HIV/AIDS prevalence testing – merits, methodology and outcomes of a survey conducted at a large mining organisation in South Africa

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Objectives. To determine the HIV prevalence rate at Anglo Platinum, a large, multinational organisation operating in South Africa (Gauteng, Limpopo and North-West), and to assess the merits, methodology and outcomes of the survey.

Methods. A sample of 11 339 individuals, representing 18.4% of the organisation's employees, were tested for HIV. HIV prevalence was determined using the Wellcozyme HIV 1+2 GACELISA test (oral fluid assay), and variables such as age, site, grade and gender were analysed.

Results. The overall prevalence rate was 24.6% (95% confidence interval (CI): 20.4 - 28.8), translating into approximately 15 167 HIV-infected individuals. Interestingly, there was considerable variation in prevalence between sites within the same geographical regions, highlighting the limitations of using data obtained from antenatal HIV surveillance surveys. As an example, the prevalence at sites in Limpopo province ranged from 9.8% to 19%, with the same basic demographic data in terms of race, age and gender.

Conclusion. The survey data enabled the organisation to plan resource allocation appropriately for each business unit following their commitment to the treatment of infected employees with antiretroviral therapy. These baseline prevalence data also provide an opportunity for monitoring of proposed interventions using cross-sectional surveys at designated intervals in the future.

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Estimates of the number of adults and children living with HIV/AIDS in South Africa range between 3.8[1] and 5.3 million individuals.[2] The annual national antenatal surveillance survey in 2003[3] revealed an HIV prevalence rate in the adult population of 27.9%, a figure that has risen steadily for over a decade. Substantial differences in HIV prevalence have been documented across the provinces, with KwaZulu-Natal having the highest prevalence at 37.5% and the Western Cape the lowest rate at 13.1%.[3] Using the Metropolitan-Doyle model[4] it is estimated that the annual number of AIDS deaths will increase from 120 000 to between 545 000 and 635 000 between 2000 and 2010.

South Africa is therefore experiencing an HIV/AIDS epidemic of enormous proportions, and like all the other sectors the workplace will be adversely affected. In fact it is estimated that the HIV/AIDS epidemic will cost South Africa 17% in GDP growth by 2010.[5] This epidemic has forced the business sector to reconsider its role in disease prevention and management.

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Antenatal HIV survey data may be severely limited when extrapolated to estimate prevalence in the general population or large workforces. Data on children and the elderly, who are at substantially lower risk of HIV, are not captured by antenatal surveys. With regard to adults in sexually active age groups, the antenatal survey prevalence figures do not reflect the lower overall risk for men, people who are less sexually active, and communities accessing private sector facilities. Some studies[6,7] indicate that fertility among HIV-positive women is substantially lower than among uninfected women, and this suggests that antenatal data may in fact underestimate HIV prevalence in women of reproductive age in many communities. A systematically sampled national household HIV prevalence survey conducted in 2002[8] estimated the HIV prevalence rate in the general South African population to be 11.4%.

Other studies investigating HIV prevalence in companies and communities have demonstrated large differences in prevalence within provinces, and between social and racial groups.[9] In an attempt to determine the costs of HIV/AIDS to business in southern Africa Rosen and colleagues[10] surveyed 6 formal-sector enterprises in South Africa and Botswana. Organisations provided detailed company-specific data on employees, costs and estimated HIV prevalence. Using a 9-year median survival time, the undiscounted costs as a percentage of payrolls were calculated as 4.8% for agribusiness, 12.2 - 18.1% for mining and 1.8% for retail respectively. Similar studies in Kenya, Botswana, Zimbabwe, Malawi and South Africa have found that increased employee benefit claims, increased absenteeism, and increased expenditures

on recruitment and training are among the highest HIV-related costs faced by companies.[10] Evian and colleagues[11] demonstrated an average HIV prevalence rate of 16% on data accumulated from 34 workforces, totalling 44 000 employees, in South Africa. Prior investigation by Corbett and colleagues of 1 773 mineworkers revealed an HIV prevalence rate of 27%.[12]

The role of HIV testing in the workplace has been the centre of much controversy in South Africa. Although the Employment Equity Act (No. 55 of 1998) prohibits employers from conducting pre-employment HIV testing without labour court permission,[13] the value of anonymous, unlinked prevalence testing as part of a workplace programme is not clear. This article presents the findings and lessons learned during a prevalence survey conducted at Anglo Platinum, a large, multinational organisa- tion operating in South Africa and employing over 50 000 people.

Methods

Company preparation

Essential to ensuring a successful prevalence survey is the preparation phase conducted by the company. In this regard the following was done: (*i*) all major work force unions were consulted and the rationale for the prevalence survey was well explained; (*ii*) labour court consultation was undertaken; (*iii*) communication regarding the survey was carried out by each respective business unit, communication packs were provided and briefing sessions were held for the communication experts and HIV co-ordinators for each business unit; (*iv*) confidentiality agreements were signed by the organisation conducting the testing and Anglo Platinum; and (*v*) ethics approval was obtained from the University of the Witwatersrand (ethics number 001109).

Each business area within each site at Anglo Platinum was responsible for conducting its own awareness programme before the testing dates. This entailed explaining that the testing was voluntary and anonymous, and the underlying rationale for the testing. Designated HIV/AIDS co-ordinators at Anglo Platinum were briefed before the testing and trained to assist in sample collection.

Study population

Eleven thousand three hundred and thirty-nine respondents from Anglo Platinum participated in the HIV prevalence testing, representing a sample of 18.4% of the total employees (including contractors) working at the mine. Participation was voluntary and samples were collected at the respective sites during the period 22 October - 29 November 2002.

Sampling methods

Stratified random sampling was used across the organisation, with stratification by subgroup, site and grade. Because of the large sample size, age was not targeted as a necessary category to be considered for sample selection, but was recorded and checked against the population for representation.

A 100% response rate from the entire organisation is obviously preferable, as it also serves the purpose of creating awareness during participation. This can be prohibitively expensive and often very little additional information is obtained by surveying the entire population. Because of the stigma associated with HIV/AIDS, added to the fact that people who know their status may not participate, a non-response bias may be present if anything less than 100% is obtained. However, from the outset one can create a target sample group, for example an entire shift.

It may also be necessary to oversample certain categories; for example, more employees in upper income grades may know their HIV status and as such they may not participate readily. Oversampling may also be necessary when reporting back on a smaller business unit in order to keep the participants anonymous. Further oversampling may be necessary to ensure that smaller demographic groups are sufficiently represented albeit at the expense of oversampling on larger demographic groups. Because of the necessity of oversampling in certain instances it is essential to weight the result accordingly from the raw data, taking into account the size of the sample at each site where testing took place. This is done because the proportion of employees from each level participating in the study does not exactly reflect the proportion of employees from each level (and site) working on the mine.

Study procedures

Laboratory test methodology

Previously prevalence testing was done with conventional blood-based HIV enzyme-linked immunorsorbent assays (ELISAs) using rapid testing strategies or central laboratory-based confirmation. The fieldwork is generally arduous and time consuming since staff must have phlebotomy skills. In addition, because of the invasive nature of the process there is often reluctance on the part of potential participants to come forward for testing in the survey. Several studies in the literature confirm that individuals prefer the use of rapid, non-invasive assays.[14] For these reasons oral fluid collection was selected as the methodology of choice for the study.

Whole saliva, glandular-duct saliva, or mucosal transudates are specimens that can be collected for tests to detect antibody to HIV in oral secretions. Oral fluid is a complex mixture of salivary gland secretions, gingival crevicular fluid, bacteria and particulate matter. There are several approaches to conducting this type of testing, two of which have been used for surveillance in the South African setting: (*i*) collection of oral fluid with a device called OraSure (OraSure Technologies, Pennsylvania), and testing of this sample using the Vironostika Uniform II HIV-1/2 ELISA assay (Biomerieux, Boxtel, Netherlands), which is a Food and Drug Administration

(FDA)-approved testing combination;[15] or (*ii*) collection of whole saliva without a device and use of the Wellcozyme HIV 1+2 GACELISA test (Abbott). The latter was selected for reasons of cost, population preference and to speed up the collection process since the Orasure collection device requires several minutes to complete collection. The sensitivity and specificity of the GACELISA on saliva samples has been evaluated previously in a number of studies[16-23] and is estimated to be in the region of 96.9 - 100% and 99.8 - 100% respectively. These reported sensitivities and specificities compare well with those of serum-based assays and qualify oral fluid for the screening of HIV infection in both high- and low-risk populations. It should be noted that the GACELISA is no longer commercially available and has been withdrawn by the supplier since the conduct of this study for financial reasons.

Procedure for sample collection

A minimum of 0.5 ml of oral fluid was required for the testing strategy. A bar-coded sticker was affixed to each sample bottle; the sample collector recorded the age, employment grade, gender and site code on the relevant sticker. The samples were then transported to the CLS Serology Laboratory on a daily basis. The samples were placed in a freezer at the laboratory at the University of the Witwatersrand Medical School where they were frozen and stored at –15 - –25°C. Once ready for testing the relevant samples were thawed and then tested according to the manufacturer's instructions.

Data capture and statistical analysis

The results from each participant were recorded and analysed using Excel and a statistical processing package called Number Crunching Statistical Software (NCSS). The following variables were captured for analysis: test result, age, site, grade and gender. For purposes of the study the variable 'grade' was split into four broad bands, namely 'contractor' (any contractor on site), 'upper', consisting of executive and upper management, 'middle', consisting of middle management and skilled artisans, and 'lower', consisting of the remainder of the less-skilled workforce. A fifth category was used to record data for trainee staff and bursary students.

Significant steps were taken to ensure quality assurance of the data: (*i*) 20% of the total study data captured were reinvestigated for data-capture errors by referring to the original results from the medical laboratory; and (*ii*) frequency counts for each of the variables investigated, and minima and maxima for interval or ratio level data, were generated in order to ensure that no values were missing, that no values had been entered incorrectly, and that there were no obvious and inexplicable outliers.

It is obvious that the results are highly dependent on demographic subgroups. A logistical regression analysis was performed to ensure that the correct weighting per demographic subgroup was used on the raw data to correct for any possible over- or undersampling and the best estimated prevalence per site was calculated based on the population versus the sample taken. This best estimate of prevalence per site was then further weighted correctly per geographical region to obtain an overall company HIV prevalence rate. Geographical criteria were used as this seems to be the most defining factor regarding HIV prevalence throughout South Africa, barring race which was not recorded.

Results

Response rate

The response rate at each site was investigated and revealed no more than 5 refusals per site. Only 1 site (A4) had a noticeably poor response rate. An overall value could not be reported since each site was investigated separately. This is discussed further in the text.

Prevalence results before implementation of weighting strategy

The results are depicted as bar charts in Figs 1 - 3. The bar charts present the data as the number of positive individuals out of the total number of samples tested, and also reflect this as a percentage value. The demographic subgroups investigated were region, age and employment grade.

Weighted HIV prevalence by site

The HIV prevalence rate at Anglo Platinum was estimated by combining the individual best-estimated HIV prevalence for each site and then making a weighted overall estimate (Table I). The estimate of each site was also weighted accordingly. This was done to correct any potential over- and undersampling,

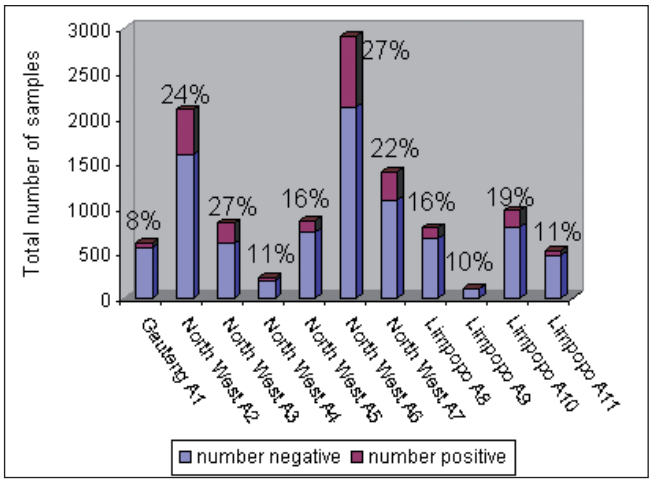

Fig. 1. Number of HIV-positive samples identified within each region. The percentage of positive individuals is shown on each bar. Site A4 should be read with caution as a strong element of non-response bias was suspected.

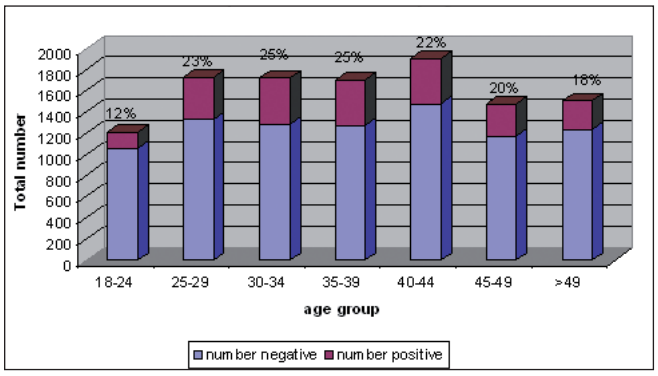

Fig. 2. Number of HIV-positive individuals by age distribution. The percentages per group are shown on the bars.

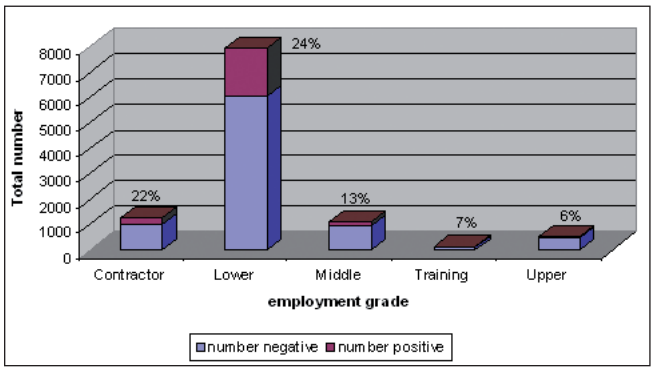

Fig. 3. Number of HIV-positive individuals by employment grade.

and correctly apportions the sample to the population demographic characteristics. Even though an entire shift was targeted and very little non-participation was experienced owing to the fact that HIV prevalence testing was voluntary, it is still often necessary to oversample to ensure that a spread of demographics is obtained. These data are also presented in bar-chart format in Fig. 4, including the antenatal clinic data for each region.[3]

The overall estimate of HIV prevalence for the mine was therefore calculated as 24.6%. Since this estimate is based on a specific sample size, lower and upper confidence limits can be calculated such that there is a 95% chance that the true proportion of HIV-positive employees lies between those confidence limits. In this study the lower confidence limit was 20.4% and the upper limit 28.8%. Table I also represents each business unit separately with its respective confidence limits. As an example, at site A2 the measured prevalence was 24.5%, which means that an estimated 2 748 employees of the total 11 211 employees at this site were HIV-positive. Using the confidence limits as presented, we are therefore 95% certain that A2 has between 2 366 and 3 131 HIV-positive employees.

Discussion

Several interesting observations emerged during the course of this prevalence survey. As demonstrated in Table I, the

Table I. Weighted HIV prevalence data by site/ region

Region	Site	% estimated HIV-positive (95% CI)	Sample size
Gauteng	A1	7.8% (5.4, 10.3)	848
North-West	A2	24.5% (22.1, 27.9)	11 211
North-West	A3	27.7% (23.2, 32.1)	3 976
North-West	A4	9.3% (6.0, 14.6)*	529
North-West	A5	17.3% (14.5, 20.1)	1 928
North-West	A6	28.1% (23.5, 32.8)	27 900
North-West	A7	22.8% (18.5, 27.1)	8 496
Limpopo	A8	16.5% (12.8, 20.2)	1 640
Limpopo	A9	9.8% (5.4, 14.2)	164
Limpopo	A10	19.0% (16.1, 22.4)	2 942
Limpopo	A11	12.3% (7.2, 17.4)	1 930
Group		24.6% (20.4, 28.8)	61 564

*Site A4 should be read with caution as a strong element of non-response bias was suspected.

overall estimate of HIV prevalence for the mine was 24.6% (95% confidence interval (CI): 20.4, 28.8), which meant that approximately 15 167 employees were HIV-positive at the time of sampling. These results have ensured that appropriate information was available for accurate costing and planning models, thus providing Anglo Platinum with invaluable data on expected trends relating to number of HIV-positive employees, AIDS-sick employees and AIDS deaths. Given Anglo Platinum's commitment to the treatment of infected employees with antiretroviral therapy, the future cost implications can be estimated with a degree of accuracy. In addition, this provides a further platform for the investigation of different risk groups that may require specific interventions. As mentioned above these numbers differed per business unit and the costing model allows each business unit to plan independently.

These baseline prevalence data also provide an opportunity for monitoring of proposed interventions using repeat

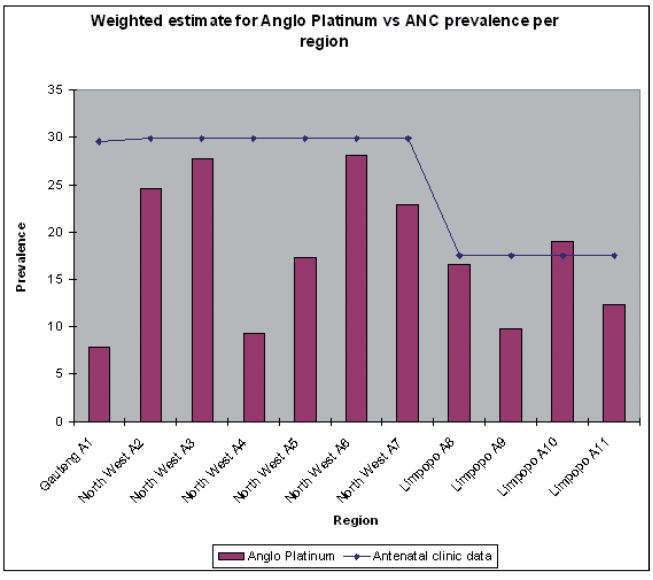

Fig. 4. Antenatal HIV survey prevalence values compared with Anglo Platinum prevalence values for the regions.

cross-sectional surveys at designated intervals in the HIV management programme. A study conducted on workplace programmes in South Africa in 1995 revealed that few organisations ever conducted formal evaluations of their interventions.[24]

As expected, it was observed that prevalence by age (Fig. 2) was highest in the 30 - 39-year age group (approximately 25%). This is in contrast to the national antenatal clinic prevalence data from 2003[3] which show consistently different prevalence rates, with the 25 - 29-year age category showing the highest prevalence at 35.4%. The lowest prevalence in this mining population appeared to be in the 18 - 24-year age group (12%). The Human Sciences Research Council (HSRC) data report the rate among males in the 18 - 24-year age group to be 7%, also the lowest when compared with these relevant age groups.[8] The above results may suggest that there is an effective induction and education programme in place for staff. The future challenge will be to maintain this trend as employees move into the higher age categories and to keep new recruits well educated, with the aim of lowering this percentage further.

Different sites were chosen in order to obtain a representative sample (prior prevalence surveys indicated differences between different business areas (sites) even though geographically the sites wore in close proximity to each other). There was considerable variation in prevalence between sites in the same geographical region (Table I). To quote an example, the prevalence in Limpopo Province ranged from 9.8% to 19% (sites A9 - A11), with the same basic demographic data. A similar picture was observed for North-West province (sites A2 - A7), where HIV prevalence ranged between 16% and 27% (site A4 was excluded here because of suspected non-response bias). Further research is therefore needed to try to delineate specific reasons for the differences observed between sites that are often no more than 10 km apart. Possible factors to be explored are the intervention programmes of individual mining sites, staff recruitment policies, sexual behaviour patterns and ethnic differences.

The key factor in a successful prevalence survey appears to be participation of all stakeholders, as was observed in this study. During the course of the process the following qualitative factors appeared to influence success: (*i*) upfront awareness as to why the prevalence survey was being done; (*ii*) the fact that the survey was conducted by an outside independent organisation; (*iii*) participant awareness that company management would not have access to the raw data and that the organisation conducting the survey would report back in a way that eliminated disclosure of any smaller demographic grouping and that avoided discrimination against any particular group; and (*iv*) the choice of non-invasive saliva-based assay for HIV testing.

Non-response bias is introduced into a sample when potential participants are free to decide whether or not they would like to participate in a study, and their choice is likely to be influenced by some feature of the study itself. This creates the possibility that those respondents who participate willingly could differ systematically from those who choose not to participate. In this study it was found that many lower-income grade employees participating at the start or end of an underground shift agreed to participate if the first person in the shift (or the shift boss) agreed to participate, and refused participation when that person refused participation. This is likely to have reduced non-response bias because only the first person in the queue (or in some cases the shift boss) made the conscious decision to participate or not participate based on his/her HIV status or orientation towards HIV prevalence testing. The other members of the group did not make a conscious decision based on knowledge of HIV status or any other obvious variable. Thus the non-response bias was limited to a small percentage of the sample. The large sample size and the relatively small proportion of individuals who were aware of their HIV status also mitigated against the biases described above.

On the other hand, employees in higher-income grades and in more general business services tended to make their decision to participate or not on their own, and therefore the impact of non-response bias was potentially greater. As expected, significant differences were noted in the prevalence statistics when separation was done by employment grade. The highest prevalence was in the lower-income grades and among contractors at prevalence levels of 24% and 22% respectively among those tested. The remaining income grades (middle and upper) showed 13% and 6% prevalence rates respectively among those tested.

A positive outcome of prevalence surveys is the awareness created among the employees. One particular business unit worth mentioning was a small unit where close to 100% of the staff participated owing to strong management leadership. Information on the treatment programme provided by Anglo Platinum and voluntary counselling and testing (VCT) for staff (provided by an independent service provider) were offered on site at the feedback session. Employees were encouraged to use this service on the day. The uptake (on site) was extremely positive, encouraging further on-site VCT. The awareness created by a prevalence survey may therefore assist in the uptake of VCT services in the workplace.

This study serves to highlight the fact that although models based on antenatal surveillance or insurance modelling give some sort of indication of HIV prevalence, they are not useful for the implementation of an HIV management programme within an organisation at a micro level. The study also demonstrates that a substantial amount of information can be generated from prevalence surveys to assist and monitor ongoing workplace programmes. However antenatal clinic data are useful on a macro level in predicting the extent of HIV

prevalence in terms of geographical location while making adjustments for age, gender, and income/education level (private versus public health).

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