio**
aOR – adjusted Odds Ratio **p value – level of significance**
* No data were available for the 2000 survey for HIV
** No data were available for the 1999 survey for self-reported symptoms
'Symptoms' referred to self-reported symptoms of STIs in the last year, these included pain during urinating, discharges and sores. 'Had' included having had one or more episodes in the last year.

8.4 Summary of the analysis of biomedical indicators

In summary – for men and women in Khutsong, as well as for the mineworkers, the intervention to reduce the number of prevalent STDs did not seem to have been very successful. In fact, only syphilis decreased in all three groups, while the incidence of all other measured STDs increased. Fewer respondents reported symptoms of STDs in later than in earlier surveys, and this trend was significant for all three groups, men from Khutsong, women from Khutsong and mineworkers.

As far as HIV is concerned, there were significant increases in the prevalence for women of Khutsong and for mineworkers, but not for men of Khutsong. No change in the prevalence rate for HIV is probably the best outcome that (for HIV) the interventions could have hoped for. The prevalence would simply stay the same if there were no further infections and it would slowly decrease as infected individuals die. This result needs to be treated with caution, though, as we simply cannot reject the null hypothesis. The finding therefore remains inconclusive.

Having studied the changes in the biomedical indicators, the research team next moved on to the risk factor analysis.

9 Risk factor analysis for HIV and reported symptoms of STIs

In the analysis above we first examined the sample of the different surveys to make sure that the data were comparable across the different years, or controlled for. An analysis was subsequently made of the behavioural factors and the impact of the intervention on these behavioural indicators was tested. Next the biomedical indicators were analysed and changes in the infection rates of STDs and HIV over the different years for the different groups were analysed.

The second objective of the study was to try and establish what the risk factors for infection with HIV and STDs were during the study. In other words, to try and establish what behaviour or independent variable put some groups of respondents at greater risk of being infected with HIV/AIDS or STDs than others. To do this type of analysis, all the background variables (independent variables, like age, educational qualifications) that showed a statistically significant trend during the first analysis were controlled for again. All behavioural variables (dependent variables like the number of sexual partners, and condom use with casual sexual partners, but treated as independent variables in this analysis), as well as all the biomedical variables (like presence of gonorrhoea or chlamydia) were entered into the model with only one risk factor variable (the only dependent variable in this analysis), for example HIV infection.

The behavioural variables that were included in the risk factor analysis were:

- Having used a condom with the last casual sexual partner
- Knowing somebody infected with HIV/AIDS
- Risk perception of the respondent
- Willingness to tell anybody if infected
- Having made any changes to behaviour to avoid HIV/AIDS infection
- Having ever used a condom

The biomedical factors, namely infection with gonorrhoea, chlamydia or syphilis, were included in the model for the risk factor analysis together with the behavioural factors mentioned in the previous paragraph. In other words, all the independent variables that showed statistically significant changes across the surveys were controlled for again; then all the dependent variables (behavioural or biomedical) were entered into the model to test which of these factors would indicate a greater risk of infection with HIV. The data from all the different surveys were used together in this analysis, because the aim was not to compare surveys to look for changes any longer – I was simply trying to see which factors or behaviours predict infection with HIV/AIDS during the study. This analysis was then repeated by testing the risk for having self-reported symptoms of STDs during the study.

In the earlier analysis of the HIV/AIDS infection, it was observed that for women in Khutsong there was an increase in the rate of HIV infection and this trend was significant. For men in Khutsong there were no increases in the prevalence of infection with HIV during the study . For mineworkers there was again an increase in the HIV infection rate. Since this trend was also significant, this analysis was done for mineworkers as well. For this reason a risk factor analysis could be done for women of Khutsong and for mineworkers to see what the risk factors for infection with HIV were. It would not be sensible to do this analysis for men of Khutsong as the trends of HIV infection rates among men were not significant and the results remained inconclusive. For men and women in Khutsong, as well as the mineworkers, the decline in self-reported STDs was significant. There were fewer men and women of Khutsong and mineworkers who had reported symptoms of STDs in the last 12 months and a risk factor analysis was therefore made for this variable as well.

The women in Khutsong also revealed an increased number of infections with other STDs and these were therefore included in the risk factor analysis. For the men in Khutsong, only chlamydia prevalence increased, of which the trend was significant, while the incidence of syphilis as well as of self-reported symptoms of STIs also decreased (of which the trend was once again significant). For the men of Khutsong the analysis of risk factors will include these two STDs and the self-reported symptoms of STIs. For the mineworkers, HIV and chlamydia showed significantly increased trends, while syphilis showed a significant decrease and for the mineworkers these STDs will therefore be included in the risk factor analysis for HIV.

9.1 Risk factor analysis for Khutsong women

The risk factor analysis was done by entering all the behavioural and biomedical factors into the model, while controlling for the independent variables for a multi-variate analysis. An aOR (adjusted Odds Ratio) value was produced. All the behavioural and biomedical indicators were also entered into the model one by one, while controlling for the independent variables, and this produced the OR (unadjusted Odds Ratio) value.

A risk factor analysis was performed for the other STDs that showed a significant trend in the previous analysis. This analysis was not included here, as only gonorrhoea showed a significant effect on chlamydia and vice versa, but no other factor had any predictive value for these other STDs. If a woman from Khutsong was infected with chlamydia, then she was over three times more likely to be infected with gonorrhoea than those not infected with chlamydia. Although biomedically measured outcomes for STIs is more reliable than self reported symptoms, the analysis could not be included due to the fact that there was no significant effects for these indicators. It is of little value to try and establish risk factors if the previous analysis showed no clear influence of the variables on HIV acquisition during the time period of the study.

The findings of the risk factor analysis for HIV in women are reported in Table 31. This analysis did not include the behavioural factor for the number of casual partners the person had had in the last 12 months. This was due to the fact that no data were available for this variable in 1998 and also no data for HIV in 2000. These shortcomings rendered useless any analysis that would include these variables.

From the analysis it is clear that there were only two factors that showed significant predictive value for HIV infection in women. Having used condoms in your life caused a significant trend (p=0.0292) and an aOR of 0.662. According to the explanation of the OR in Section 5.10 (Data Analysis) of this study, having used a condom in your life had a 66% predictive ability for HIV. Thus, if you had used a condom in your life before, you were 66% less likely to be infected with HIV than those who had never used a condom.

The second factor that showed predictive ability for infection with HIV was infection with gonorrhoea.

This analysis has shown that STDs, except for gonorrhoea, are not co-variates of HIV in this female population. Gonorrhoea had an adjusted Odds Ratio of 2.2189, which means that you are at least twice as likely to be infected with HIV if you have tested positive for gonorrhoea. It stands to reason that the eradication of STDs, except in the case of gonorrhoea (regardless of how important a cause that might be in itself) will most probably not have a restrictive effect on the incidence of HIV/AIDS in this female population.

The variables in the behavioural and biomedical analyses were not good predictors of the outcome of HIV infection. In other words, the epidemic in the female population was not driven by any of the variables included in the analysis of this study – except to a lesser extent gonorrhoea and the fact that someone had used a condom in her life before. There was, however, a significant increase in the number of women from Khutsong who had used male condoms in their lives in later surveys, and this could well play a vital role in years to come, but consistent condom use remains an elusive intervention outcome.

Even the substantial behavioural changes that have been introduced were, according to this analysis, unlikely to have an effect on the rates of HIV infection.

Table 31 Risk factor analysis for HIV in female residents of Khutsong

		n	% of HIV+ in each category	OR (P value)	aOR (P value)
Condom use with casual	Never used	560	40.6	1	1
Partners	Used	90	47.1	0.9340 (.7082)	0.8525 (.5656)
Know somebody infected	Do not know	546	41.9	1	1
with HIV/AIDS	Know somebody	80	39.0	0.9843 (.9292)	0.7172 (.1660)
Chances of getting infected	Low risk	268	44.7	1	1
with HIV/AIDS	At risk	135	44.6	1.0664 (.6905)	0.9324 (.6803)
Changes to behaviour to avoid	Yes	237	43.9	1	1
HIV/AIDS	No	413	40.2	1.0225 (.8609)	1.0655 (.7204)
Tell somebody if infected	Tell someone	468	40.4	1	1
with HIV/AIDS	Keep it secret	182	44.3	0.9323 (.5980)	1.1033 (.5719)
Have used a condom in	Yes	295	52.9	1	1
their lives	No	351	35.2	1.1048 (.4409)	0.6627 **(.0292)**
Gonorrhoea	Negative	565	39.5	1	1
	Positive	85	60.7	1.0060 (.9764)	2.2189 **(.0060)**
Chlamydia	Negative	568	40.4	1	1
	Positive	82	50.6	1.2672 (.2077)	1.3755 (.2230)
Syphilis (RPR)	Negative	603	40.6	1	1
	Positive	47	55.3	1.2888 (.2986)	1.3862 (.3048)

n = number of respondents **OR = unadjusted Odds Ratio**
aOR = adjusted Odds Ratio **P value = level of significance.**
'Condom use with casual partners' refers to having used condom with the casual sexual partner. 'Know somebody infected with HIV' indicates that the respondent knew somebody who was infected with HIV. 'Chances of getting infected with HIV' refers to the respondent's perception of being at risk of getting infected with HIV. 'Changes made to avoid HIV' refers to changes to the behaviour in order to avoid getting infected with HIV. 'Tell somebody if infected' refers to the respondent's willingness to tell somebody if she got infected with HIV. 'Ever used a condom' refers to the respondent previous use of a male condom in her life, and 'gonorrhoea' refers to the result of the biomedical test for gonorrhoea performed on the urine sample of the respondent. 'Chlamydia' refers to the result of the biomedical test performed on the urine sample of the respondent to test for chlamydia.

Table 32 Risk factor analysis for reported symptoms of STIs for women from Khutsong

		n	% of reporting symptoms	OR (P value)	aOR (P value)
Casual partners	None	249	29.6	1	1
	Had casual partners	268	36.2	2.0545 **(.0000)**	1.4379 (.1009)
Condom use with casual partners	Never used	688	37.0	1	1
	Used condoms	137	38.2	1.2064 (.1581)	1.2969 (.1989)
Know somebody infected with HIV	Do not know	386	37.2	1	1
	Know somebody	97	34.0	1.1229 (.4262)	0.9947 (.9787)
Risk perception	Small chance	174	41.3	1	1
	At risk	159	45.8	1.3675 **(.0366)**	1.3527 **(.0527)**
Changes made to avoid HIV	Yes	205	37.3	1	1
	No	315	37.2	0.9033 (.3884)	1.0309 (.8278)
Tell somebody if infected with HIV	Tell someone	608	35.7	1	1
	Keep it secret	217	42.2	1.1464 (.2118)	1.1289 (.3937)
Ever used a condom	Yes	354	39.1	1	1
	No	464	35.8	0.8844 (.2227)	0.9747 (.8680)
Gonorrhoea	Negative	744	37.1	1	1
	Positive	81	38.9	1.0646 (.6914)	1.0726 (.7390)
Chlamydia	Negative	723	36.9	1	1
	Positive	102	39.5	1.1996 (.2017)	1.1153 (.5666)
Syphilis (RPR)	Negative	712	36.2	1	1
	Positive	113	45.6	1.1913 (.2363)	1.2337 (.2887)

n = number of respondents **OR = unadjusted Odds Ratio**
aOR = adjusted Odds Ratio **P value = level of significance**
'Casual partners' refers to the number of casual sexual partners a respondent reported to have had in the last 12 months. 'Had casual partner' implies having had one or more casual partners. 'Condom use with casual partners' refers to having used a condom with casual sexual partners. 'Know somebody infected with HIV' indicates that the respondent knew somebody who was infected with HIV. 'Risk perception' refers to the respondent's perception of being at risk of getting infected with HIV. 'Changes made to avoid HIV' refers to changes to the behaviour in order to avoid getting infected with HIV. 'Tell somebody if infected with HIV' refers to the respondent's willingness to tell somebody if she got infected with HIV. 'Ever used a condom' refers to the respondent's earlier use of a male condom in her life. 'Gonorrhoea' refers to the result of the biomedical test for gonorrhoea performed on the urine sample of the respondent. 'Chlamydia' refers to the result of the biomedical test for chlamydia performed on the urine sample of the respondent.

From Table 32 it is clear that the behavioural variables did not have great predictive ability for the reported symptoms of STIs in women. In fact, only one of these factors, namely risk perception, proved to have an almost significant predictive value ($p=0.0527$). This variable was the self-reported chance of getting infected with HIV.

Very interestingly none of the STIs, as tested biomedically, had any influence over the self-reported symptoms of STIs. It would seem that respondents' experiences of symptoms of STIs and the actual testing of these STI were not related. It should be kept in mind that the testing was done at a specific point in time while the question on the experience of symptoms was asked over a period of one year.

The behavioural risk factors tested for in the surveys were not good predictors of the self-reported symptoms of STIs for women of Khutsong. This would mean that even if the desired behavioural changes could be made, it would not significantly decrease the prevalence levels of self-reported symptoms of STIs for women of Khutsong.

9.2 Risk factor analysis for Khutsong men

For men the same procedure as for women was followed, yet focusing only on the reported symptoms of STIs as discussed previously.

All the variables that were included in the behavioural analysis for men were entered into the model to test the risk factors of having self-reported symptoms of STDs in the last 12 months. This was done through a multi-variate analysis and produced an aOR (adjusted Odds Ratio). All the behavioural and biomedical indicators were also entered into the model one by one, while controlling for the independent variables, and this produced the OR (unadjusted Odds Ratio) value. From the previous analysis of the biomedical indicators transpired that the changes in prevalence of HIV among men in Khutsong did not change and therefore were not included in further analysis. Although men were infected outside of the time period studied and they were therefore also subjected to risk factors, this analysis was not included due to the fact that the focus of this study was on the changes in prevalence of HIV during the time period of the study and the risk factors associated with these changes. The risk factor analysis was done for those outcomes that had increased or decreased significantly during the previous analysis. The risk factor analysis in this study was done to test whether the significant trends that we saw in the analysis of the biomedical indicators were directly attributable to the trend, increase or decrease, we saw in the factors we hope had influenced it. Therefore, in men there was no detectable trend for HIV/AIDS during the study, and thus no analysis of could be done to see which factors could be attributable. A risk factor analysis for having had self-reported symptoms of STDs is included for men in this discussion below.

Respondents who indicated that they had made changes in their sexual behaviour to avoid HIV/AIDS were three times (roughly 33%) less likely to have reported symptoms of STDs. As can be seen in Table 33, the adjusted Odds Ratio for this variable was 0.3183.

Table 33 also shows the rest of the behavioural factors:

- Having used condoms with their casual sexual partners
- Knowing somebody who was infected with HIV
- Perceiving themselves to be at risk of getting infected with HIV
- Having made changes to the behaviour in order to avoid getting infected with HIV/AIDS
- Having used a male condom before

The latter behavioural factor showed no predictive ability for having self-reported symptoms of STDs, and the biomedical indicators did not have a significant predictive value for men who had self-reported STDs over the last year either.

As was found in respect of the women, even if the behavioural changes could be made, they would not necessarily affect the prevalence of self-reported STDs in Khutsong men.

Table 33 Risk factor analysis for reported symptoms of STIs in men from Khutsong

		n	% of reporting symptoms	OR (P value)	aOR (P value)
Condom use with casual partners	Never	367	27.9	1	1
	Used condoms	101	25.3	0.8052 (.1853)	0.6293 (.1120)
Know somebody infected with HIV	Do not know	360	26.6	1	1
	Know somebody	83	31.3	0.9535 (.8038)	1.0507 (.8613)
Risk perception	Low	124	28.6	1	1
	At risk	127	32.8	1.3173 (.1442)	1.3779 (.1335)
Changes made to avoid HIV	Yes	251	29.4	1	1
	No	214	25.3	0.8786 (.3495)	0.3183 **(.0222)**
Have used a condom	Yes	191	23.9	1	1
	No	170	21.4	0.7678 (.0592)	0.6228 (.0534)
Gonorrhoea	Negative	449	27.3	1	1
	Positive	19	28.8	1.2551 (.5239)	1.2070 (.6998)
Chlamydia	Negative	429	26.9	1	1
	Positive	39	33.1	1.5728 (.0554)	1.8797 (.0851)
Syphilis (RPR)	Negative	430	26.8	1	1
	Positive	38	34.2	1.5842 (.0960)	1.2661 (.5798)

n = number of respondents **OR = unadjusted Odds Ratio**
aOR = adjusted Odds Ratio **P value = significance**
'Condom use with casual partners' refers to having used a condom with casual sexual partners. 'Know somebody infected with HIV' indicates that the respondent knew somebody who was infected with HIV. 'Risk perception' refers to the respondent's perception of being at risk of getting infected with HIV. 'Changes made to avoid HIV' refers to changes to the behaviour in order to avoid getting infected with HIV. 'Ever used a condom' refers to the respondent's earlier use of a male condom in his life. 'Gonorrhoea' refers to the result of the biomedical test for gonorrhoea performed on the urine sample of the respondent. 'Chlamydia' refers to the result of the biomedical test for chlamydia performed on the urine sample of the respondent.

9.3 Risk factor analysis for mineworkers

The same procedure as for women and men from Khutsong was followed for the risk factor analysis for mineworkers. In the latter case, the HIV risk factor analysis was once again included (as for the Khutsong females), since the increase in HIV was significant in mineworkers as well. For mineworkers, a risk factor analysis was also performed for each of the following: chlamydia, syphilis and the self-reported symptoms of STDs. This was because all of these showed significant trends for mineworkers. However, the risk factor analyses for chlamydia and syphilis are not included in the tables below as once again none of the behavioural factors showed any predictive value for these STDs. The only significant risk factor was chlamydia, which was a significant risk factor for gonorrhoea and vice versa, as with the women from the residents of Khutsong. If a mineworker was infected with chlamydia, then he was 20 times more likely to be infected with gonorrhoea. The relationship between chlamydia and gonorrhoea cannot be described as causal, but it does seem that infection with the one is a very high risk factor for infection with the other.

All the variables that were included in the behavioural analysis and in the biomedical analysis for mineworkers were entered into the risk factor analysis model while controlling for the independent variables. This was done through the multi-variate analysis and produced an aOR (adjusted Odds Ratio) value. All the behavioural and biomedical indicators were also entered into the model one by one while controlling for the independent variables, and this produced the OR (unadjusted Odds Ratio) value.

When considering the HIV risk factor analysis in Table 34, three variables are found that were significant in the uni-variate analysis, but only one that was significant in the multi-variate analysis. The three variables that were significant in the uni-variate analysis for the risk of getting infected with HIV were whether the respondent knew somebody who was infected with HIV, whether the respondent would tell somebody if he got infected with HIV, and infection with gonorrhoea. In the multi-variate analysis, the only variable that showed a statistically significant value was gonorrhoea. It can thus be concluded that only gonorrhoea showed a significant trend of being a risk factor for HIV. Thus if a person was infected with gonorrhoea he/she was 2.3 times more likely to be infected with HIV as well. In terms of the objectives of this study, namely to find the risk factors for HIV infection, gonorrhoea can be seen as an important risk factor for infection with HIV in mineworkers.

It is clear from Table 35 that only two variables were significant as factors for reported STI symptoms in mineworkers. Both these variables were significant in the uni-variate and the multi-variate analysis. These variables enquired about the number of casual sexual partners and about what respondents felt their chances of getting infected with HIV were. Both variables showed quite a strong link with reported symptoms of STIs and could thus be good predictors. If a person has casual sexual partners, he/she has a 3.17 more likely chance of having self-reported symptoms for STIs. In the same way, if mineworkers thought that they had a good chance of being infected with HIV, they had a 1.56 more likely chance of having self-reported symptoms for STIs.

What is surprising from this risk factor analysis is that the other STIs were not significant predictors for symptoms of STIs. In other words, there does not seem to be a link between the STI tested for in the biomedical test and the reported symptoms of STIs. As the STIs tested for in the biomedical test are symptomatic, this is indeed surprising. It should be kept in mind once again that the self-reported symptoms of STIs enquired about the last 12 months, while the biomedical measures were determined at a certain point in time. The previous suggestion that the reduction in the levels of syphilis and the reduction in the levels of the reported symptoms of STIs might be linked, is also not confirmed by the risk factor analysis for symptoms of STIs, as there is no significant trend to support this suggestion.

Table 34 Risk factor analysis for HIV in mineworkers

		n	% of HIV+ in each category	OR (P value)	aOR (P value)
Condom use with casual partners	Used condoms	167	35.1	1	1
	Never used	756	30.2	1.1618 (.1759)	0.9582 (.8406)
Know somebody infected with HIV	Do not know	796	31.9	1	1
	Know somebody	81	26.0	0.7259 **(.0240)**	0.8403 (.4496)
Risk of being infected with HIV	No chance	337	31.6	1	1
	At risk	239	35.9	1.1183 (.3145)	1.1059 (.4950)
Changes made to avoid HIV	Yes	408	31.4	1	1
	No	513	30.7	1.0092 (.9163)	1.0276 (.8612)
Would you tell somebody if infected with HIV	Tell somebody	618	30.6	1	1
	Keep it secret	249	35.1	1.2014 **(.0497)**	1.2567 (.1477)
Ever used a condom	Yes	297	33.7	1	1
	No	362	30.0	0.9442 (.5750)	0.9077 (.5516)
Gonorrhoea	Negative	886	30.7	1	1
	Positive	37	37.4	1.5700 **(.0426)**	2.3388 **(.0244)**
Chlamydia	Negative	883	31.3	1	1
	Positive	40	25.2	0.7585 (.1593)	0.6589 (.2920)
Syphilis (RPR)	Negative	889	30.9	1	1
	Positive	34	32.4	1.2528 (.3063)	1.4755 (.3297)

n = number of respondents **OR = unadjusted Odds Ratio**
aOR = adjusted Odds Ratio **P value = significance**
'No chance' includes no and moderate chance of getting infected with HIV. 'Would you tell somebody' refers to whether the respondent would tell somebody if he was infected with HIV.

Table 35 Risk factor analysis on reported STI symptoms in mineworkers

		n	% reporting symptoms	OR (P value)		aOR (P value)	
Have had casual partners	No casual partners	127	14.5	1		1	
	Had casual partners	394	38.0	2.5809	**(.0000)**	3.1782	**(.0000)**
Condom use for casual partners	Used condoms	688	28.2	1		1	
	Never used condoms	163	31.6	1.2023	(.1376)	1.0291	(.8850)
Know somebody who is infected	Do not know	691	28.4	1		1	
	Know somebody	100	29.8	1.1432	(.4095)	1.2439	(.2722)
Risk of being infected with HIV	No chance	310	30.1	1		1	
	At risk	258	37.2	1.4411	**(.0033)**	1.5633	**(.0013)**
Changes made to avoid HIV	Yes	340	28.2	1		1	
	No	504	28.9	1.1808	(.1006)	1.0577	(.6998)
Would you tell somebody	Tell somebody	576	28.5	1		1	
	Keep it secret	199	29.0	0.9117	(.4314)	0.9275	(.6277)
Have used a condom	Yes	308	25.3	1		1	
	No	352	23.3	0.8606	(.1388)	0.8614	(.3450)
Gonorrhoea	Negative	805	28.5	1		1	
	Positive	46	34.6	1.4579	(.0795)	1.3338	(.3637)
Chlamydia	Negative	782	28.5	1		1	
	Positive	69	31.8	1.0600	(.7564)	1.2591	(.4042)
Syphilis (RPR)	Negative	807	25.8	1		1	
	Positive	44	33.6	0.9543	(.8384)	1.0996	(.7451)

n = number of respondents **OR = unadjusted Odds Ratio**
aOR = adjusted Odds Ratio **P value = significance**
'No chance' includes no and moderate chance of getting infected with HIV. 'Would you tell somebody' refers to whether the respondent would tell somebody if he was infected with HIV.

The association between HIV and gonorrhoea is quite strong and was expected. It is not clear why chlamydia and syphilis were not associated with HIV as well, as the p value of neither of these is close to showing significance. The sample that could be included for the risk factor analysis for HIV consisted of 932 HIV+ respondents, because it was possible to put all the respondents for all the surveys together for this analysis. This means that the power of analysis is strong and the lack of the links between the variables cannot be blamed on the lack of power in the analysis.

Values could once again not be calculated for the number of casual sexual partners as these data were missing for 1998 and the HIV data were missing in 2000.

9.4 In conclusion – about the risk factor analysis

Although the risk factor analysis did not produce factors that would clearly predict the outcome of HIV infection during the study and the outcome of reported symptoms of STIs, or the outcome of any other STDs; it is nevertheless important to look at the factors as they did indicate quite a number of significant behavioural changes in the population. One of the aims of the intervention was to change behaviour and thus it is encouraging that the significant change in the behaviour reported here was observed. Why the biomedical indicators did not reflect on these behavioural changes is not immediately clear.

The behavioural factors that showed a significant change seem to be almost the same for men and for women, with a few exceptions. Women have made more significant changes in their behaviour than men. What is also curious is that both men and women indicated that they had made some changes to their risk behaviour, but when questioned about changes that they had made to avoid HIV, there was no significant increase in the number of respondents who admitted to having made changes to avoid HIV.

10 Discussion

During the late 1980s and early 1990s HIV/AIDS became visible in Africa for the first time. From early on in the history of the pandemic it became clear that the disease was going to be very different to the epidemics that the rest of the developed world was facing. In Africa transmission of the disease seemed to be mostly heterosexual and spreading rapidly (Abdool-Karim, 2000). In view of this impending disaster, many of the world's scientists and relief agencies started working in Africa to try and curb the rapid spread that threatened to destroy years of painstaking progress in Africa.

The first huge efforts came in the form of trials to try and treat STDs and, in doing so, to halt the progress of HIV/AIDS due to the covariance or interdependence of STDs and HIV/AIDS. The first of these efforts was the trial in Mwanza. The research team in Mwanza found a strong protective effect against HIV if STDs were treated effectively (Grosskurth *et al.*, 1995a; Grosskurth *et al.*, 1995b). The world sat up and there was huge interest in the findings: the next step would be to try and eradicate the treatable STDs altogether. Hence the next big intervention was planned and the Rakai study tried to wipe STDs out by mass treatment with broad-spectrum drugs to target most STDs (Wawer *et al.*, 1998). However, it soon became apparent that this intervention did not result in a substantial decline in the rate of infection with HIV. The world of HIV/AIDS in Africa had become muddled once more. There were many theories and speculation as to why these trials produced such different results (Barnett & Whiteside, 2002; Gray *et al.*, 1999; Wawer *et al.*, 1999; WHO, 2000b). Simply blaming the difference in findings on "badly done" science was not a sufficient explanation (WHO, 2000b). The Masaka trial followed and at the onset of this study in Carletonville, the findings of the Masaka trial were not yet available. During the Carletonville intervention, it became clear that in the Masaka trial STD management did not show an impact on HIV/AIDS either (Grosskurth *et al.*, 2000; Kamali *et al.*, 2002).

The Carletonville intervention was designed to treat STDs, but in a much more ecological environment (taking into consideration the behavioural aspects and all the interdependent aspects) than had been done before. Only the trial in Masaka (described in the literature review above) included a behavioural component to interventions. The Masaka trial was done roughly at the same time as the Carletonville study. Attempts to change behaviour through peer education of high-risk groups, specifically mineworkers and commercial sex workers living in informal settlements next to the mine hostels, as well as the intensified distribution of condoms, were included in the Carletonville intervention. The introduction of mass treatment of STDs for these high-risk groups was added later. From early on it became clear that the residents of Khutsong township could not be excluded as the contact between the hostel residents and the residents of Khutsong was high and the prevalence measured among the residents of Khutsong was well above expectations. In fact, the levels of infection seen in the baseline surveys had previously been seen only in sex worker populations (Williams *et al.*, 2003). The Khutsong residents had to be part of the intervention as it would not succeed without strong interventions there as well.

10.1 Behavioural interventions

The behavioural change interventions were aimed at increasing condom use and promoting risk reduction strategies, such as reducing the number of casual sexual partners. The intervention focused on working with mineworkers, CSWs, as well as the youth in Khutsong. Peer educators were trained and they interacted with residents of all the areas and engaged in activities such as public meetings, where role playing and interactive processes were used to disseminate information.

The following behavioural markers were selected for this study to monitor behavioural change:

- Whether a condom was used on an ongoing basis with casual partners
- Whether the respondent knew somebody who was infected with HIV/AIDS
- whether the respondent felt that he/she had made any changes to avoid HIV/AIDS
- whether the respondent would tell anybody if he/she got infected with HIV/AIDS

- whether the respondent had ever used a condom in his/her life

All of these factors were included for a specific reason and to measure a specific outcome for which the intervention was designed.

10.1.1 Condom distribution

One of the four main aims of the project was to improve condom distribution and to saturate the greater Carletonville area with free condoms available from government agencies and the local Department of Health. To achieve this aim, the project team monitored the supply at all the existing distribution points like hospitals and clinics, as well as introduced new distribution points like bars, clubs and taxi ranks. They also supplied condoms to a youth initiative called the "Youth-friendly clinic" that had been established in Khutsong.

10.1.2 Knowing someone with AIDS

The literature review of this study revealed some studies that suggested that knowing someone who was infected with HIV/AIDS increased individuals' perception of their own risk and led to less risky sexual behaviour (AIDS Policy Law, 1996; Macintyre *et al.*, 2001).

10.2 STD treatment intervention

As one of the interventions in the Carletonville study, control of STDs were improved by treating STDs syndromically and attempting to increase the effectiveness of the treatment provided by all the health facilities in the area. It was hoped that this intervention would eradicate the STD disease burden and therefore lower HIV/AIDS prevalence due to the covariance of these diseases.

10.3 Summary of the findings for Khutsong female residents

The project aimed to change risky sexual behaviour of the residents of Khutsong and of the mine hostels, as well as of mineworkers and commercial sex workers living in squatter communities next to the mine hostels. The behavioural changes were measured through a number of indicators or dependent variables, namely:

- The number of casual sexual partners that respondents had in the last 12 months
- The respondents' perception of risk, which was measured by asking if they thought they were at risk of getting infected with HIV/AIDS
- Whether the respondents had changed their sexual behaviour to avoid the risk of getting infected with HIV
- The respondents' perceptions of stigma surrounding people infected with HIV
- Willingness to tell anybody if they got infected with HIV
- Whether they knew anybody who was infected with HIV/AIDS

The latter variable showed up in the literature to be of value as a deterrent for changing high-risk sexual practices. The effect of the distribution of condoms was measured by asking firstly if respondents had ever used a male condom, and secondly if they had used a condom with their casual sexual partners in the last 12 months.

The analysis of the results shows that, from the first survey in 1998 to the last survey in 2001, a behavioural change took place among women living in Khutsong. Over the period of the study, the women of Khutsong changed their sexual behaviour by reducing their number of casual sexual partners and using condoms more frequently. In later surveys, more female respondents also reported that they knew someone infected with HIV, more respondents experienced themselves to be at risk, more respondents would tell somebody if they were infected and more respondents had used a male condom. So, it can conclude that there were some important behavioural changes among the women of Khutsong over the period of the intervention.

Did these behavioural changes reduce the rate of infection with HIV or any STDs? No, they did not. On the contrary, over the period of the study the women of

Khutsong experienced rising rates of infection with HIV and all STDs, except syphilis.

From the above findings we have to conclude that the biomedical intervention involving intensified treatment of STDs and the behavioural change that we have seen did not reduce the rates of infection in the female sample of respondents in Khutsong. As far as these females were concerned, the behavioural intervention was successful on its own, but it did not translate into the reduction of HIV and other STD infections. In the same way, the biomedical interventions did not reduce the infection rates for STDs or HIV.

The impact of the intervention on the rates of infection with HIV and other STDs in the female sample of the residents of Khutsong was thus not successful. In time, the changes made in behaviour may have had an impact on the rates of infection. Not having used condoms proved to be a risk factor for HIV infection and condom use went up from around 6% to around 19% for women of Khutsong. For some individuals the impact might reduce their immediate risk, but on a public health level the changes in behaviour and the wider treatment of other STDs did not reduce the infection rates of HIV in the population.

It could well be expected that condom use would reduce the number of HIV infections. In this case the number of respondents who had used a condom in their lives increased, and this would reduce their risk. However, unless condoms were used consistently, the respondents' risk might be reduced but not eliminated and therefore HIV prevalence would still be increasing. Although the duration of the intervention and the measurement was short, only four years, there was no impact on the rates at all – despite the fact that an impact was expected, especially on the rates of STD infections. In terms of what the project set out to do with regards to STD control and HIV reduction, it was unsuccessful.

In the risk factor analysis for women in Khutsong the risk factors for HIV infection were studied. Respondents who used condoms and who were not infected with gonorrhoea were less likely to be infected with HIV. All other behavioural changes proved to be not predictors of HIV infection. The behavioural changes regarding condom use reduced their risk of becoming infected with HIV, but it did not eliminate such risk. Condom use also did not increase enough for it to have an impact on a public health level, as it was still less than 20% for females in Khutsong.

10.4 Summary of the findings for male residents of Khutsong

For the males of Khutsong the comparison of the samples also identified some changes. The high-risk sexual behaviour of men had changed to some extent over the period of the intervention. From 1998 to 2001 there was a decrease in the number of casual sexual partners that men had, their use of condoms increased, more participants knew somebody who was infected with HIV and more men would tell somebody if they were infected with HIV. The main difference between the male and the female samples was that more males initially indicated that their chances for getting infected with HIV were good. In other words, males had a higher risk perception than women, but this did not change for men while for women there was an increase in risk perception. More males than females also indicated that they had used a male condom in their lives.

As in the case of the females, the next step was to see if these changes in behaviour and intervention around the treatment of STDs had an impact on the rates of infection with HIV and other STDs in the sample of male residents of Khutsong.

It was interesting to note that for men the trends were different than for women of Khutsong. For men there was no increase in the infection rates of HIV and gonorrhoea. However, chlamydia had increased among the male sample, similar to what was the case for the female sample. Infection with syphilis was also the same as in the female sample and this was the only STD that had shown a decrease over the period of the intervention. These analyses seem to indicate a stable number of HIV infections for male residents of Khutsong. Even though this finding remained inconclusive, it seems possible that the interventions might have had an effect on HIV prevalence on a community level. None of the indicators and behaviour measured in this study could adequately explain the reason for this difference in infection rates between women of Khutsong and men of Khutsong, as well as between the mineworkers and men of Khutsong, as all the significant changes in the behaviour of men from Khutsong were mirrored by the women of Khutsong.

10.5 Summary of the findings for mineworkers

The mineworker respondents also displayed changes in behaviour. Over the period of the study, hostel residents at the mines reduced their number of casual sexual partners and increased their condom use with such partners. For mineworkers there was an increase in the prevalence of HIV. Not using condoms did however not seem to be a risk factor for HIV infection and it could be that the condom use of respondents from the mines did change, but it was not consistent enough or there were not enough of the mineworkers who had made these changes for the changes to have any effect on the infection rates. The number of mineworkers who indicated that they used condoms with casual partners increased, but the figure remained below 20%.

What was very interesting in respect of mineworkers was that there was a reduction in their risk perception. In 2001 more of them indicated that they were not at risk of becoming infected with HIV compared to the earlier surveys and they indicated that they had changed their behaviour in order to avoid becoming infected with HIV. In terms of the impact of the intervention, changing behaviour to avoid getting infected with HIV/AIDS was one of the aims of the intervention. The fact that there was change thus indicates possible success of this intervention.

However, despite mineworkers indicating that they had made changes to avoid infection with HIV/AIDS, there was a higher prevalence of HIV in this group and they were therefore still at very high risk of being infected with HIV. Their perception that they were less at risk might not have been realistic. This will of course depend on the type of changes they had made and the surveys were not able to answer this question. For instance, if mineworkers were using condoms consistently, then they would be less at risk, but if they simply cut down on the number of causal partners, it would not have a big impact. Prevalence of HIV infection among their potential casual sexual partners was high and therefore the probability of infection from such partners would remain high. The results of the analyses show that there was both a reduction in the number of casual sexual partners and an increase in condom use in the mineworker samples. In contrast, men and women from Khutsong saw themselves to be at greater risk of infection with HIV and nevertheless did not make changes to avoid HIV.

More mineworkers had used condoms by the end of the study than at the onset. The intervention involving condom distribution among the mineworker residents seemed to have been successful and in terms of the earlier discussion on risk perception and the changes made in behaviour, this seems to be an important finding. More mineworkers having used condoms could indicate less risky behaviour by this group.

Once again, as was the case in the sample from the female residents of Khutsong, we can see that there was some reduction in risk behaviour of the mineworker sample. However, what then needed to be established again, was if these changes actually translated into reduced rates of infection for the mineworkers.

The prevalence of HIV and chlamydia increased, while the prevalence of active syphilis infection, as well as the number of self-reported symptoms of STDs decreased. Furthermore, the prevalence of gonorrhoea among the mineworkers did not increase. It would thus seem that STD control through the interventions aimed at the mineworkers was only partly successful.

Even though behaviour had changed and the treatment of other STDs had improved, HIV prevalence in the mineworker sample did not show any signs of declining. However, towards the end of the study there was a reduction in all of the other STDs observed, and this could well be attributed to the PPT intervention. It was nevertheless difficult to make assumptions based on only two data points.

In the risk factor analyses, the findings for both mineworkers and the female residents of Khutsong were the same in respect of the fact that HIV infection had increased. Gonorrhoea was the only risk factor that could be identified in the analysis for mineworkers. In other words, if a mineworker was infected with gonorrhoea, he was more likely to be infected with HIV as well. These two infections seemed to co-vary and there is a strong association between them. As in the case of the women from

Khutsong, behavioural factors did show a positive change, but the risk of getting infected with HIV for mineworkers nevertheless increased.

10.6 In summary about the findings

In the linear regression analyses done for the three groups we saw substantial changes in risky behaviour among all three groups. Not all groups changed their behaviour in the same way, but all three had made changes.

10.6.1 Behavioural changes

In the analysis of the data above it was clear that there was substantial behavioural change among the respondents. Female residents of Khutsong had used condoms with casual sexual partners more often; they had fewer casual sexual partners; and more women had used condoms in the later surveys than in 1998. Their risk behaviour thus declined during the course of the intervention. Male residents of Khutsong also reduced their number of casual sexual partners, and increasingly used condoms with these casual partners during the period of the intervention. Mineworkers too had fewer casual sexual partners and more of them had used condoms with these casual sexual partners during the course of the intervention. If the outcome of the intervention with regard to behavioural change was a visible reduction in the risk behaviour of the respondents, then it can be considered a success. It would also mean a smaller number of concurrent partners and this is a successful outcome of the intervention.

Of course, it would not be possible to isolate the information or increase in knowledge of the people from this area to measure the effect that peer education had. The research team therefore analysed the answers to the following questions to determine what knowledge and information the people of this area had regarding HIV/AIDS:

- How many casual sexual partners did you have in the last 12 months?
- What are your personal risks, in other words, what do you consider your chances of being infected with HIV?
- Have you changed your behaviour to avoid getting infected with HIV?

- Would you tell anybody if you were infected with HIV?

The latter question was asked to test the shift in attitudes towards people who are infected with HIV/AIDS and the stigma attached to this disease.

From the analysis for women, it could be noticed that women from Khutsong decreased their number of casual sexual partners. Their personal perception of risk increased as more women indicated that they considered themselves at risk of getting infected with HIV during the course of the intervention. The number of women who eventually indicated that they had changed their behaviour to avoid getting infected with HIV consequently increased. It is clear that female respondents from Khutsong had changed their behaviour towards less risky behaviour, even if they themselves did not seriously consider that to be the case. Once again the intervention alone cannot be credited with this impact as there could have been many other influences. Nevertheless, it is assumed that the intervention was successful as there was a decrease in risk-taking behaviour in Khutsong by females over the course of the intervention.

The analysis of men from Khutsong revealed that men also reduced their number of casual partners. In addition, their risk perception also improved slightly, but they did not feel that they had made changes to their sexual behaviour to avoid getting infected with HIV. As in the case of female residents from Khutsong, it would seem that there were trends to reduce risky behaviour. Men seemed to be taking fewer sexual risks, which cannot, of course, be attributed to the intervention alone, but it would suggest that the intervention was relatively successful in this regard.

Mineworkers also reported a decrease in the number of casual sexual partners and indicated that they had made changes to avoid HIV, thus reducing their chances of getting infected with HIV. There was consequently a decrease in their risk perception as fewer mineworkers considered themselves at risk of infection with HIV towards the end of the study than at the beginning. This finding is in stark contrast to the men and women of Khutsong where the personal risk perception of both groups showed an increase as more males and females indicated that they considered themselves to be at risk of infection with HIV. Among mineworkers there was a reduction in the number of reported casual partners and an increase in condom use, but the relative risk of mineworkers to be infected, in the light of the increasing prevalence of HIV/AIDS in females and mineworkers themselves, had not decreased and mineworkers would increasingly be at greater risk due to this fact. The intervention therefore did not succeed in creating a greater awareness of personal risk in mineworkers as they considered themselves less at risk of getting infected with HIV.

Overall, it would seem that in this area the information regarding safe sexual practices and the risk perception of respondents in Khutsong had increased. Peer education was offered at all the high-risk hotspot communities, among the youth in Khutsong and among mineworkers. Even though all the decrease in high-risk behaviour that we observed here cannot be attributed directly to the interventions, there was nevertheless a behavioural change in this area. There even seemed to be a reduction in the stigma as far as HIV/AIDS is concerned as both men and women from Khutsong indicated that they would tell somebody if they were infected with HIV.

Among mineworkers there seemed to greater reluctance to tell somebody about their HIV status and a further analysis showed that they would specifically be very reluctant to tell their employer. At this point there was still no anti-retroviral therapy available, but the mine health services did offer treatment and advice to those infected with HIV. Men working in the mines were more aware of the possible negative outcome if they revealed their status. They obviously feared that it might influence their future working relationship and possible employment status. Often, in conversations with staff of the project team, mineworkers expressed their concern that they would no longer be employed if the mine management should become aware of their HIV+ status.

In the analysis, data regarding condom use were also studied. In response to the question if the respondent had used a condom with his/her last casual sexual partner in the last 12 months, both male and female residents of Khutsong reported a substantial increase in the use of condoms.

On the issue of condom use of mineworkers, the research team observed that the number of respondents who indicated that they had used condoms with their last casual sexual partner in the last 12 months increased from 10% in 1997 to 24% in

2000 and then decreased again to 17% in 2001. Overall, the percentage of mineworkers who used condoms with their last casual sexual partner in the last 12 months had increased.

Another question in the surveys that dealt with condom use enquired if the respondent had ever used a condom in his/her life. Over the period of the study the percentage of women who used condoms increased from 30% to 40%. In 2001 a larger number of mineworkers than in 1997 also indicated that they had used condoms before.

Overall, it would thus suggest a successful intervention in so far as the increase in condom use was concerned. The increased distribution and supply could well have been responsible for the increase in use of condoms. Of course this needs to be considered in the light of the other interventions occurring in Khutsong and in the rest of the country as a whole, as people were becoming more aware of the dangers of HIV/AIDS. In this intervention there were also peer education activities that reminded people of and educated them on the use of condoms. However, none of the efforts to increase condom use would have been possible if there were no condoms available and therefore we can conclude that the project mainly succeeded in its aim because condoms were made more widely available.

This study shows that for men and women from Khutsong there had been an increase in the number of people who indicated that they knew somebody who was infected with HIV. For men this figure increased from 8% in 1998 to 19% in 2001 and for women from 9% to 17%. For mineworkers there was an increase as well, but a decline again from 2000 to 2001. However, there was still an overall increase in their admission of knowledge of HIV cases over the time of the study.

It would thus seem that all three groups admitted to knowing an increasing number of people who were infected with HIV. This is hardly surprising in the light of the high HIV prevalence figures in the greater Carletonville area. When tested if this knowledge was a predictor for HIV infection, it was found not be the case, and neither was it a predictor for infection with any of the STDs. In their literature study Camlin and Chimbwete (2003) could not find any correlation between condom use and whether the respondent knew someone infected with HIV either. The current study also shows that there was no indication that knowing someone infected with HIV would reduce risk behaviour in respondents.

10.6.2 STD interventions

None of the interventions aimed at other STDs or behavioural change had any impact on the rate of infection with HIV. In fact, the analysis above showed that the prevalence of HIV increased in the female residents of Khutsong over the four years of the intervention. Among mineworkers there was also a substantial increase in the prevalence of HIV. In view of the intensive intervention as far as STDs were concerned and the efforts put into this intervention, it was disappointing that it had no reducing effect on HIV infection rates, which kept on growing. In fact, the impact of the intervention on the prevalence of STDs was also questioned. Among the Khutsong women, the prevalence of all STDs except for syphilis increased. Syphilis had a low rate of infection and was therefore not so important in this study, despite the fact that it had decreased in male and female residents of Khutsong. It can therefore be concluded that the intervention did not have the desired effect on the prevalence of HIV, but in the same vein it did not have the desired effect even on the prevalence of STDs either. One could argue that this was due to the fact that STDs are common in high-risk groups, and that the high-risk behaviour of these groups would keep exposing them to STD infection. Such high-risk behaviour might even increase their risk of infections with STDs if they became infected with HIV, as HIV infection would immediately reduce their general resistance.

The Preventative Periodic Treatment intervention may have started to have an effect on the mineworkers. A decline was noted in the infection rates of all STDs in the year 2001 after the PPT had been introduced at the beginning of 2000. The measurements are however too close to each other and the time interval not long enough to make valid conclusions on this decline and apparent trend.

During the lifespan of the Carletonville intervention, speculation on and discussion of the results of the earlier trials on STD control in Africa continued. Several theories were discussed in the literature review of this study. One of the most important explanations for these differences came from Hitchcock and Fransen (1999), who focused on the different stages of the epidemic in the population where the interventions were introduced. It would seem that in Carletonville the epidemic had moved well into the latter stages and was not in Stage 1 any longer. Therefore the local study seems to confirm that the stage of the epidemic had an important influence on the ability of STD control to reduce infection with HIV.

According to the theory above, STD treatment is very effective at reducing HIV infections if the epidemic is in the first stage. In this stage, high-risk individuals who are exposed to STDs on a regular basis carry the epidemic and the treatment of STDs in this group has a huge effect on the spread of HIV. Then the epidemic slowly moves into the next phase where groups who would generally be considered to have a low risk of infection with HIV, for instance married couples, are being infected. People who have been infected with HIV remain infectious and keep on spreading the disease, in contrast to other STDs which are cured and do not spread too far beyond the borders of high-risk groups. A good example of this difference in infection patterns is Herpes Simplex Virus 2 (HSV2), which follows this same pattern of infection as HIV although it is in most cases not life threatening. HSV2 is also a viral infection like HIV and therefore the virus never leaves the body again and cannot be removed from the body. Since treatment for HSV2 mainly involves the repression of symptom, there were high levels of HSV2 in Khutsong (Auvert *et al.*, 2001). HIV is spread by people in low-risk situations in Stage 2 of the epidemic. It keeps on spreading because of the frequency of sex in low-risk groups, like married couples, where one of the partners is infected and due to the frequency of sex the other partner will be infected in time. At this stage it does not help to treat the STDs to reduce infection with HIV anymore, as the population in which HIV is now spreading is not at high risk of STDs anyway. At this stage the background disease burden is such that the treatment of STDs is no longer really effective in preventing the spread of HIV.

Considering the prevalence rates of HIV in the greater Carletonville area (including the mineworkers), it can be concluded that the epidemic in Carletonville was definitely in Stage 2. For women in Khutsong the average prevalence of HIV increased from 37% in 1998 to 45% in 2001. For mineworkers the average prevalence increased from 22% in 1997 to 36% in 2001, while for men in Khutsong HIV prevalence did not increase but remained high at around 20%.

10.7 Impact of the intervention

The research question on which this study was based, was: What was the impact of the intervention on the rates of infection? The data were analysed to answer this question, and the behavioural components of the study were analysed first. From this analysis it was clear that a substantial behavioural change occurred, as has been described above. The second analysis, involving the biomedical factors, showed that these factors indicated change in STD prevalence and HIV prevalence, but the rates increased instead of decreased. In other words, the intervention did not have the intended impact on the rates of infection with HIV or STDs.

The impact of the study on the behaviour of residents from Khutsong and the mineworkers seems to be clear. Some substantial behavioural changes did take place. These changes, however, did not translate into reduced infection rates.

In discussions on the study with other scientists, many of them suggested that the lifetime of the intervention was too short to see an effect of the intervention on rates of HIV infection anyway. Prevalence rates change slowly and even successful interventions would need a considerable time before showing any impact on the prevalence rates of HIV. This study was obviously too short to see this kind of change, and no impact could be seen on the STD prevalence measured either. Measuring the incidence of STDs is often used to give early indications of changing levels of HIV infection in a community due to the fact that changes in HIV prevalence occur so slowly. However, there was not even a slowdown in incidence if we consider that for female residents of Khutsong and mineworkers the prevalence of HIV increased substantially. For men in Khutsong the null hypothesis could not be rejected either, as it was not possible to say that there had been change in the rates of infection with HIV for men in Khutsong. The sample was not big enough to detect the size of the change in the male sample; the prevalence would have had to change more than 7% for it to be detectable by this sample.

To measure incidence, or the number of new cases per year, would have produced a better indication of the effect of the interventions. In this study that was clearly not possible. The study was based on cross-sectional surveys and not on cohort data. There was thus no way of telling whether the individuals who made up the prevalence in the first survey were the same individuals that made up the prevalence in subsequent surveys or if they were new infections. To this end randomised controlled trials are much better instruments for isolating variables and measuring incidence. It was however not possible to create a control group for this study.

The fact that there were substantial behavioural changes among the residents of Khutsong on a number of indicators (as mentioned above) would only have an effect if these indicators and behavioural change had a drastic impact on the progression of HIV/AIDS. It would thus seem that, due to the stage of the epidemic among the residents of Khutsong and the mineworkers at the time of the interventions, even substantial behavioural change was not enough to slow down the number of HIV or even STD infections. The transmission rates are thus not reduced enough by the behavioural changes made by these individuals to have an impact on the progression of the disease.

On an individual level, behavioural change may of course have meaningful outcomes. If an individual should decide to abstain or consistently use condoms, that would reduce (if not totally eliminate) his/her risk of HIV infection, but on a public health level a critical number of people living in the community would have to adhere to this kind of behavioural change for it to show any impact. Even though behavioural change has been substantial, not nearly enough individuals have totally eliminated or reduced their risk by a big enough margin for it to show an effect on prevalence in the community.

It stands to reason that the effect of the interventions in a community where the disease burden is so high, also needs to be high to stem the tide. STD treatment and behavioural change in this intervention were obviously not sufficient. The Odds Ratio for any intervention that is going to be effective must be high. Transmission needs to be cut by at least 7 or 8 times before one would be able to see an effect on

HIV prevalence. The Odds Ratio would thus have to be at least 7 or 8 for the interventions to have any impact in view of the huge disease burden. There would have to be very substantial and drastic changes in the community to have any impact on the risk of the individual to be infected. In other words, the disease is so widespread and the prevalence so high that the risk of any individual to become infected is very high. Any intervention needs to make very drastic impacts before it will be noticeable at the population level.

According to the analysis of the biomedical indicators, the stage of the epidemic in Khutsong also seems to have had an influence on the impact of the interventions. As was discussed above, STD interventions usually seem to be the most effective in a Stage 1 epidemic. It was concluded that the epidemic in Carletonville had definitely moved from Stage 1 to a Stage 2 epidemic, and various studies (Gray *et al.*, 1999; Hitchcock & Fransen, 1999) indicate that during Stage 2 epidemics STD management no longer has such a profound effect on HIV prevalence.

(Gray *et al.*, 1999; Hitchcock & Fransen, 1999) point out that STDs increase the shedding of HIV cells in the HIV-positive person, which drastically increases his/her infectiousness. In other words, the rate of transmission of the virus is quite low, but in the presence of another STD this situation changes dramatically and the person is a lot more infectious. An HIV-negative person is also at a greater risk of infection if he/she has an STD, because open lesions and susceptible cells increase in the membranes that are in contact with the infected partner. There is a strong impact of STDs on the transmission of HIV because both infectiousness and susceptibility are increased. People who have a large number of partners have fewer sex acts with each individual partner. They are, however, more likely to have STDs and so their risk of infection is increased. The control of the STDs will therefore reduce this risk (Hitchcock & Fransen, 1999).

During a Stage 1 epidemic, HIV prevalence is relatively low, at around 4%, and people with many partners are mostly the ones who are infected. This means that STD control is very effective at preventing the spread of HIV because it seems that STDs are driving the epidemic during this stage (Hitchcock & Fransen, 1999). The picture changes however when we move to a Stage 2 epidemic.

During Stage 2 of the epidemic the virus moves beyond the highly susceptible members of the population (those with many sexual partners) to the less susceptible members of the population (those with few sexual partners). During Stage 2 HIV prevalence is high and people with only one or a few sexual partners, who would normally not be at risk, are now at risk. This is because the frequency of sexual acts between these less susceptible people is a lot higher and sooner or later infection takes place. Removing the STDs in this Stage is not effective because the frequency and regularity of sex between partners ensure that transmission of the HI virus will eventually take place. Therefore – once the epidemic has moved beyond Stage 1, interventions to reduce infection with HIV by treating STDs will have little impact on the epidemic (Hitchcock & Fransen, 1999).

The epidemic seems to have moved from Stage 1 to Stage 2 in the population in the Carletonville study. The studies quoted here were published during the Carletonville study and the contribution of the Carletonville study in this regard clearly seems to confirm the arguments quoted. The impact of the intervention on the prevalence of HIV and STDs was not successful.

It is clear that this intervention was designed and implemented to reduce the incidence and prevalence of HIV through the control and reduction of STDs and through behavioural change facilitated by peer education and condom distribution. The impact of the intervention on the prevalence of HIV and STDs was not successful and this may have been due to the stage of the epidemic as well as the short duration of the intervention. The impact of the behavioural changes was not successful in reducing HIV prevalence either. Even though there were behavioural changes and a reduction of risk, it seems to be a case of "too little, too late" and the extent of the behavioural changes would have had to be much greater for them to result in a reduction in infection rates.

This study did not yield the type of results that it was designed to achieve. In many ways it showed that the strategies implemented were not successful in reducing the prevalence of HIV. The intervention seemed to have caused some positive behavioural changes, but these changes would have to be much greater before they would have any public health impact. The study nevertheless carried forward the debates around HIV/AIDS interventions and added to the body of knowledge – even though its main contribution seems to have been to establish that this kind of ecological interventions were not really successful in reducing rates of infection in a Stage 2 epidemic.

The impact of the intervention on the infection rates was minimal. It can therefore be concluded that there were many factors that influenced such outcome, and some of the explanations offered in literature seem plausible for explaining the lack of definitive findings for this study.

Some of the limitations of the study were that it was not a randomised controlled trial and causality is thereof very difficult to establish. It was not possible to isolate the variables being studied. The study did not enrol cohorts of participants and the data was derived from cross sectional surveys only, with all of the limitations such a design brought about.

Studying the number of new infections with HIV could have been a better way to detect an impact of the interventions. However with a cumulative prevalence measure like with HIV prevalence this is obviously not possible in cross sectional studies. For the rest of the STIs included in this study the prevalence is not necessarily cumulative and these would therefore also be deemed to be better indicators of changes in sexual behaviour and infection patterns. The findings of the STIs is not that clear in this study, but the interventions did not seem to have had a large impact on these either.

It was not possible to have a control group in this study and this made the findings about changes observed in the community not directly attributable to the interventions. However, the aim of this analysis was simply to track the changes in the presence of a community intervention to see what the progression of the disease was during such an intervention.

11 And finally…

The fight against the most widespread and most lethal pandemic to be experienced by humankind will continue. At this stage some progress is being made. There are studies that have shown positive results with regard to creating a vaccine (Joseph *et al.*, 2005), although at the present moment none is available yet and trials are still being conducted (Walker *et al.*, 2005). There is progress, however, on the microbicides front. These are usually available in the form of gels and creams to be used by women internally to protect against infection with HIV/AIDS. Some of these trials have suffered setbacks, as certain microbicides did not pass the safety phases of trials (Van Damme *et al.*, 2002). Work continues, however, and more recently progress has been made, but it seems that the research into microbicides is slow and it will not be available for some time to come (AIDS Alert, 2004; Brown, 2004). Further studies investigated other female barrier methods as well, where diaphragms were used together with gels (Guest *et al.*, 2006). The outcomes of these studies are still being awaited.

More recently a trial for investigating the protective effects of safe male circumcision was completed in Orange Farm. The trial was stopped before its scheduled conclusion by the Data Safety and Management Board (DSMB) that oversaw the trial, due to the strong protective effect of 60% protection shown by male circumcision. It was no longer ethical to delay safe male circumcision for males (Auvert *et al.*, 2005). This trial is seen as a breakthrough for prevention strategies.

It seems unlikely at this stage that there will be a so-called "magic bullet" in the fight against HIV/AIDS. It seems rather that painful step by painful step more and more interventions and therapies will become available and will be combined into a multi-disciplinary strategy to fight this threat to mankind, but specifically to the poor living in Africa. It should also be kept in mind that even if very effective interventions are found, interventions have always been difficult to implement in resource-poor environments like sub-Saharan Africa. Finding interventions that can prevent or treat is important, but research around how to implement such strategies would be critical to their success (Coovadia & Hadingham, 2005). The implementation process would depend on strong leadership and guidance from the government as well (Mohiddin & Johnston, 2006), and this has been particularly problematic in the South African context in recent years.

HIV/AIDS has already had a huge impact on the poor nations of the world and of the Third World and this situation is set to continue until such time as science can provide better answers to and assistance in the fight against this pandemic. More studies like this one is required to build our database of knowledge about the disease and, in doing so, to enlarge our capacity to deal with and treat those infected, as well as prevent more infections.

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