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# **Changing patterns of knowledge, reported behaviour and sexually transmitted infections in a South African gold mining community**

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## **ABSTRACT**

**Background:** In 1998, a major HIV intervention project was started in a mining community in Carletonville, South Africa. This included community-based peer education, condom distribution, syndromic management of sexually transmitted infections (STI), and presumptive STI treatment for sex workers.

**Objectives:** To investigate changes in sexual behaviour and the prevalence of STI before and 2 years after the start of the HIV prevention programme.

**Methods:** Cross-sectional surveys were carried out in 1998 and 2000 among mine-workers, sex workers and adults in the community. Demographic and behavioural factors were recorded and participants were tested for syphilis, gonorrhoea and chlamydial infection and, at the start of the intervention, for HIV.

**Results:** In 1998, the prevalence of HIV among men and women in the general population, mineworkers, and sex workers, was 20%, 37%, 29% and 69%, respectively. In 2000, syphilis, gonorrhoea and chlamydial infection had increased among mineworkers; chlamydial infection had increased among men and women, and syphilis had increased among women. There was evidence of positive behaviour change but this was not substantial or universal. Knowledge of HIV/AIDS and awareness of the epidemic were high but condom use remained low.

**Conclusion:** There was little evidence of significant behaviour change and the prevalence of curable STI increased. The prevention programme had had less impact than expected. Reasons for the reduced impact, and the lessons for future intervention projects are discussed. There is a need for further monitoring of the HIV epidemic especially as its impact increases.

## INTRODUCTION

At the end of 2001, an estimated 40 million people were living with HIV/AIDS, 28 million in sub-Saharan Africa alone [1]. The epidemic of HIV reached South Africa relatively recently but spread rapidly; the prevalence among women attending antenatal clinics increased from less than 1% in 1990 to 24% in 2000.

Antiretroviral drugs are not generally available in developing countries and the prevention of HIV infection relies predominantly on behaviour change and educational programmes. It is important to understand the response of individuals and communities to attempts to control sexually transmitted infections (STI) and to change behaviour.

The present study was carried out in Carletonville, South Africa, the biggest gold-mining complex in the world. Detailed investigations of the prevalence of disease and behavioural factors and their association with HIV infection in Carletonville have been published elsewhere [2,3]; here data from two surveys, carried out in August 1998 and in October 2000, are used to examine the extent to which various biomedical, behavioural and social risk factors for HIV infection changed over a 2 year period when a major HIV intervention programme was introduced.

## METHODS

### Setting

Carletonville with its large gold-mining complex was chosen as the site for a major intervention programme to control the spread of HIV [4]. In Gauteng, the province within which Carletonville falls, the prevalence of HIV infection among women attending antenatal clinics increased from 22.5% ( $\pm 2.7\%$ ) in October 1998 to 29.4% ( $\pm 1.8\%$ ) in October 2000 [5,6]. In a survey conducted in 1999 among young adults between 15 and 25 years of age living in Khutsong, the

township adjacent to Carletonville, the prevalence of HIV infection among 24-year-old women reached 67% [95% confidence limit (CI), 56-77] and that of herpes simplex II 94.3% (95% CI, 88-100) [\[2\]](#).

For this study, the population of the district was stratified into the general population (about 125 000 adults) living in Khutsong, about 12 km northwest of Carletonville town, mine workers (about 70 000 men) living in 12 single-sex mine hostels to the south of Carletonville and commercial sex workers (about 1500 women) living in informal settlements, locally known as 'hotspots', close to the mine hostels.

### Intervention

In February 1998, Mothusimpilo ('working-together- for-health'), a community based intervention to control the spread of HIV and STI, was started. The intervention included recruiting and training peer educators from among sex workers, mine workers and youth in the area, distributing condoms and training health service providers in syndromic management of STI [\[4,7\]](#). Monthly periodic presumptive treatment for curable STI among sex workers started in February 2000.

During the course of the project, 89 women at high risk were trained as peer educators by the project and eight of these were trained as group leaders. Two mining houses in Carletonville recruited and trained 185 peer educators. An insurance company in South Africa had started peer education among school children in Khutsong in 1996 but many had since left school. Mothusimpilo provided further training for young people and had trained 51 peer educators in the two high schools in Khutsong by December 1999. Implementation of a peer education programme was left up to each school but discussed with them. Seventeen unemployed young people who had left school were also trained as peer educators. Condoms were provided free by the Department of Health and were distributed by peer educators and through local clinics.

The South African Institute for Medical Research (SAIMR) provided training in the syndromic management of STI. Over 3 days, nurses were trained to examine patients for STI and in the use of syndromic management flowcharts, while information, education and communication were stressed. After returning to their place of work, the nurses examined patients with an STI for 10 days under the supervision of a mentor trained by the SAIMR. By the end of the year 2000, 100 of the 145 nurses in the area had been trained. Doctors and senior nursing sisters in the district were offered a programme of continuing medical education run jointly by the SAIMR and the Mothusimpilo staff, and this was taken up by 57 out of 68 registered general practitioners and 80 senior nursing sisters. STI treatment, including drugs, is free in the public sector and on the mines. Sixty-one of an estimated 200 traditional healers were trained in the management of STI and HIV/AIDS, partner notification, syndromic management and counselling. About 30 actively supported the programme and provided counselling, issued condoms and partner notification slips, and referred patients presenting with symptoms to local medical services. The cost of the intervention was about US\$150 000 per year or US\$0.73 per year per adult.

Finally, a periodic presumptive treatment programme for commercial sex workers was started in February 2000, 9 months before the second survey. A programme in a similar setting had reported a dramatic reduction in STI among sex workers and mineworkers [\[8\]](#) and it was felt that a similar programme should be offered to women at high risk in Carletonville. Two fully staffed and equipped mobile clinics made monthly visits to all the major sites where mine workers go for commercial sex. Women who presented with an STI syndrome were treated; those who did not were offered directly observed presumptive treatment with 1 g azithromycin, which is effective against *Neisseria gonorrhoeae* and *Chlamydia trachomatis* infections and early syphilis. By the end of the year 2000, about 1200 women had been enrolled in the periodic presumptive treatment programme.

## Surveys

The first survey, carried out in August 1998, has been described in detail elsewhere [3] and the same sampling methodology was used in the second survey carried out in October 2000. Briefly, a cluster sampling technique was used to select houses randomly from areas stratified by housing type. In Khutsong, all men and women aged 14 to 49 years who slept in each house on the previous night were eligible for inclusion. A random sample of miners, stratified by hostels, was taken, as well as a small convenience sample of sex workers. Those who agreed to participate were transported to a nearby facility for interviews and the collection of blood samples.

## Questionnaires

A questionnaire developed by UNAIDS [9] was adapted, where necessary, to the local situation and to the three groups of people: miners, adults in the township and commercial sex workers. Participants were asked in their own language if they wished to take part and, if so, to sign the consent form. Trained interviewers completed the questionnaire during a private interview in the first language of the interviewees. Data were collected on background and behavioural characteristics, knowledge of and attitudes towards HIV as well as medical and sexual histories. Regular sexual partnerships, included those who were married or living as married, were treated separately from casual partnerships. Detailed information was collected about the last non-spousal sexual partner. In the year 2000, questions about sources of information about HIV and questions about reasons for using or not using condoms were included.

## Biological tests

A qualified nursing sister drew venous blood and participants delivered approximately 10 ml of first-flow urine. These were transported overnight to SAIMR Johannesburg, where they were stored at -70°C and where all tests were done. A single Capillus HIV-1/ HIV-2 latex aggregation test (Cambridge Biotech,

Galway, Ireland; sensitivity and specificity . 99.9% and. 99.6%, respectively) was used to test for HIV infection. Syphilis antibodies were detected using a rapid plasma reagin test (Immutrep-Carbon Antigen; Omega Diagnostics, Alloa, Scotland) but only those that were confirmed with a treponema antigen test (Cellognost Syphilis H; Dade Behring, Marburg, Germany) were regarded as positive. DNA sequences specific for *N. gonorrhoeae* and *C. trachomatis* were detected in the urine samples by using a ligase chain reaction (Abbott Laboratories, North Chicago, Illinois, USA; *N. gonorrhoeae* sensitivity 94.9%, specificity 99.0%; *C. trachomatis* sensitivity 89.7%, specificity 93.5%). STI treatment was offered to all participants found to be infected with a curable STI; once this had been done, names and address were removed and blood samples were tested for HIV. All participants were offered a separate HIV test with pre- and post-test counselling, to be arranged through the normal clinic channels, if they wished to know their HIV status, but no one took advantage of this.

#### Data management

Laboratory results and questionnaire data were entered twice into a database (Microsoft Access) by different people. The entries were compared, discrepancies were corrected and the data were checked for inconsistencies. SPSS 8.0 (SPSS, Chicago, Illinois, USA) and SAS version 6.12 (SAS Institute, Cary, North Carolina, USA) were used for statistical analysis.

#### Statistical methods

People were grouped into three categories by age: 15 to 24 years, 25 to 39 years, and > 40 years. For variables that depend directly on sexual behaviour, only those who reported ever having had penetrative sexual intercourse were included and are referred to below as 'sexually active'.

Logistic regression was used to determine which factors had changed significantly between the two surveys. Associations between the dates of the surveys (1998 or 2000) and other factors were explored after adjusting for

background factors including age, place of residence and education that might explain some of the observed changes.

Ethical approval was obtained from the Committee for Research on Human Subjects of the University of Witwatersrand, Johannesburg, on 10 March 1997 (Protocol number M 970235).

#### Validation study

Following the year 2000 survey, a validation study of reported sexual behaviour was undertaken in January 2001 among 452 individuals randomly selected from the participants. People were again asked their age at first sex and their lifetime number of sexual partners at the time of the survey. Interviews were done over an intercom system so that the interviewer and the interviewees did not come face-to-face. Statistical comparisons were made using the Wilcoxon matched-pairs signed-ranks test. Strictly, this only established the consistency of the answers but it did provide some confidence in their reliability.

## RESULTS

#### HIV prevalence

In 1998, 28.6% of mineworkers, 68.6% of sex workers, 20.2% of men and 37.1% of women in the community were infected with HIV. Among young people, aged 15–24 years, 10.2% of men and 45.5% of women were infected, reflecting the more rapid increase of infection with age among young women compared with young men [\[10,11\]](#).

#### Miners

[Table 1](#) shows the survey results for miners and sex workers in 1998 and 2000 with odds ratios for each variable adjusted for age. Among mineworkers, knowledge of HIV, which was already high in 1998, had improved significantly 2 years later. However, the proportion of mineworkers who thought that they were

at high risk remained constant at just over 20%, and the proportion who said that they would keep their HIV status secret did not change significantly. In neither survey did anyone say that they knew their HIV status. There was an overall improvement in behaviour associated with the risk of HIV: alcohol consumption had fallen, fewer mineworkers reported more than six lifetime partners or on-going casual partnerships, and condom use increased, especially with casual partners.

However, these modest but significant changes were accompanied by an increase in all three curable STI and in the proportion of men who had experienced a genital sore in the previous year. The only improvement was a fall in the proportion of men who had experienced a discharge or pain when passing urine in the previous year.

#### Sex workers

The number of sex workers sampled was small so significance is harder to establish. There was some improvement in knowledge of HIV: the number of women who knew someone with HIV doubled to 23%; the number of women who knew that a person with HIV can look healthy increased to over 50%, and the number who said that they would keep it secret if they were infected with HIV fell by a half to 15%. However, the consumption of alcohol increased dramatically and infection rates for all three STI increased, though not significantly.

#### Men and women in Khutsong

The survey results for men and women in Khutsong are given in [Table 2](#). Levels of employment, already very low, fell by half over the 2 years of the study, and only 10% of adults said that they were fully employed. Over the course of the study, knowledge of HIV and attitudes to the epidemic improved further from already high levels: in the year 2000, more people knew somebody with HIV; more women thought that they had a good chance of being infected with HIV;

more people said that being faithful to one partner would protect you from HIV; more people knew where to get condoms and fewer people said that they would keep their status secret if they were infected themselves. However, only one man and two women in the second survey knew their HIV status.

There was some improvement in sexual behaviour. In the second survey, fewer men had more than six lifetime partners, although the same proportion were in a casual relationship. In 2000, more women had used condoms and more casual partnerships were protected with condoms compared with the first survey. However, the prevalence of all STI was higher in 2000 than in 1998 while the prevalences of chlamydial infection in men and women, and syphilis in women, were substantially and significantly higher.

#### Young men and women in Khutsong

Young people, and especially young women, are at very high risk of infection [10,12] and the data were analysed for this age group separately (Table 3). Comparing the 2000 survey with that in 1998, knowledge was again high and improving; the number of people who knew someone with AIDS doubled over the 2 year period but, as before, no-one had been tested for HIV. Alcohol consumption had increased and more young men were sexually active. However, more young women had used condoms; fewer young men had casual partners and twice as many said that they always used condoms with casual partners. As for adults, these changes in behaviour did not translate into reductions in curable STI as almost all had increased, chlamydial infection significantly so.

#### Additional results

In the validation study, carried out 3 months after the 2000 intervention, reported age at first sex was not significantly different between the survey and the validation study for either men ( $P = 0.58$ ) or women ( $P = 0.68$ ). The reported lifetime number of sexual partners was not significantly different between the

survey and the validation study for women ( $P = 0.57$ ) but was slightly higher for men (mean difference in number of partners 0.4;  $P = 0.049$ ).

[Table 4](#) gives additional data concerning sources of information on HIV and reasons for the use or non-use of condoms, collected only in the year 2000. The most important source of information was television and radio. With regard to the use of condoms, most people said that they used condoms to avoid getting a disease while about 25% of women also used condoms to avoid pregnancy. The availability of condoms was still a problem for some men but not, it seems, for women or mineworkers. More women than men said that their partners objected to the use of condoms and more men than women said that they do not like using condoms.

Data on condom distribution, obtained from the records of the intervention project, showed that the number of condoms distributed had increased from million in 1998 to 4.66 million in 1999 and 4.81 million in 2000; this is consistent with a two- to threefold increase in reported condom use with casual partners by men.

## **DISCUSSION**

Carletonville is characterized by a very high prevalence of HIV and by an intervention programme that is more extensive than in most other parts of South Africa. Levels of knowledge of HIV, which were already high, increased further over the course of the study and there were encouraging changes in reported sexual behaviour. However, the prevalence of all three curable STI either remained steady or increased over the 2 years across all groups of people: mineworkers, sex workers, men and women in the general population and young people.

The proportion of people who said that casual partnerships were always protected by condoms more than doubled among mineworkers and men in the community and increased by 38% among women in the community. However, the study revealed a reluctance among men to use condoms and a limited ability of women to insist on the use of condoms. The difficulties faced by young people in this regard have been explored in a qualitative study in the same area [13] and it may be difficult to increase condom use further.

The intervention programme made a substantial effort to standardize STI treatment by all health service providers, most of whom were trained in syndromic management. Nevertheless, the prevalence of chlamydial infection, gonorrhoea and syphilis all increased, suggesting that much greater changes in behaviour would be needed to reduce their prevalence significantly. The programme of presumptive treatment for sex workers was started only 9 months before the second survey but the dramatic reductions in the prevalence of STI reported among mineworkers and sex workers in a similar setting by Steen *et al.* [8] were not observed in the present study, although the Steen *et al.* study only tested women participating in the presumptive treatment programme.

The intervention did not succeed in many of its aims. The implementation was very intense in certain places, in particular the 'hotspot' known as Leeupoort, but considerably less so in other places and in particular among miners; the mines in Carletonville have only recently begun to intensify their workplace interventions. While the communities outside the mines are relatively stable, the mineworkers are mostly migrants from rural areas in South Africa or neighbouring countries and this contributes to the demand for commercial sex and the spread of HIV and other STI [14–16]. The extent to which the project succeeded in improving the quality of STI management in the public and the private sector is still uncertain and needs further investigation.

Nevertheless, a number of important lessons may be drawn from what was the first major attempt to reduce the transmission of HIV at a community level in South Africa. First, such interventions probably require considerably greater resources, both human and financial, than were available in this study. Second, the study took place at a time when the very role of HIV in the AIDS epidemic was a matter of intense debate leading to contradictory and inconsistent information from political and social leaders and the media. Third, while the project was deliberately set up to be interdisciplinary, involving biomedical and social scientists, conflicting views among the stakeholders as to the most important priorities made it difficult to develop a clear and consistent management over time. Fourth, because the epidemic is so recent, the mortality from AIDS was still low, making it difficult to convince people of the reality and urgency of the problem. Finally, the 2 year duration of this study is probably too short to observe a significant change in behaviour at a community level and it will be important to continue to monitor this community to determine the extent of changes over a longer period of time.

In spite of the very high prevalence of HIV in South Africa, which has been carefully monitored since 1990, when the prevalence of HIV infection among women attending antenatal clinics was, 1%, effective prevention programmes have not been developed or implemented. While there was some evidence of behaviour change in the present study, this was not substantial or consistent among the different groups. The prevalence of STI has not fallen and in some cases increased significantly. This intervention took place at a time when the national government was still ambivalent about the causes and extent of the epidemic of HIV/ AIDS, and AIDS deaths were then only starting to become apparent in communities such as Carletonville. Both have now changed, and political and social leaders are engaging directly in the fight against AIDS while the demand for effective action by people in badly affected communities is growing. While these two factors will undoubtedly help to create an environment in which behaviour change is more likely to occur, this study shows that much

greater efforts and much more extensive programmes will be needed to change the course of the epidemic significantly. A range of other complementary interventions should be considered, including the provision of highly active antiretroviral therapy, and consideration should be given to making male circumcision available as a public health measure. There is no reason to believe that the substantial decline in prevalence that has been achieved in Uganda over the last 10 years [\[17\]](#) cannot be achieved in South Africa and there is evidence from other studies that interventions such as increasing condom use [\[18\]](#), improved STI management [\[19\]](#) and voluntary counselling and testing programmes can have a significant impact on HIV transmission [\[20\]](#). The current study reinforces the need for broad and effective action.

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