

**As the ASSA2000 model has yet to be fully calibrated figures are for illustrative purposes only and not to be quoted without first speaking with the author.**

# **THE DEMOGRAPHIC IMPACT OF HIV/AIDS IN SOUTH AFRICA BY PROVINCE, RACE AND CLASS**

BY ROB DORRINGTON

## ABSTRACT

This paper presents the results of the ASSA2000 AIDS and Demographic model developed by the AIDS Committee of the Actuarial Society of South Africa. This model has been calibrated to produce results for each of the provinces separately. From this and other research only, at most, five of the provinces appear to be experiencing similar epidemics, but starting at different times, while the other four (KwaZulu-Natal, Western Cape, Northern Cape and Northern Province) are clearly experiencing different epidemics. In the no-intervention, no-behaviour change scenario the ANC clinic prevalence is expected to plateau in KwaZulu-Natal at nearly 40% while it may barely reach 18% in the Western Cape. The results also show differences in life expectancy, child and adult mortality, numbers of orphans, numbers infected, numbers of AIDS sick and numbers of AIDS deaths, by province, race and gender. Understanding why different provinces are experiencing different epidemics will go a long way to helping us identifying the forces that drive the spread of this epidemic. The paper also contains a brief analysis of the likely impact by socio-economic class.

## KEYWORDS

HIV, AIDS, model, population projection, provincial estimates, South Africa

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## 1. INTRODUCTION

Since we now know more about the epidemic and have more data against which to calibrate the model, and also know more about certain uses to which the model has been put it was decided to update the ASSA600 model and the results arising from them. This paper briefly describes the ASSA2000 suite of AIDS and demographic models. In effect three versions have been developed: the full version, which models at a national level each of the four population groups separately and aggregates to produce results for the population as a whole; the 'lite' version which has the same basic structure but models the country as a single population group; and the application of the

full model to each of the provinces, which once aggregated gives a third, and presumably most accurate, estimate for the population as a whole.

At this stage the models have only been calibrated at the national level. Calibration at the provincial level is still awaiting more detailed data from the Department of Health. Thus this paper reports on 'work in progress', and the results are for illustrative purposes and should not be quoted or used.

To supplement the results from the model the paper also presents briefly the patterns of prevalence by urban and rural residence, gender, race and job grade.

## 2. BRIEF DESCRIPTION OF THE MODEL

The ASSA model has its origins in the Doyle-Metropolitan model originally proposed by Doyle and Millar (1990). As this model was proprietary to Metropolitan Life the AIDS Committee of the Actuarial Society of South Africa (ASSA) decided to develop a spreadsheet model which could be used by insurers, researchers and policymakers to assess the impact of HIV on mortality rates. This model (ASSA500) was a model of a hypothetical (black) population.

In 1998 the Committee constructed the ASSA600 version. It was described at the time as an AIDS model of the third kind (Dorrington, 1998) for two reasons, first to distinguish it from 'macro' and 'micro' AIDS models, but more importantly to distinguish it from the traditions of AIDS models which ignore demographic imperatives (or at most afford them second class status) and demographic models which at that stage, at least in South Africa, were ignoring the impact of HIV/AIDS (and even today still afford it second class status). The big advantage of modelling both together is that not only does it produce better demographic projections but also it gives more to check the model against in the sense that it produces realistic and measurable outputs. In particular, in the case of the ASSA2000 model, the model has been calibrated against the deaths (recorded by the Department of Home Affairs and corrected for under-reporting (Dorrington *et al*, 2001 and Timaeus *et al*, 2001).

A brief description of the ASSA600 model appears in Appendix B. A detailed description of the ASSA600 model appears in Dorrington (1998) and an update in Dorrington (1999a).

The ASSA2000 suite of models was developed in 2000<sup>1</sup>. The following are the major improvements on the ASSA600 model:

- adjustments to incorporate updated empirical data and understanding of the epidemic
- improvements to the model to
  - o improve the fit to ANC survey data
  - o allow for the possibility of making separate male and female assumptions
  - o model the population groups separately
  - o limit the trend in mortality and fertility rates over time
  - o limit future in-migration
  - o change HIV survival curve to be a function of a Weibull distribution

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<sup>1</sup> The ASSA2000 and ASSA2000lite models can be downloaded from [www.assa.org.za](http://www.assa.org.za) (The provincial versions have been delayed awaiting the release by the Department of Health of the more detailed results of the provincial antenatal surveys.)

- allow for bimodal distribution of paediatric HIV survival
- disaggregate the ‘contagion matrix’ into more measurable and controllable sexual behaviour parameters.
- calibrate the model to the most recent estimates of mortality.

These changes are documented in more detail in Dorrington (2001).

The ASSA model is a component population projection model which models the demographic impact of the heterosexual epidemic only. The ASSA2000 version of the model is a significant advance on the earlier versions in that it attempts to model sex activity as part of this process. This enhances the usefulness of the model as a tool to assess the impact of various behavioural changes and intervention strategies.

As illustrated by the figure in Appendix B the model splits the population into sub-groups depending on various risk factors associated with the mechanism of transmission and chance of becoming infected, namely:

- Age (0-13, 14-59, and 60+)
- Behaviour (nationally, about 1% of the population in the high-risk (PRO) group (e.g. commercial sex workers and their clients), about 20% are those who regularly suffer sexually transmitted diseases (STDs) which significantly increase the probability of transmission, about 30% simply behave in a risky way (RSK), and the remainder of the population is assumed not to be significantly exposed (NOT))
- Race (which may be a proxy for various socio-economic factors)
- Geographic (provinces).

At present the model does take into account sex between people from different races or provinces.

### 3. CALIBRATION

Calibration is the process by which unknown parameters in the model are set so as to best reproduce past data. For the first time an attempt was made to calibrate the model to data on the number of deaths collected from the DHA (Dorrington *et al*, 2001 and Timeaus *et al*, 2001) as well as the ANC survey data. Unfortunately the two sources of data produced inconsistent results, with the model calibrated to the ANC data producing too many deaths. After much consideration it was decided that this probably suggested that the ANC survey results before 1998 (when a new protocol was introduced) exaggerated the true extent of the epidemic (probably as a result of the early sites being predominantly in the urban areas). This bias is assumed to have disappeared over the years as more (and better chosen) sites were added to the survey and as the difference between urban and rural prevalence reduced.

Details of the assumptions made and the resulting fit of the calibration exercise are documented in Appendix A.

### 4. RESULTS

As was pointed out above, only the national model has been fully calibrated. Further data is still awaited from the Department of Health in order to finalize the

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calibration of the provinces. In the meantime what is presented below are the results of the fits to date.

##### 4.1 *The fit to the population groups*

Figures 1 - 4 show the resultant fit using racially specific assumptions for the following: sex activity, probability of transmission, mortality, fertility, migration, condom usage, risk-group proportions, and number of imported infected.

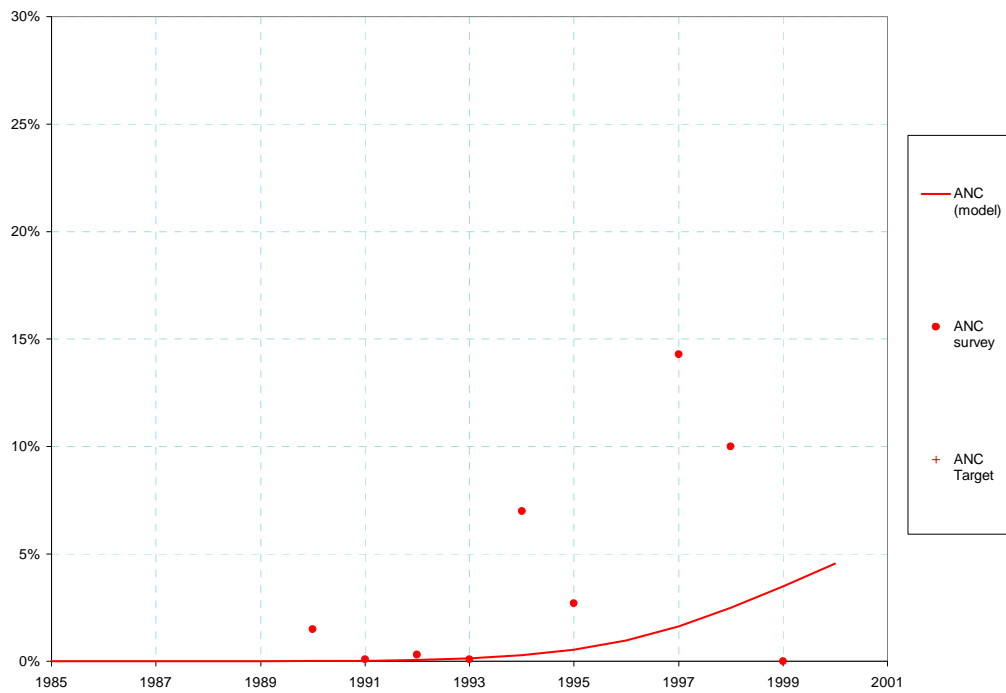


Figure 1: Comparison of projected ANC prevalence with survey data: Asian population

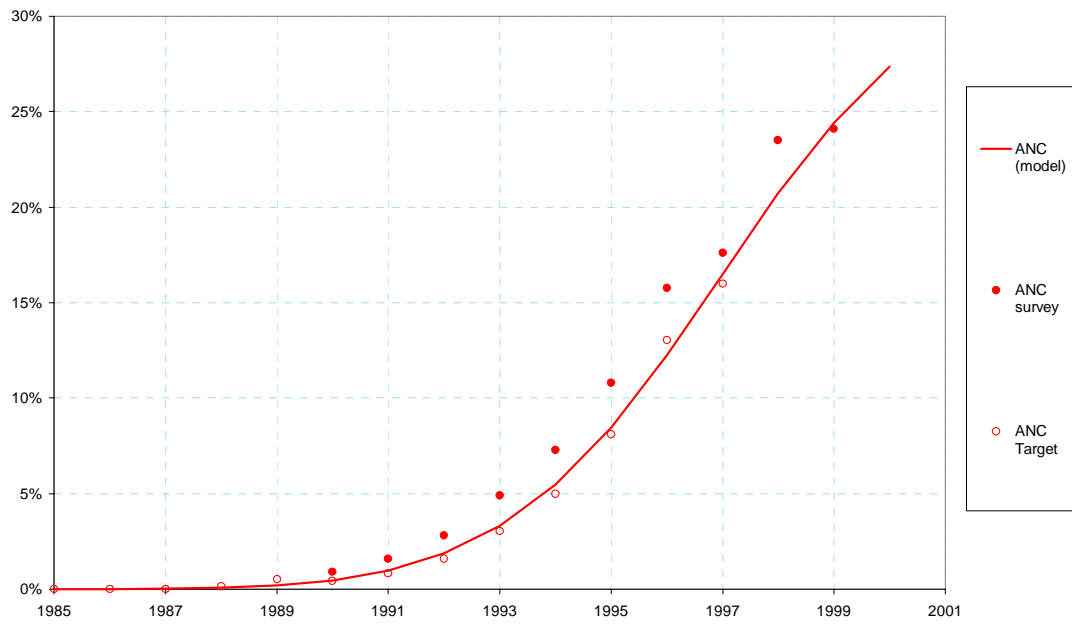


Figure 2: Comparison of projected ANC prevalence with survey data: black population

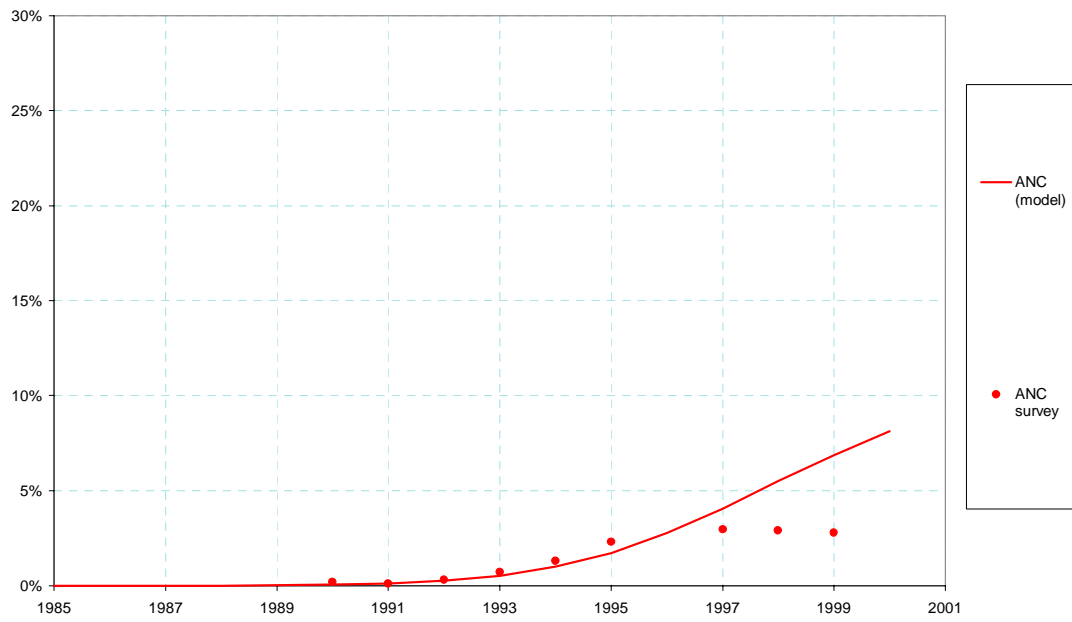


Figure 3: Comparison of projected ANC prevalence with survey data: coloured population

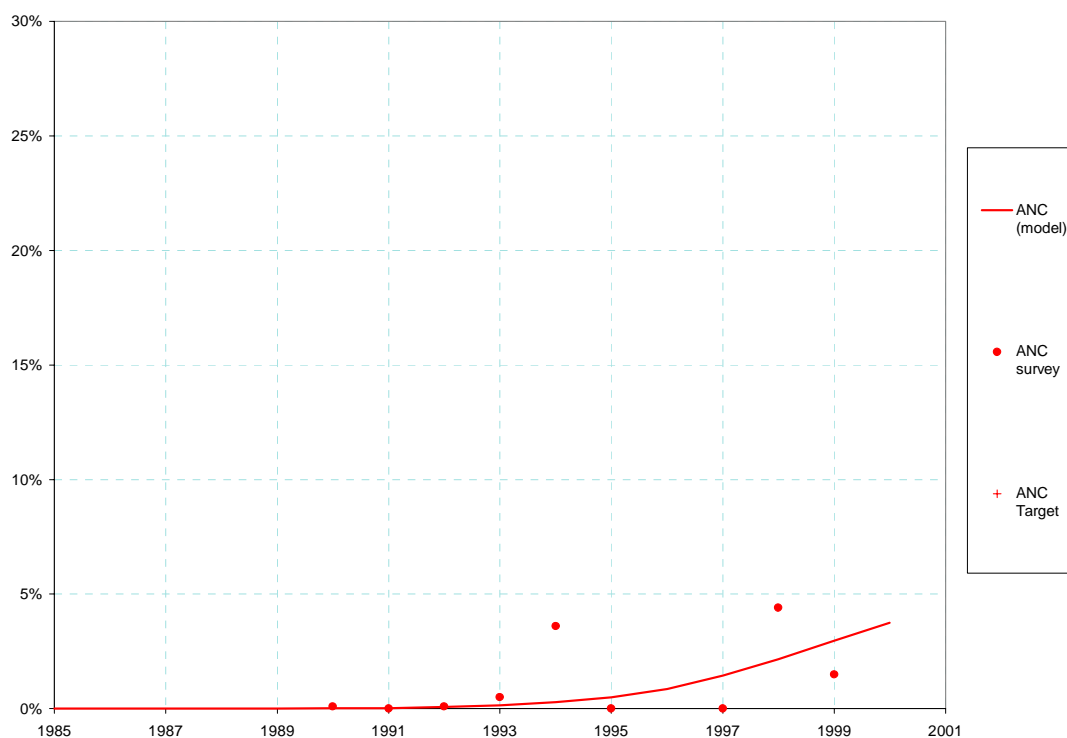


Figure 4: Comparison of projected ANC prevalence with survey data: white population

Obviously it is impossible to draw any conclusions about the Asian and white curves. These were fitted taking into account data from the insurance industry and the private sector which suggest that people applying for insurance above the minimum testing limit and those in the higher job grades have a prevalence of between 2,5% and 3%.

The fit to our estimates of the black survey prevalence is rather good (bearing in mind the suspicion of bias in the early ANC data), while that to what little data there is on coloured prevalence appears to be a too high and more research is needed to understand why this is so.

#### 4.2 *The fit to the provinces*

The fit to the individual provinces is shown in Appendix A. The resultant projections (assuming no behavioural change or interventions) of the prevalence rates for the provinces is shown in Figure 5. Essentially, as was shown in Dorrington (2000d) five of the provinces appear to be following similar epidemics while the other four (KwaZulu-Natal, Northern Province, Northern Cape and the Western Cape) are experiencing different epidemics. Not only do the provinces differ in term of ultimate plateaus (ranging from a low of 18% for the Western Cape to a high of nearly 40% for KwaZulu-Natal) but the patterns differ both from one another, and also from that of the country as a whole.

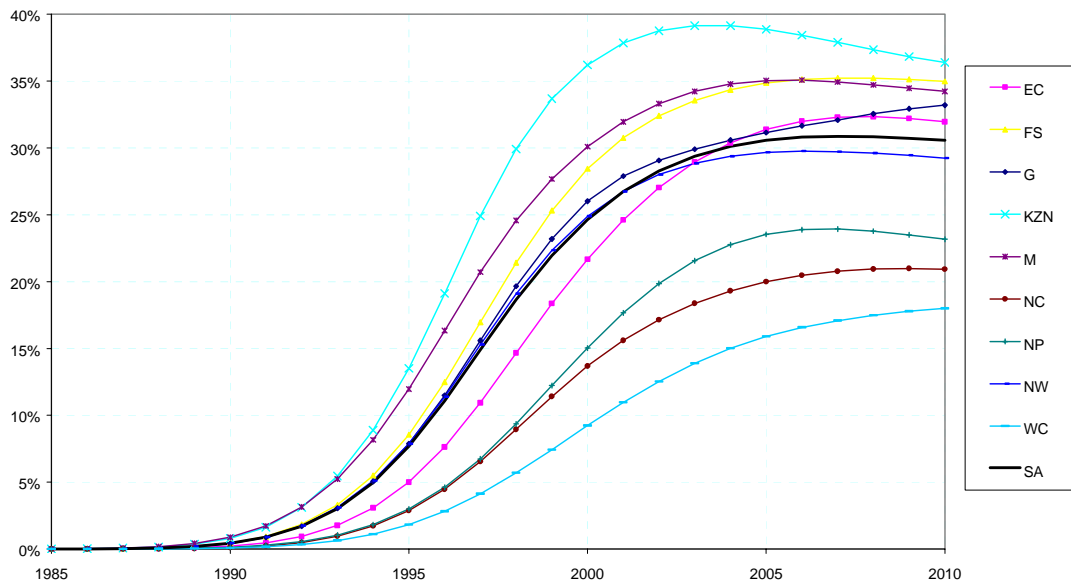


Figure 5: Comparison of the projections of the prevalence of ANC clinic attendees by province

#### 4.2 Fit to recorded deaths

Figures 6 and 7 compare the recorded deaths, adjusted for under-recording in 1999/2000 with those projected by the model. With the exception of ages above 60<sup>2</sup> the fit is remarkably good.

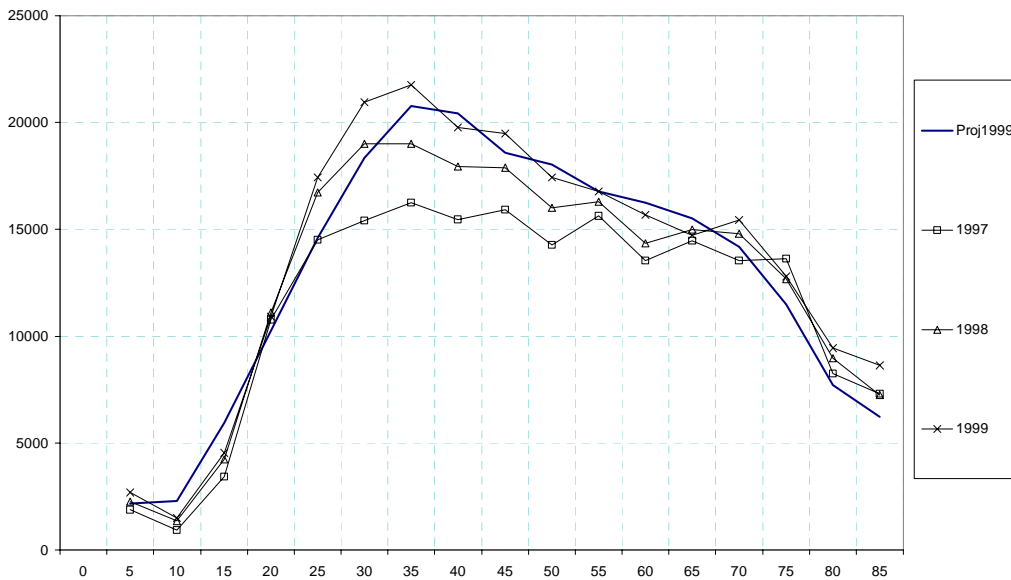


Figure 6: Recorded deaths (adjusted for under-recording) and projected death for 1999: Males

<sup>2</sup> At this stage it is unclear how much of this difference is due to age exaggeration in the deaths and how much to over correction for age exaggeration in the population estimates.

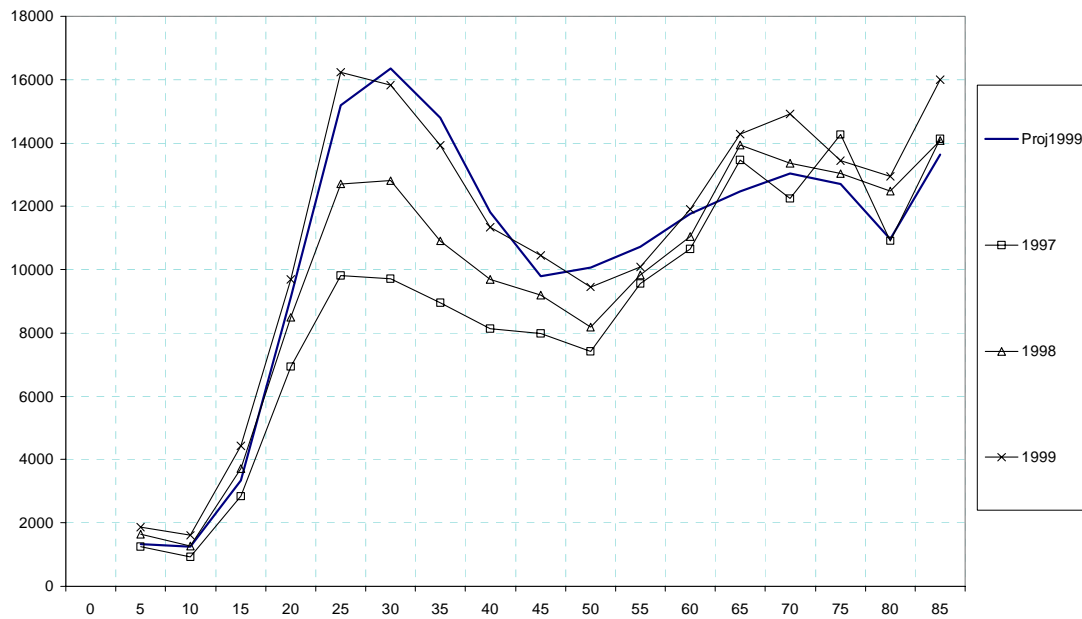


Figure 7: Recorded deaths (adjusted for under-recording) and projected death for 1999: Females

#### 4.3 *National comparisons*

Figure 8 compares the projections of the various versions of the model with that from their predecessor the ASSA600 model. From this we see that the projections are not very different, all suggesting that without behavioural change or significant intervention the prevalence as measured at antenatal clinics is likely to plateau at between 31% and 32%<sup>3</sup>.

<sup>3</sup> The 1998 observation should be adjusted downwards by about 2%. See Appendix A1.2 for explanation



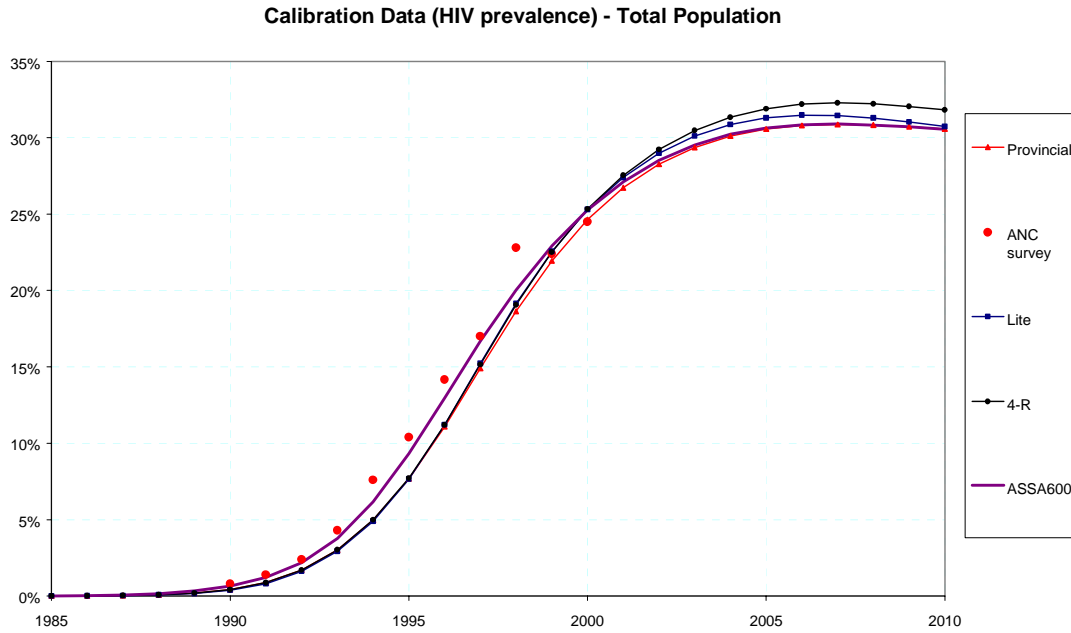


Figure 8: Comparison of the national projections

#### 4.3 *The impact*

Figures 9-12 show the impact of the epidemic on the provinces by comparing life expectancy, childhood mortality, adult mortality and the number of AIDS sick by province over time.

From these comparisons we see, not surprisingly that the biggest impact in terms of mortality is on KwaZulu-Natal followed by Mpumalanga and Free State, with Western Cape being by far the lightest followed by the Northern Cape. The impact on adult mortality is quite startling. Nationally the chance of a 15-year old not surviving to age 60 will rise from a little over 30% to around 75%. Put another way this suggests that without significant changes in behaviour or interventions over 45% of adults in the country will ultimately become infected with the virus!

As far as the number of AIDS sick is concerned KwaZulu-Natal has the highest followed by Gauteng. The Northern Cape will have the fewest partly because it is the least populous, followed by the Western Cape. An interesting feature of these graphs is the sharp turn around in numbers of people sick with AIDS in Gauteng. This is undoubtedly a result of a population skewed towards working ages.

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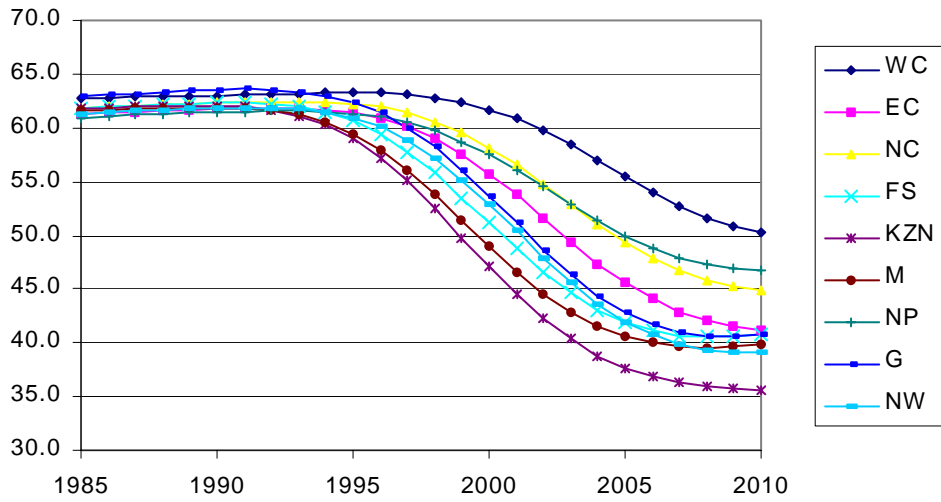


Figure 9: Comparison of the projections of life expectancy by province

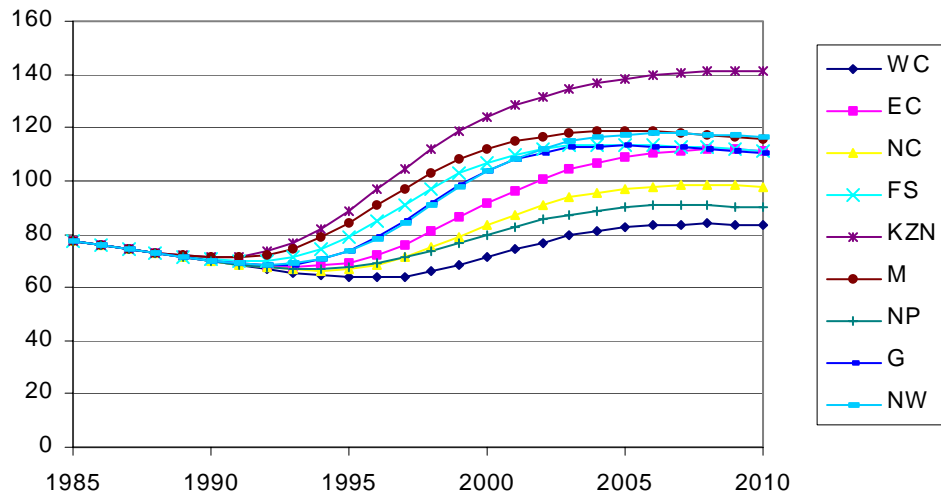


Figure 10: Comparison of the projections of the number not surviving to age five out of 1000 newborns by province

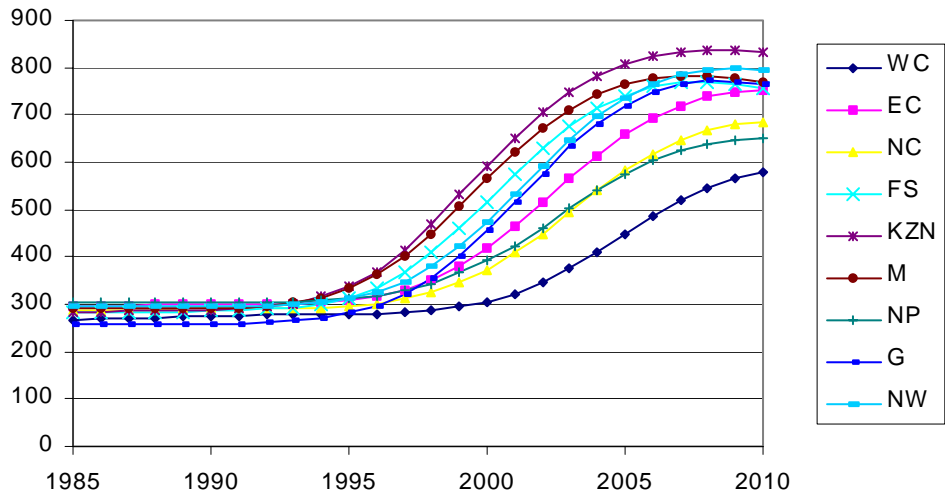


Figure 11: Comparison of the projections of the number not surviving to age 60 out of 1000 fifteen year olds, by province

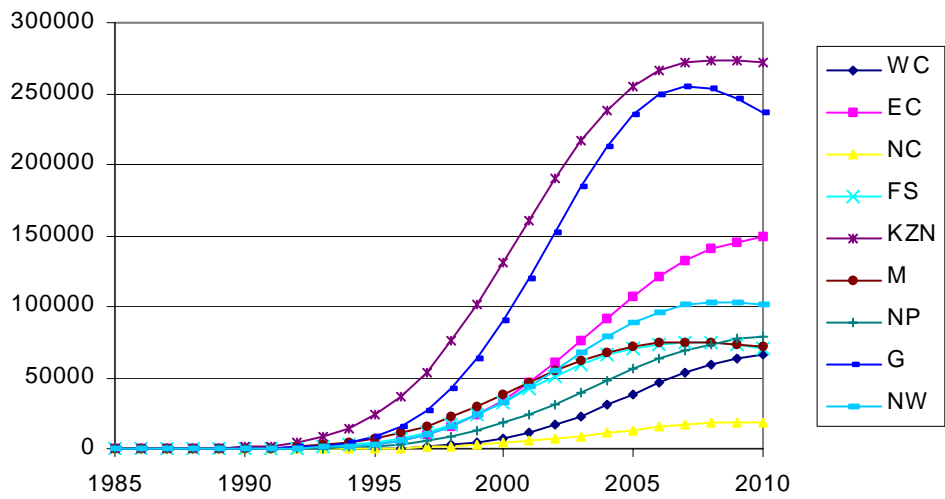


Figure 12: Comparison of the projections of the number of AIDS sick by province

Figure 13 shows the expected number of maternal orphans aged less than 15 for the country as a whole.

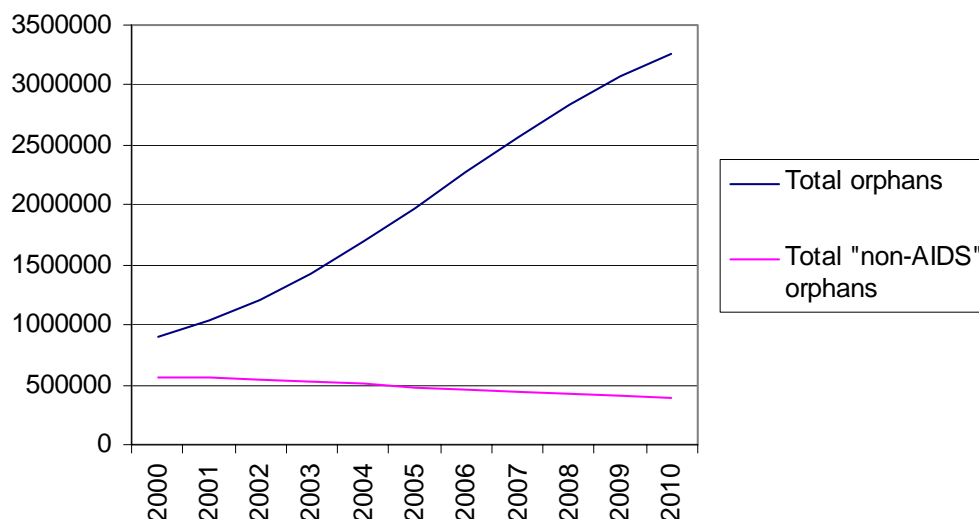


Figure 13: Number of maternal orphans under the age of 15

#### 4.4 *The impact by socio-economic class and gender*

Data for measuring the impact by class and gender are very scarce. Outlined below are patterns that have been observed in data from various, often confidential, sources. They are presented more to give an idea of the patterns than to give absolute measures of the prevalence level for specific subgroups. They represent a broad average of sectors and as prevalence in different sectors can be very different they should not be taken to represent any particular sector.

##### 4.4.1 *Gender and age*

Figure 14 shows the by now commonly observed pattern of prevalence by age for males and females in the population and for women attending ANC clinics, namely that the prevalence in women occurs at a younger age and is more peaked than that of men and that the prevalence of women attending ANC clinics is higher than that of all women in the youngest ages and lower in the older age categories. According to the model, applying the age-specific antenatal survey prevalences to the population of women 15-49 would underestimate the number of infected women in that age range by 6% (and in total by 9%) and underestimate the number of infected men in total by less than half a percent. In other words applying the age-specific fertility rates to the number of women in the population in the age groups and doubling the result would underestimate the total number of adults infected with the virus by about 5%

On the other hand the pattern of prevalence by age of the employed as shown in Figure 15 is somewhat different with there being little difference between the prevalence of employed women and men in the 18-39 age range.

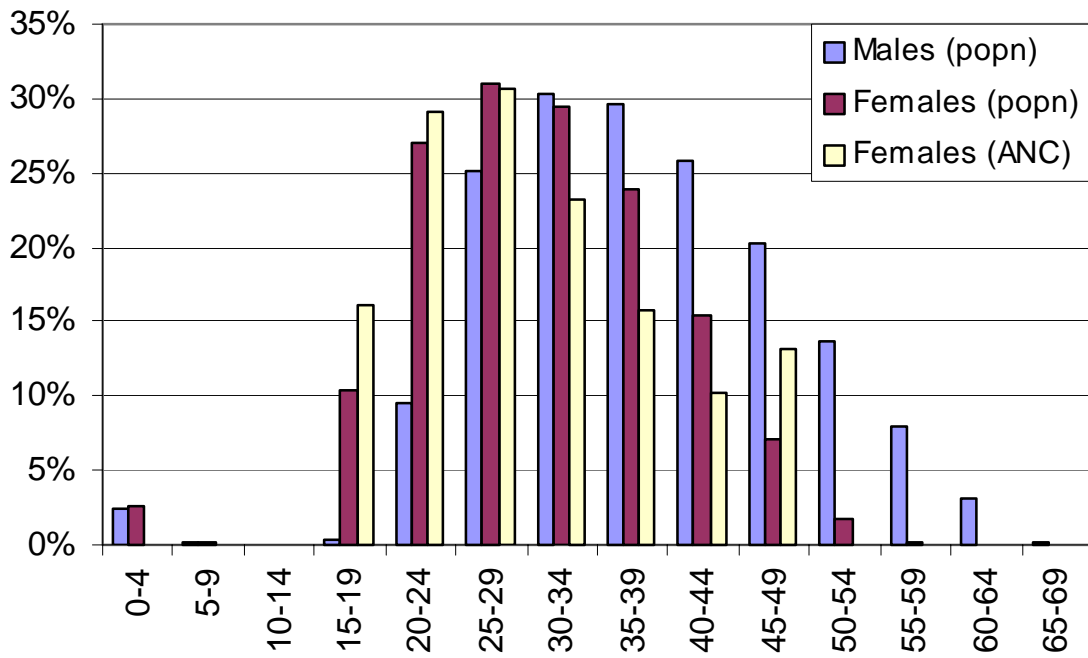


Figure 14: Prevalence by age and gender for population and ANC visitors (1999)

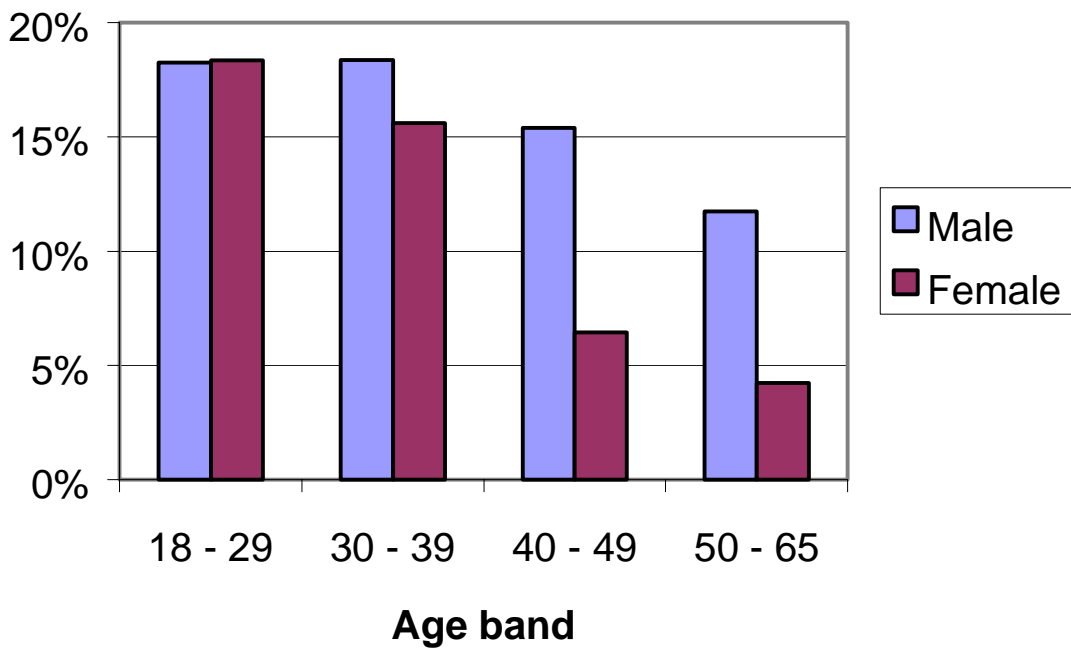


Figure 15: Prevalence by age and gender for the employed (2000)

4.4.2 Urban-rural differences

For various reasons the prevalence in the urban areas is higher than that in the rural areas. However, as can be seen from the example shown in Figure 16 (Wilkinson *et al*, 1999) the rural areas merely tend to lag the urban areas (possibly even catching up as in this example), although it is possible that in some of the more remote areas and those with less migrant labour the prevalence in the rural areas may plateau at a lower level.

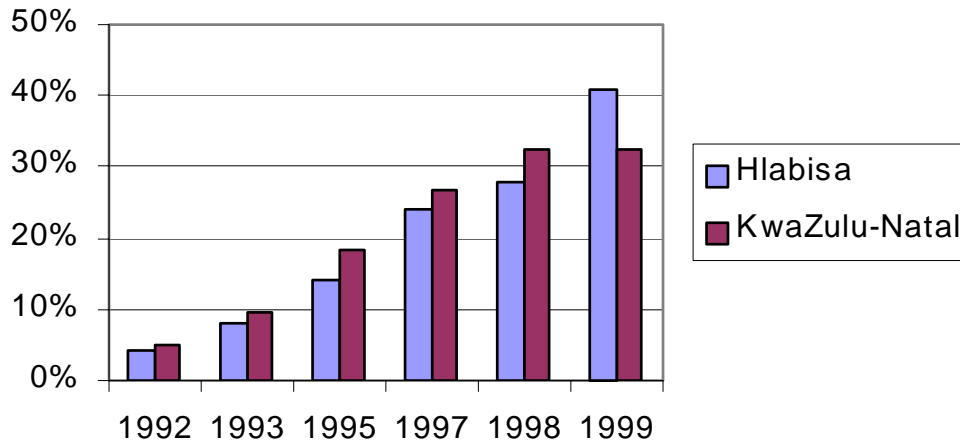


Figure 16: Example of urban vs rural prevalence in KwaZulu Natal

#### 4.4.3 *Prevalence by employment status and race*

As shown in Figure 17 the pattern is that the employed have a lower prevalence than the unemployed and this effect is much more marked in the black population group. However, this hides very big differences in the level by the sector of employment.

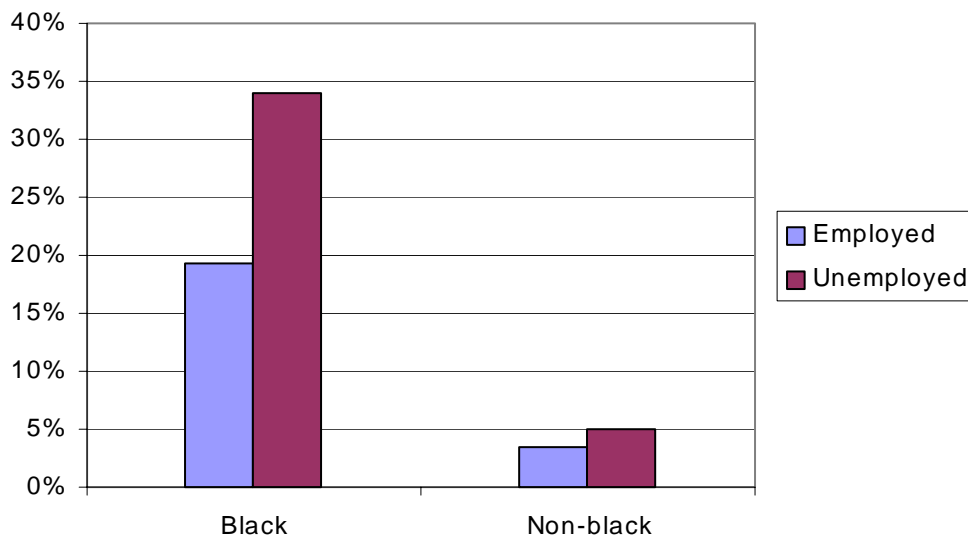


Figure 17: Prevalence by employment status (2000)

4.4.4 Prevalence by skill level and historical disadvantage

As might be expected prevalence falls with income/skill level particularly for the sector that was previously disadvantaged under apartheid as represented by the black population group such that for the highly skilled/senior management level the prevalence levels might be expected to be largely independent of race. Interestingly the prevalence amongst senior managers appears as if it could be higher than that of middle management.

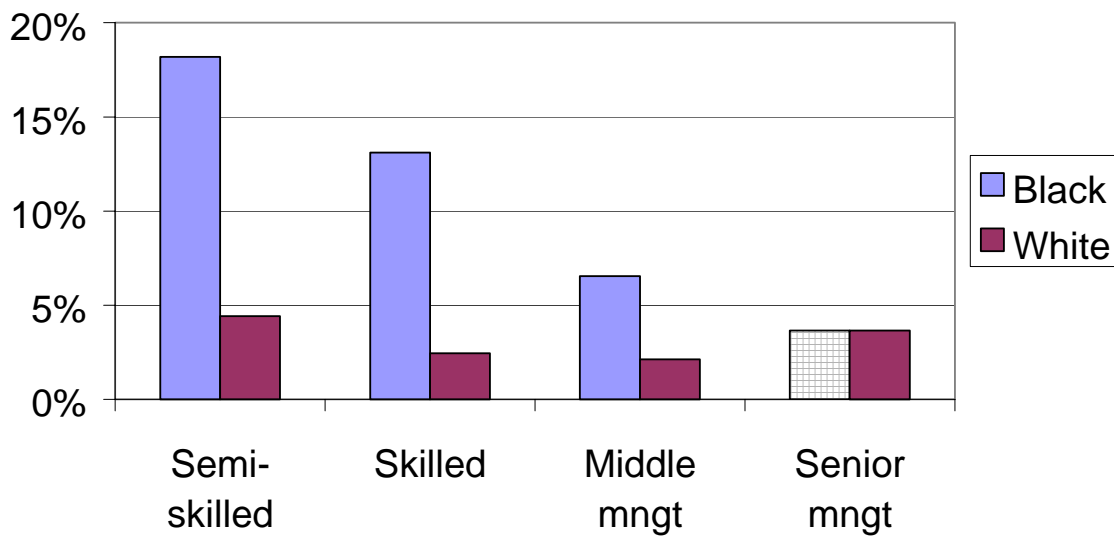


Figure 18: Prevalence by job category and historical disadvantage (2000)

4.4.5 Prevalence by level of education

Figure 19 shows, in contrast, that there isn't a simple linear relationship with the level of education in the antenatal survey data. The figure shows the results of fitting a logistic regression to the age, race, gravidity, province and education data for 1998 and 1999. It represents the levels for black women, aged 25-29, having their second child in 1999.

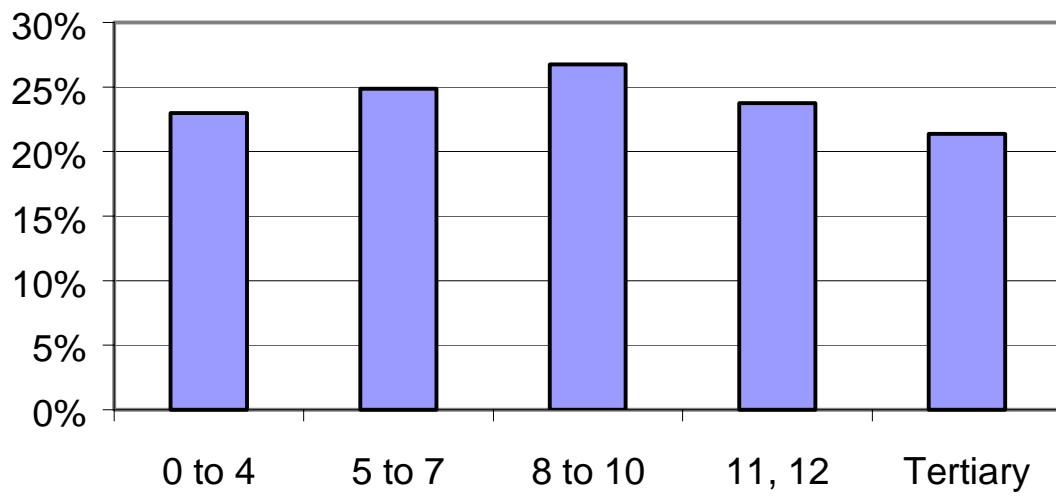


Figure 19: Prevalence by level of education of antenatal attenders



## 5. DISCUSSION

Although conclusions can only be properly drawn once the model has been fully calibrated at the provincial level, there are nevertheless a number of tentative observations one can make from the illustrative results presented above.

The first concerns the provincial data that the model doesn't fit, in particular:

- *Northern Cape*: The two most recent survey results are significantly lower than the model estimates, which could indicate that the epidemic in this province will plateau at a lower level than suggested. This needs further investigation.
- *Free State*: The recent points lie above the estimates from the model. This is because of exceptionally high rates found in the sample of coloured lives. This is unlikely to be representative of all coloureds in the province, and will need to be investigated.
- *Mpumalanga*: The 1998 observation, even after correction still appears to be out of line.
- In addition to this there are a number of other points over the years (e.g. North West 1996, KwaZulu-Natal 1996 and 1998, Gauteng 2000) which are inexplicably out of line with the rest of the data for the respective province. Without access to more detail on the methodology and data underlying particular results one is forced to question the reliability of the survey results.

The second concern must be the extremely high levels of ANC prevalence projected for KwaZulu-Natal. If these projections are correct then this would place the province amongst the worst hit areas in sub-Saharan Africa.

The third concern is why some provinces (KwaZulu-Natal, Northern Province, Western Cape and Northern Cape) are significantly different from the rest. Understanding why some provinces differ from the rest (and one another) will go a long way to helping us manage the epidemic.

Two conclusions can be drawn from this exercise. Firstly, there is great advantage to be gained from modelling the epidemic at the provincial level, particularly if one has access to detailed provincial level data and knowledge. Secondly, since the successful model relies so heavily on the accuracy of the antenatal data it is crucial that we understand what it is that the Department of Health collects and how exactly it arrives at its estimates from this data. There is much useful information that the Department of Health could release without, in anyway, threatening confidentiality of those that were tested.

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## APPENDIX A

### THE ASSUMPTIONS IN THE MODELS

Where assumptions differed from those in the ASSA600 model these are described briefly below.

#### A.1 *The 'Lite' model*

##### A.1.1 *Assumptions*

*Base population:* This was simply set to be the aggregate of the populations in the full model.

*Non-HIV mortality:* This was simply set to be the aggregate of the populations in the full model.

*Fertility:* This was set to that in ASSA600 up to 1996 and after that it was assumed to trend, logistically, to the ultimate rates.

*Migration:* This was simply set to be the aggregate of the populations in the full model.

*Percentage in the risk groups:* The percentage in the PRO group is small and was set equal to that in ASSA600. The percentage in the NOT group determines roughly the level of plateau and so was also kept the same as ASSA600. The percentages in the other two risk groups was determined using data on STD prevalence from the SADHS such that the weighted average of the transmission probabilities in the presence of STDs given in Rehle *et al* (nd) was equal to 0,007 for male to female and 0,005 for female to male.

*Source of partner matrix:* The population-group weighted average of the proportions used in the Metropolitan-Doyle model (personal communication with Stephen Kramer, Metropolitan Life) were the starting point. However, these were figures then adjusted to bring the male and female source of partner matrices into line<sup>4</sup>.

*Transmission probabilities:* The PRO and STD to PRO or STD were set to 0,007 for females and 0,005 for males. The RSK to RSK was set to 0,002 for females and 0,001 for males on the basis of the figures in Rehle *et al* (nd). The STD to/from RSK transmissions were set to be the square root of the product of these two probabilities.

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<sup>4</sup> The Metropolitan model does not balance the number of contacts between males and females and uses the same set of assumptions for source of both male and female partner.

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*Condom usage:* Figures of condom usage from the SADHS (Department of Health, 1999) were assumed to be an average of usage in all the risk groups on the somewhat arbitrary basis that usage in the PRO, STD and NOT groups was half that in the RSK group, from which the condom usage for each risk group was calculated.

*Number of new partners:* These figures of 200, 10 and 1 for the PRO, STD and RSK groups respectively were set as per Doyle and Miller (1990).

*Number of contacts per new partner for females:* The figure of 1 per partner for the PRO group is fairly common. The figures for the various combinations of the other groups were set, together with the number of imported HIV positives, by trial and error to produce a fit to the ANC survey results. The figures for males were derived from those of the females in a way that ensured consistency in the number of contacts.

A.1.2 *The fit*

The number of imported infections was set in order to 'locate' the curve in the right place in time. Figure A.1 illustrates the best fit of the ASSA2000lite version, which bearing in mind that the early ANC points are assumed to be biased upward (an estimate of the true value is included as the 'target' value for the years 1990 to 1997). The 1998 survey value is undoubtedly wrong. It would appear as if this is the unweighted result. When one weights the results by the numbers attending antenatal clinics provincially the figure drops by some 2%.

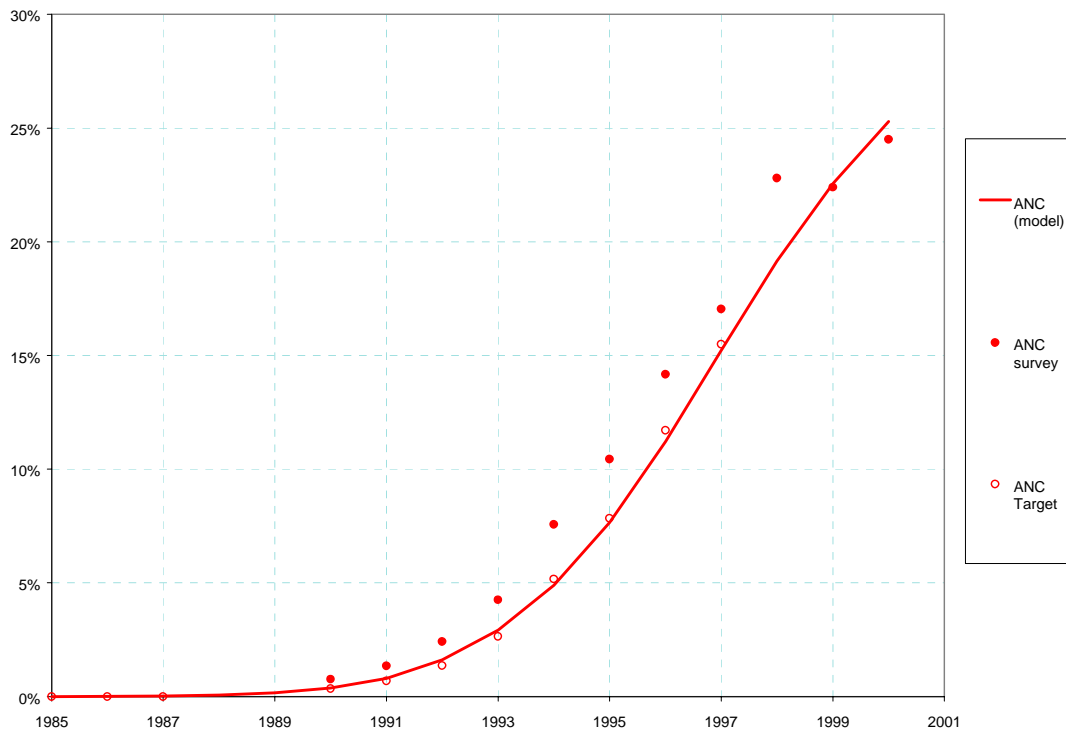


Figure A.1: Comparison of 'Lite' projected ANC prevalence with survey data

## A.2 The full model

### A.2.2 The assumptions

**Base population:** This was set applying the same method as outlined in (Dorrington, 1999) to re-estimate the 1996 census population but with the mortality assumption updated to consistent with the model.

**Non-HIV mortality:** For the years 1985-1999 a best estimate was made of the non-HIV mortality from the recorded deaths less the projected AIDS mortality (Dorrington *et al*, 2001 and Timaeus *et al*, 2001). After 1999 the mortality is assumed to trend, logistically, to ultimate rates provided by the US Census Bureau (personal communication with Tim Fowler).

**Fertility:** For the years 1985-1999 this was set to the fertility used, for each race, in the re-estimation of the 1996 census (Dorrington, 1999). After 1999 the fertility is assumed to trend, logistically, to ultimate rates provided by the US Census Bureau (personal communication with Tim Fowler).

**Migration:** This was reconstructed along the lines outlined in (Dorrington, 1999) but reworked to allow for the new mortality assumption.

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Migration after 1996 was set such that trended to zero over the following 30 years.

*Condom usage:* Figures of condom usage from the SADHS (Department of Health, 1999) for each population group separately were assumed to be an average of usage in all the risk groups on the somewhat arbitrary basis that usage in the PRO, STD and NOT groups was half that in the RSK group, from which the condom usage for each risk group was calculated.

*% in risk groups:* This was determined in a similar way to that used for the lite model except the data were split by race.

*Transmission probabilities:* These were set equal to those in the lite model by definition of the risk groups.

Calibration of the model was carried out by adjusting the number of imported HIV positives, which, in effect changes the location of the epidemic in time.

### A.2.2 *The fit*

Figure A.2 shows that aggregation of the four population groups produces a good fit to the overall ANC survey data. The aggregate prevalence for the all races combined was taken as a weighted average of the prevalence in each of the four races, using as weights the proportion of antenatal attenders in each of the race groups. Once again the model fits the data very closely if the assumption of bias in the early years is correct.

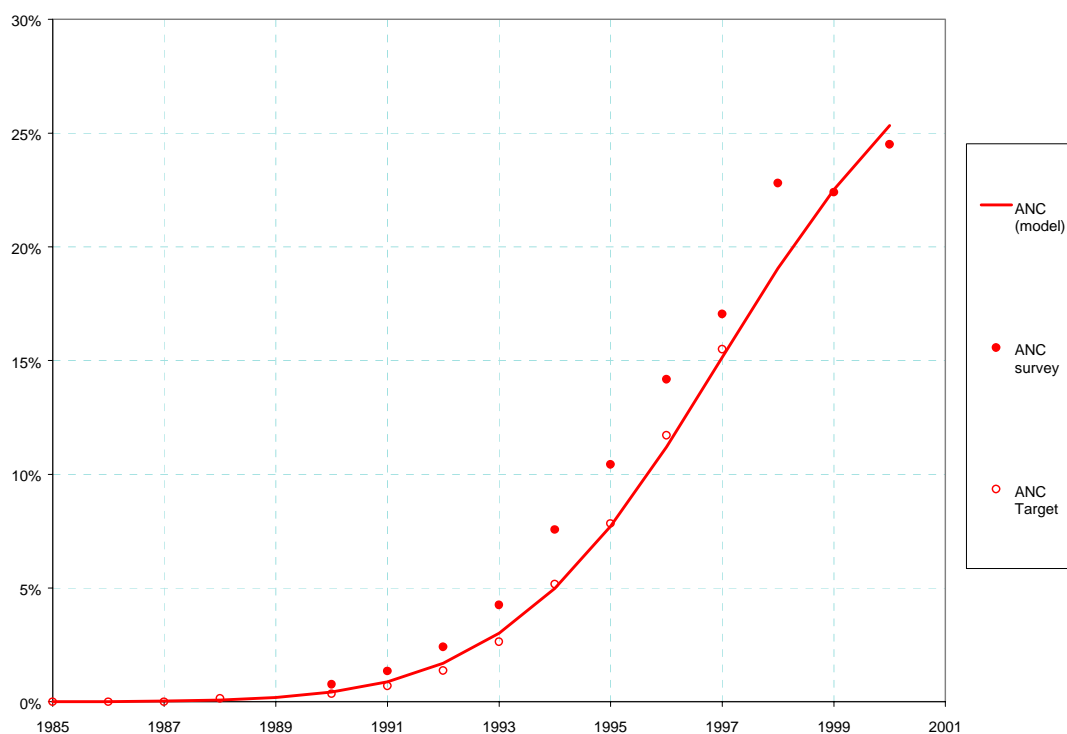


Figure A.2: Comparison of ‘Full’ projected ANC prevalence with survey data: Total population

### A.3 The provincial model

Since the existing provinces did not exist back in 1985 it was necessary to reconstruct the base population that could be expected to have been within these boundaries then.

In addition there is a great deal of uncertainty as to inter-provincial migration.

For the purposes of this exercise these numbers were estimated as follows:

The 1996 census numbers by age, gender and population group for each province were adjusted by the undercount implied by the re-estimation of the 1996 census population (Dorrington, 1999) by age, gender and population group. These figures were then projected backwards to 1985 using the full model.

As part of this process the model was calibrated to the provincial ANC figures. Surprisingly, for five of the provinces a reasonable fit was achieved by simply lagging the epidemic through adjusting the number of imported HIV positives.

The 1991 population was estimated by apportioning the 1991 national figures from the re-estimation of the 1996 census (Dorrington, 1999) by age, gender and race to the provinces on the basis of Bureau of Market Research estimates of the total populations that were expected to have been within the provincial boundaries in 1991 (Steenkamp, 1994).

Figures A.3.1 – A.3.9 show the fit achieved when the ‘full’ model was applied to each of the provinces in turn. In most cases the overall provincial prevalence was determined as a weighted average of the race-specific prevalences using the weights determined from the SADHS. However in the case of two provinces where we had

more detailed data the proportion of attendance recorded in the sample (which differed from that in the SADHS) was used.

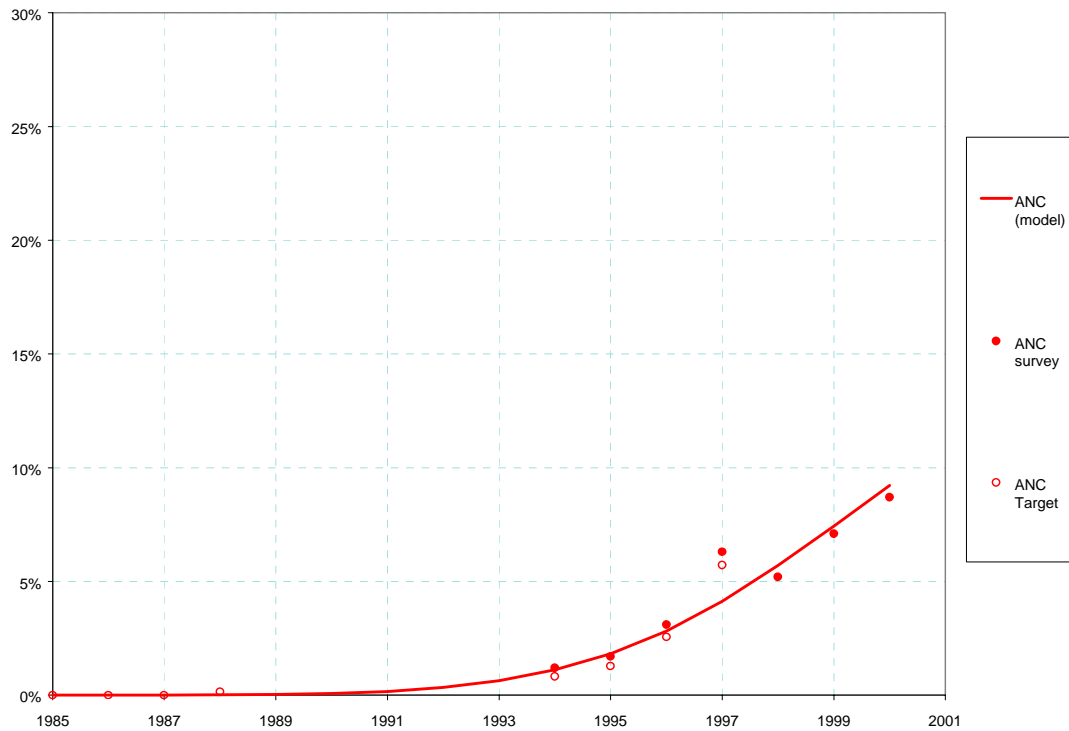


Figure A.3.1: Comparison of projected ANC prevalence with survey data: Western Cape

In the case of the Western Cape the percentage in the PRO and STD groups for the coloured and black population groups were set using the SADHS data. After this the RSK group for the coloured population was adjusted to improve the fit. The imported infected were then reduced from the proportion implied by the national fit in order to account for the fact that the epidemic in this province lags that in the rest of the country. The best fit was achieved by lagging the black population less than the other populations (presumably because this population has seen significant in-migration from the Eastern Cape of the period of the epidemic. This produced a very good fit. However, the model tends to overestimate the prevalence in the coloured population in the most recent years.



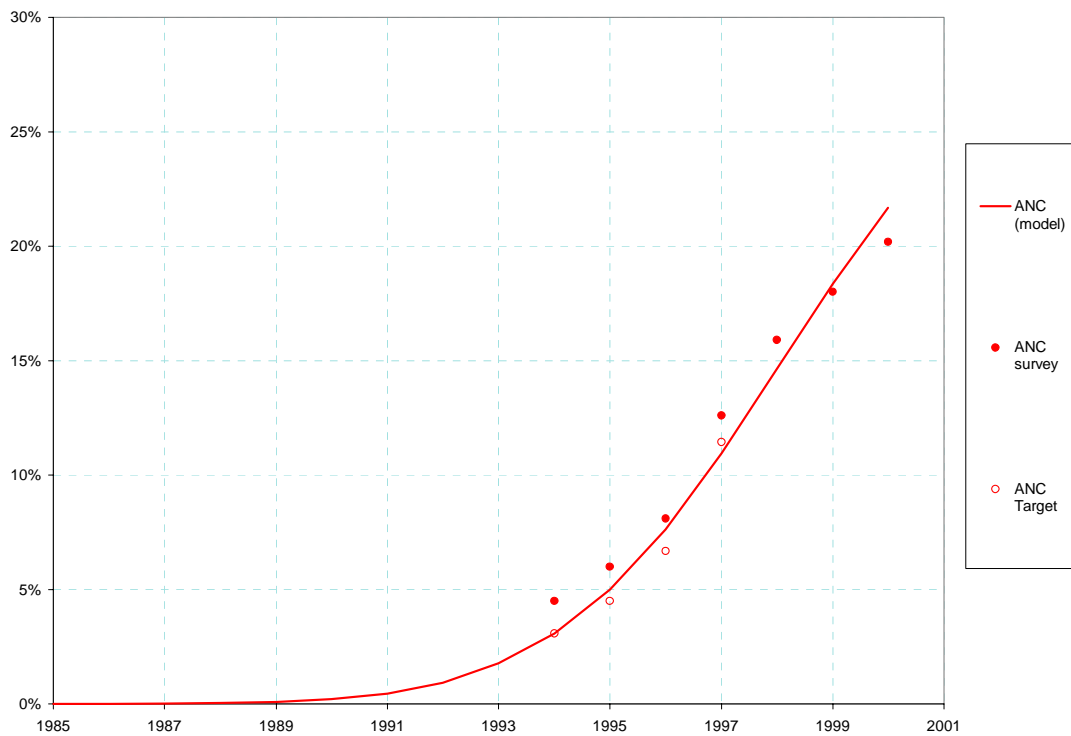


Figure A.3.2: Comparison of projected ANC prevalence with survey data: Eastern Cape

In the Eastern Cape (Figure A.3.2) the percentage in the PRO and STD groups for the black and coloured group was set based on the SADHS data. After this the number imported infections was reduced from that implied by the national fit to allow for the time lag. The fit is reasonable bearing in mind the assumed bias in the early ANC survey data.

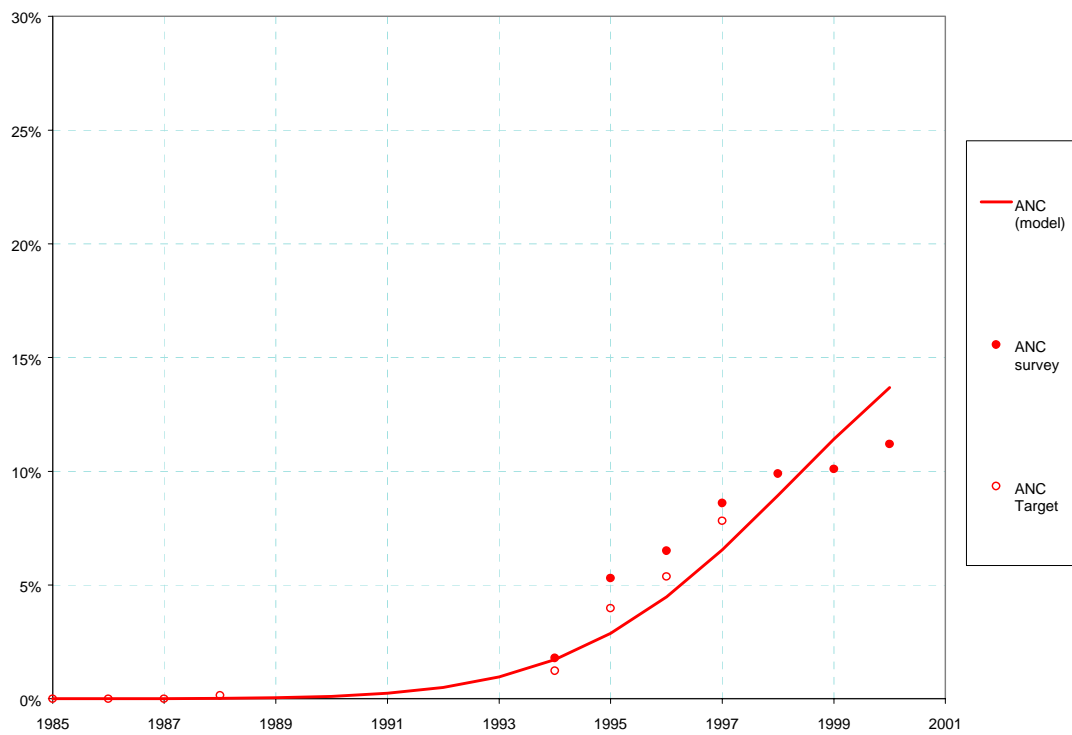


Figure A.3.3: Comparison of projected ANC prevalence with survey data: Northern Cape

For the Northern Cape the data are too scant to be able to make province-specific adjustments so it was decided to simply reduce the percentage in the RSK group down to 21.2% to bring down the curve. The fit is not very good but the numbers are small enough for it not to affect the overall estimate significantly.

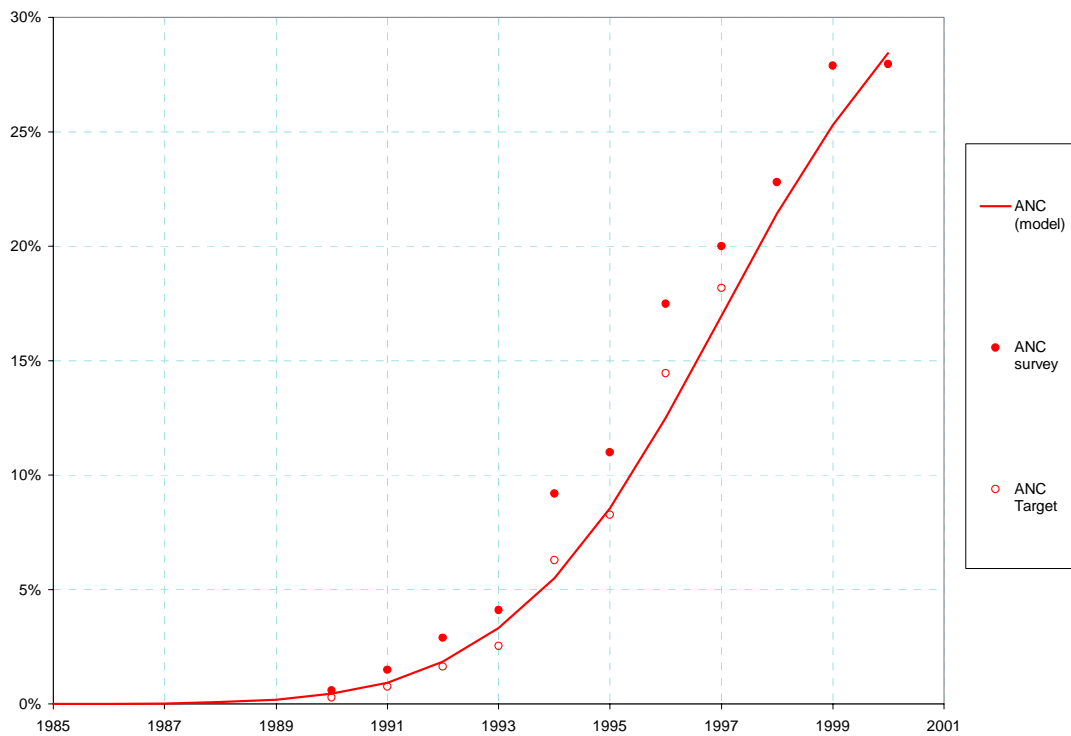


Figure A.3.4: Comparison of projected ANC prevalence with survey data: Free State

Although the fit for the Free State looks poor in the more recent years this is the result of peculiarities in the detailed data which suggest that the ANC survey results very likely overestimate the extent of the epidemic in the province. The percentage PRO and STD in the black group was initially set based on the SADHS data but subsequently reduced by 2% to produce a better fit.

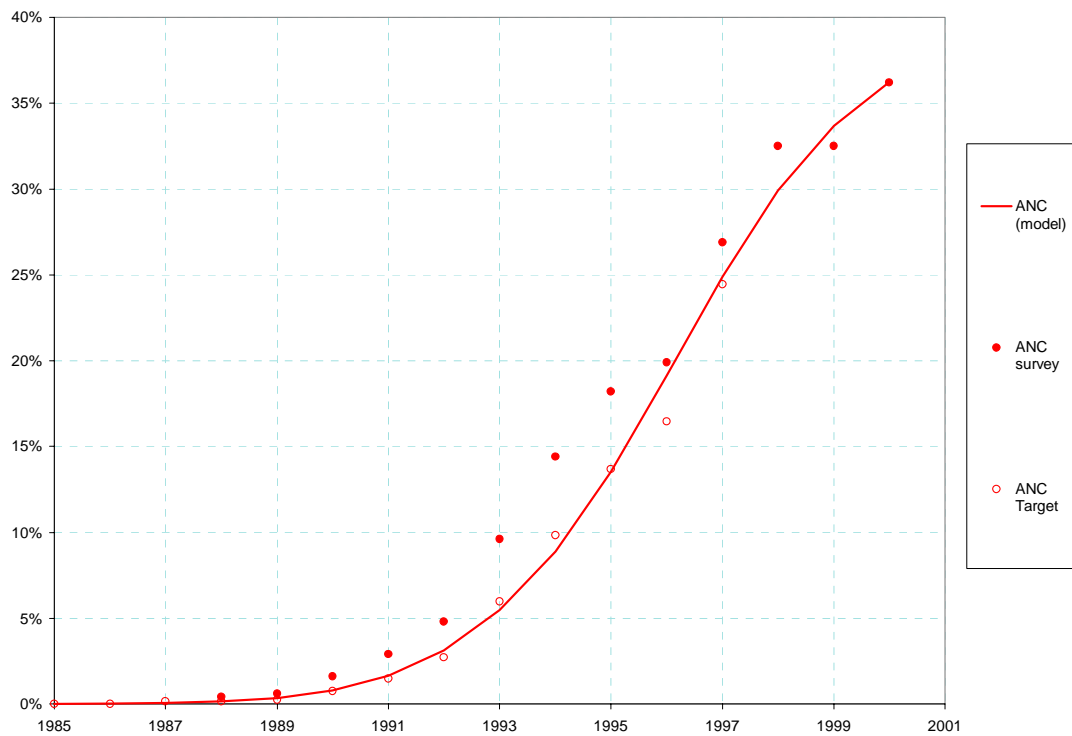


Figure A.3.5: Comparison of projected ANC prevalence with survey data: KwaZulu-Natal

The province-specific adjustments in the case of KwaZulu-Natal have produced results which fit the data reasonably well. The percentage PRO and STD in the black and Asian populations were initially set according to the SADHS but in the case of the black population this produced far too high a percentage (49% of the population) and this was reduced to 40% with the RSK group taking up the slack. The number of imported infected were increased from that implied by the national fit in order to allow for the fact that this province leads the rest of the country. The comparison of the data points (and curve) with the ‘ANC target’ points (based, from 1998 onwards, on the trajectory of the epidemic in other sub-Saharan countries) gives an indication of how much more severe the epidemic has been in this province. This fit also indicates that the epidemic in the province has yet to plateau.

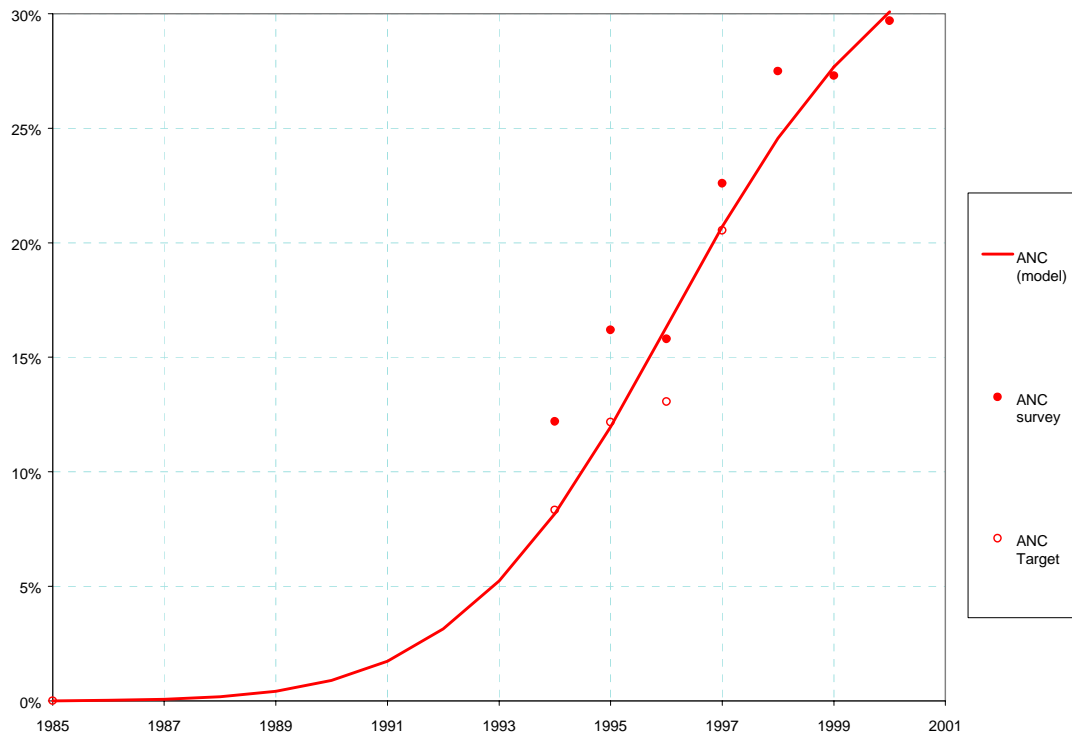


Figure A.3.6: Comparison of projected ANC prevalence with survey data: Mpumalanga

Mpumalanga is one of the provinces contributing to the surprising decline in the 1999 overall ANC prevalence from that in 1998. The official figure is 30% for 1998 but we understand that this was an error and should have been closer to 27.5%. Figure A.3.6 one would be forced to conclude (without having access to the more detailed survey data to help find another explanation) that even this result is on the high side. When fitting the model the percentage in the PRO and STD groups was estimated from the SADHS but found (at 39,2%) to be too high. The percentage STDs in this group had ultimately to be reduced to 27% and the number of imported infected doubled (to allow for the lead this province has over the rest of the country) to produce a reasonable fit.

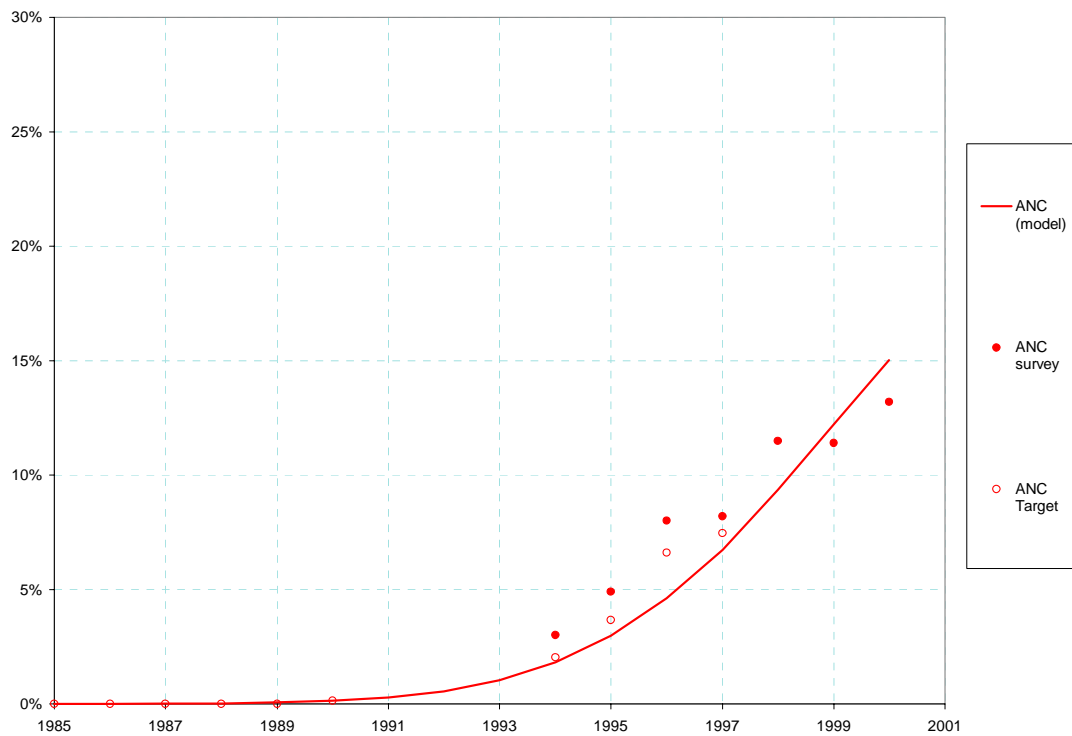


Figure A.3.7: Comparison of projected ANC prevalence with survey data: Northern Province

In the case of the Northern Province the percentage of PROs and STDs were set based on the SADHS. It proved difficult to find any combination of assumptions that could reproduce the observed data. In the end the number of imported infected were reduced (implying a lag) and the percentage in the RSK group was reduced to produce a closer fit to the two most recent years. This obviously needs further investigation.

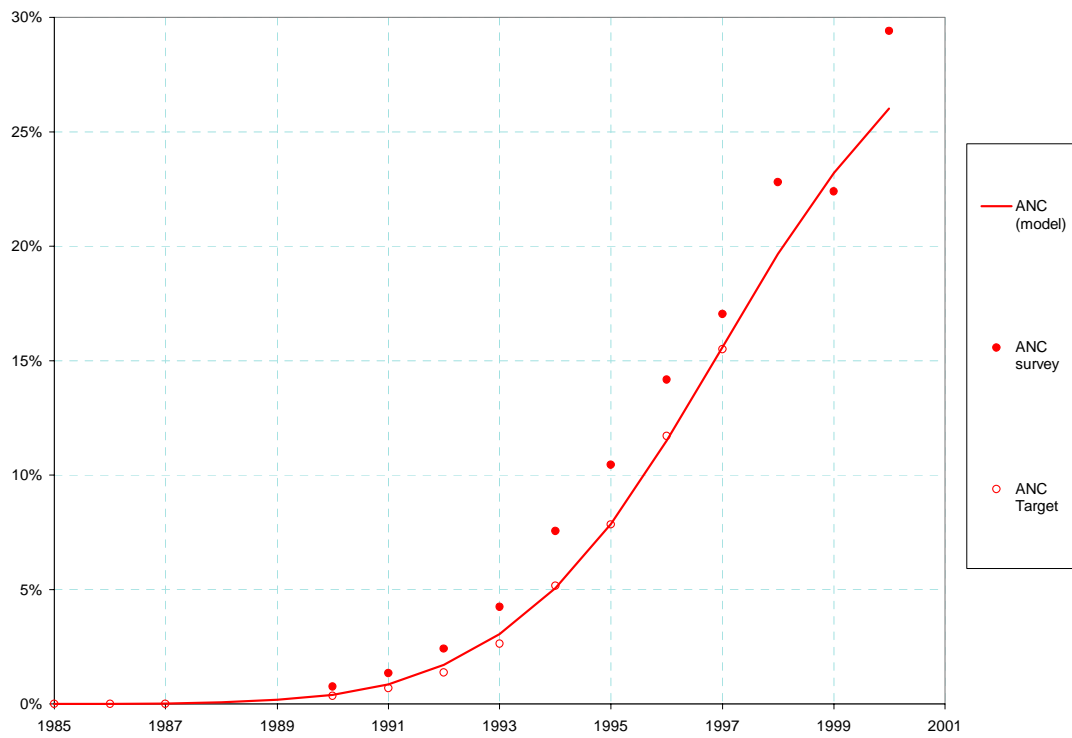


Figure A.3.8: Comparison of projected ANC prevalence with survey data: Gauteng

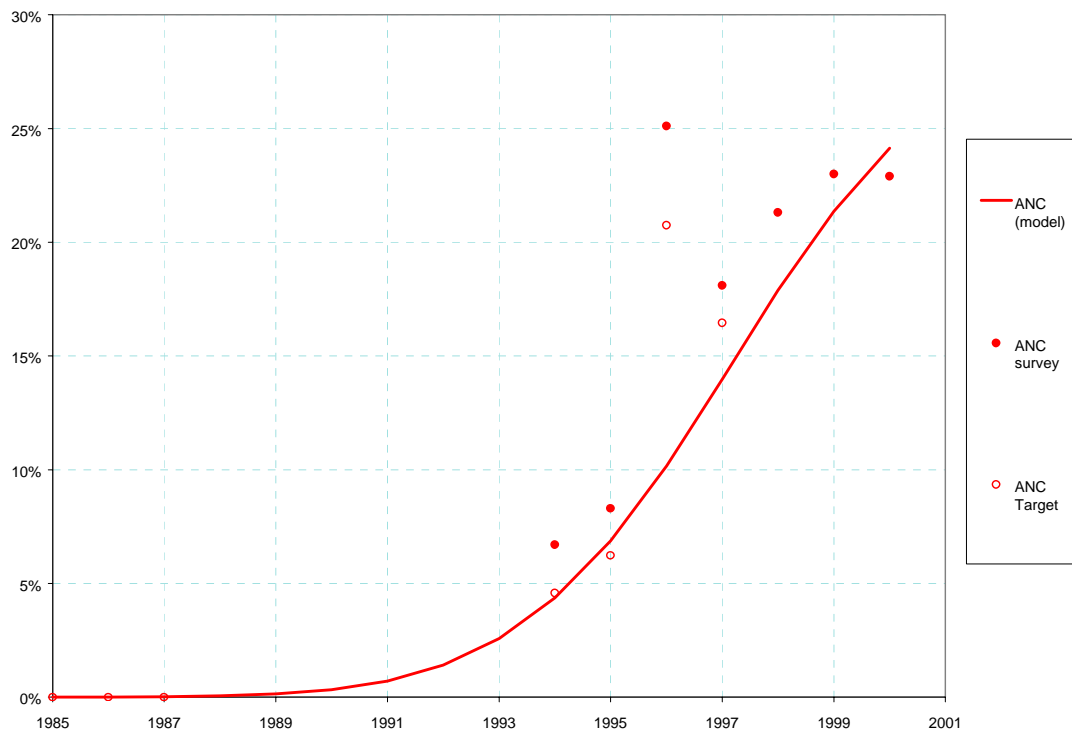


Figure A.3.9: Comparison of projected ANC prevalence with survey data: North West

Figures A.3.8 and A.3.9 show the Gauteng and North West fits. In both cases the percentage PRO and STDs in the black population was estimated from the SADHS data. In both cases this estimate proved to be too low and the STD group was set at 25% of the population. In the case of Gauteng the RSK was kept at 38% but in the case of North West it was reduced to 25% in order to model the more recent data. The fit for Gauteng is reasonably good except for the most recent observation, while that for North West is more problematic with at least one ‘outlier’!

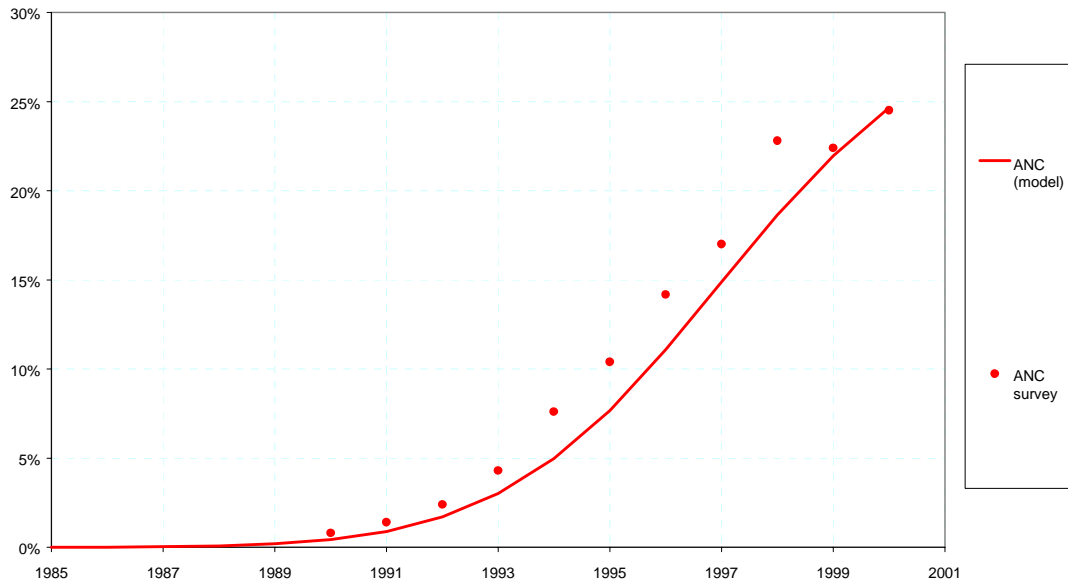


Figure A.3.10: Comparison of projected ANC prevalence with survey data: All provinces combined

Figure A.3.10 shows that the aggregation of the provincial models produces a remarkably similar fit to the lite and full versions and is comfortably close to the figures for the two most recent years. Once again the 1998 figure is obviously out of line, particularly when this feature is reproduced in only a few of the nine provinces.



## APPENDIX B

### A BRIEF DESCRIPTION OF THE ASSA600 MODEL

Essentially the model models the demographic impact of HIV/AIDS on the national population by assuming that the population (at the start of the epidemic and those turning 14) can be split into four risk groups depending on the rate of transmission over a year (namely a small very high risk group of sex workers and clients, a much larger group assumed to be at similar risk as those with STDs, an even larger group who are at risk because of their sexual behaviour and a similarly sized group who are assumed never to be at risk). The model assumes a median term to death of 10 years from HIV/AIDS mortality and effectively two years for infants born with the virus. It also allows for the impact of the virus on fertility. No behavioural changes or interventions are specifically allowed for in the model, but these can be allowed for directly to a limited extent by running the model to a point and then altering the parameters.

This is illustrated in the figure on the next page.

The model is calibrated to reproduce the results of the national antenatal survey and produce a population of 42.2 million as at the date of the 1996 census. It further assumes a net immigration, increasing rapidly from the early 1990s and levelling since 1996.

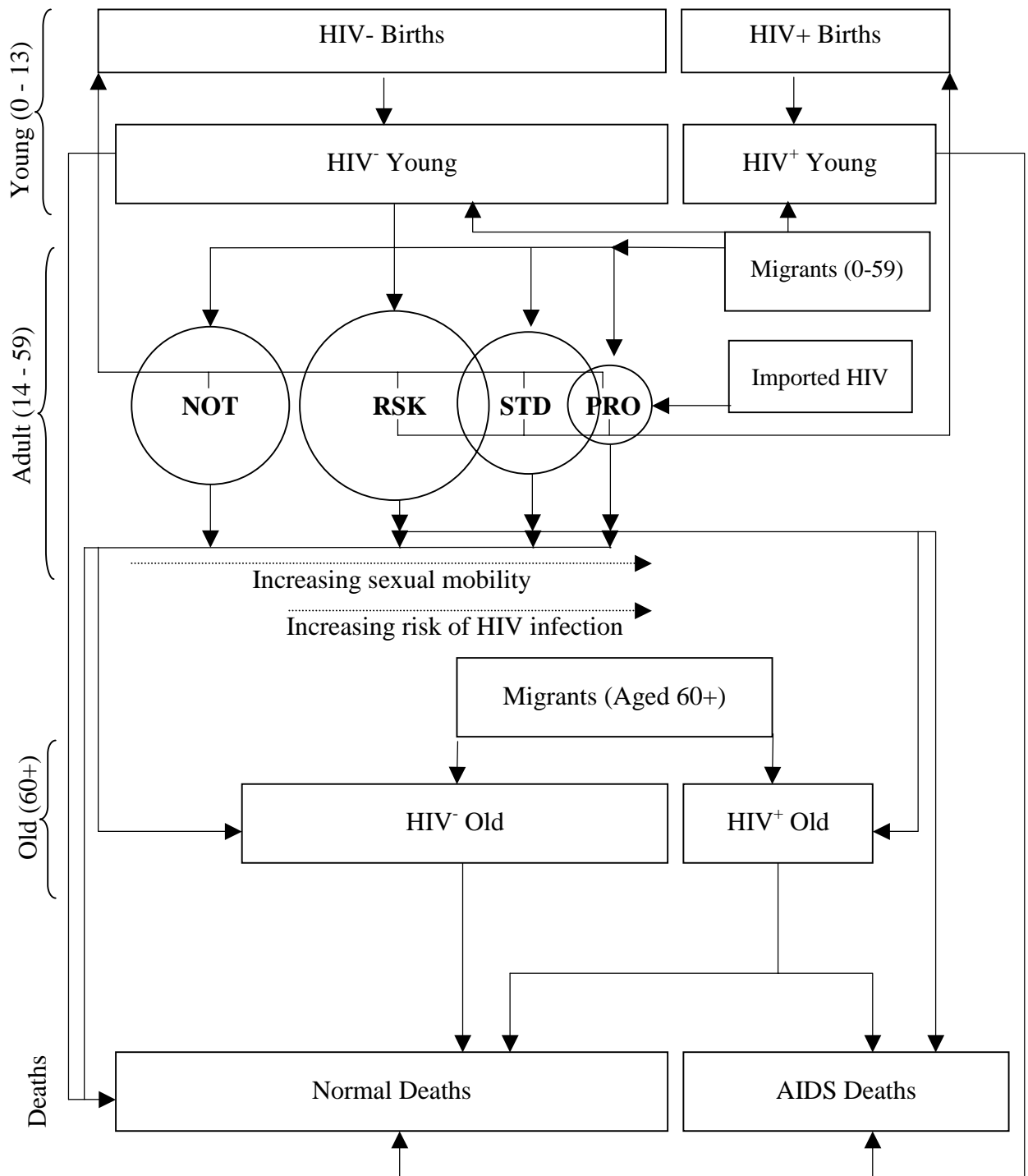


Figure B.1: A schematic diagram of the ASSA600 Aids Model