The AIDS Transition: impact of HIV/AIDS on the demographic transition of black/African South Africans

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Introduction

The earliest official diagnosis of AIDS cases in South Africa occurred in 1982 (Whiteside and Sunter 2000). AIDS is an acronym for Acquired Immune Deficiency Syndrome, the final disease manifestation from infection by the Human Immunodeficiency Virus (HIV). At the start (official) of the HIV/AIDS pandemic in South Africa, mortality and fertility rates were characterised by a declining trend within the South African population. The demographic transition theory was invoked to explain the declining mortality and fertility rates. According to the demographic transition theory mortality and fertility rates would decline to low post-transitional levels.

Variations however existed in the pace and extent of mortality and fertility decline across the four general population groups[1] in South Africa: black/African, Indian/Asian, Whites and Coloureds (Mostert *et al* 1998). The black/African population began their demographic transition at a later stage compared to other population groups in South Africa.

Consequently at the start of the HIV/AIDS pandemic the black/African population had entered a period of accelerated fertility decline although fertility decline had began in the 1960s (Moultrie and Timæus 2002). Levels of mortality had been declining since 1945 from levels estimated at 23.4 per 1000 to 9.1 per 1000 of the population in 1980 (Mostert *et al* 1998). Mortality and fertility rates were expected to continue declining to post transitional levels, as the black/African population progressed through their demographic transition.

Two decades following its official emergence, AIDS has become the single leading cause of death in South Africa, accounting for 30% of all deaths after adjusting causes of death using an AIDS demographic model (Bradshaw *et al* 2003). National sentinel surveys[2] of pregnant women attending public antenatal clinics conducted by the Department of Health since 1990 show an increased HIV prevalence from 0.7% in 1990 to 27.9% in 2003 within the South African population (Department of Health 2004). The black/African population is estimated to be the worst affected by HIV/AIDS in South Africa (HSRC 2002, Statistics South Africa 2002). The Nelson Mandela/Human Sciences Research Council (HSRC) study of HIV/AIDS conducted in 2002 estimated HIV prevalence of 12.9% (11.2-14.5)[3] for the black/African population compared with 6.2% (3.1-9.2) for the White population, 6.1% (4.5-7.8) for the Coloured population and 1.6% (0-3.4) for Indian/Asians.

The aim of this paper is twofold: 1) to introduce a more relevant and appropriate model for the altered classic demographic transition in transitional populations with high HIV prevalence: the AIDS Transition model 2) to discuss possible effects of the AIDS transition on the overall process of demographic transition of the black/African South African population.

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[1] This research does not purport to continue with the segregatory and discriminatory purpose for which population groups were used in the past, in South Africa. Reference to the population groups is purely for academic purposes.

[2] Limitations of antenatal clinic survey results include: 1) the representativeness of pregnant women who attend public antenatal clinic of all pregnant women and of the population as the survey only captures data on public clinics, 2) the bias introduced from reduced fertility due to biological effects in HIV-1 infected women and 3) under representation of smaller rural sites (Boerma, Ghys and Walker 2003).

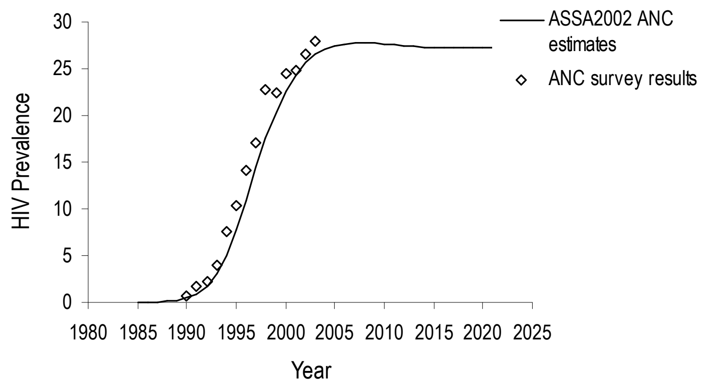
[3] Confidence intervals are provided in parenthesis.

This research does not disregard the classic demographic transition theory and subsequent refinements to the theory; its purpose is to investigate the impact of HIV/AIDS. Shortcomings of the demographic transition theory and debates on its strength as a theory are acknowledged, however the discussion is outside the scope of this paper (Caldwell 1976, Coale 1973, Goldscheider 1971, Hauser and Duncan 1951, Srinivasan 1986, Teitelbaum 1987). It is suffice to state that the classic demographic transition is considered valid and applicable to populations in so far as it can accurately depict the trend in mortality and fertility rates. The classic demographic transition theory is assumed to be applicable to the black/African South African population.

Methodology

The ASSA2002 model of the Actuarial Society of South Africa (ASSA) will be used to project the impact of HIV/AIDS on the demographic transition of black/African South Africans. Population projections were run until 2021.The ASSA2002 model is an AIDS demographic model of the Actuarial Society of South Africa (ASSA) calibrated to reproduce antenatal survey results (Figure 1). The ASSA2002 model uses the 2002 antenatal clinic (ANC) results as the latest calibration data.

Figure 1: HIV prevalence among antenatal attendees according to the ASSA2002 model and according to the Department of Health annual survey.



Source: ASSA2002 model and Department of Health (2004: 6)

The ASSA2002 estimated antenatal prevalence is a reasonably good fit of the observed antenatal clinic prevalence levels (Figure 1). Limitations of ANC data should however be taken into account.[4]Population projections of the ASSA2002 model have to be interpreted and understood in the context of assumptions made in the ASSA2002 model and limitations of those assumptions. A brief description of the ASSA2002 model and some key assumptions are provided in the appendix. Assumptions made by the ASSA AIDS Committee were not altered in running the AIDS demographic model.

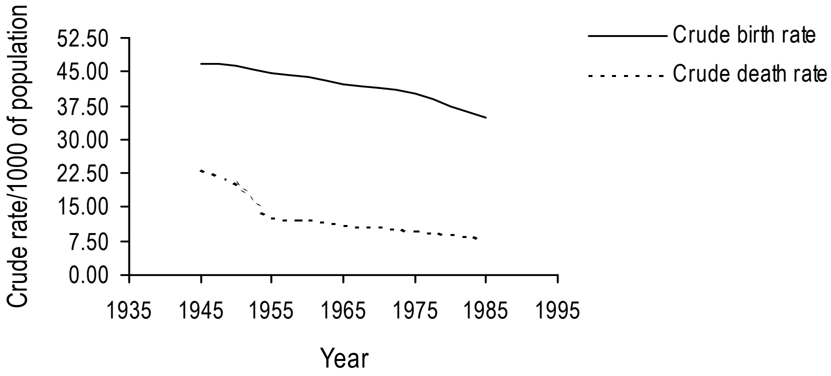
Unless a cure is found for HIV, the extent of the accuracy of the ASSA2002 population projections will not remove the impact of HIV/AIDS on the demographic transition of the black/African population. Hence the aim of this research will still be valid in its theoretical approach on the impact of HIV/AIDS.

[4] Refer to footnote 2.

The historic demographic transition of black/Africans

Mortality and fertility rates of black/Africans are estimated at approximately 35 to 40 per 1000 and 45 per 1000 respectively, at the beginning of the twentieth century (Mostert *et al* 1998). The decline in mortality and fertility rates is illustrated in figure 3, with crude rates estimated from 1945 to 1985.

Figure 3: Mortality and fertility rates of the black/African population: 1945 to 1985



Source: Mostert et al. (1998)

Crude rates[5] of mortality declined from 23.4 in 1945 to 12.8 per 1000 of the population in 1955. Mortality decline receded from 1955 to 1975 with fertility declining at a slow pace. The pace of fertility decline increased after 1975 from 40 live births per 1000 of the population in 1975 to 34.9 in 1985.

Modernization was attributed as the main cause of the demographic transition in the classic formulation of the demographic transition theory (Notestein 1945). However the term modernization is too vague and as such is associated with various processes including: industrialization, urbanization, increased education, empowerment of women, and substantial socio-economic development (Srinivasan 1986).

The role of modernization in the demographic transition of the black/African population is unclear. Mortality rates declined during periods of forced relocations into the so-called 'African Reserves', which were overcrowded with reduced land availability and cattle loss within the black/African population (Mackenzie 2000, Swartz 2002). Thus the demographic transition occurred during conditions of reduced socio-economic conditions. Nevertheless, other processes of modernization were taking place during this period, which triggered the demographic transition.

The mortality decline of black/Africans can be attributed to the following:

1. Employment in the mining industry provided income to supplement and increase the agricultural economy. Therefore nutrition and standards of living may have increased thus reducing mortality as Ross argues:

[5] Crude birth and death rates are however affected by age structure and population size.

> Migrant earnings were ploughed back into the agricultural economy of the Reserves, to the extent, for instance, that by 1930 there were nearly two and a half times as many cattle in the Transkei as a dozen years earlier, and three times as many sheep. In addition, the territory's maize yield reached its peak in 1925 (1999: 93).

2. Improved access to medical services in the rural areas (Mostert *et al* 1998).

Overcrowding in the 'African Reserves' and the fact that land in the reserves was the least arable and least water resourced resulted in the degradation of land and this prompted and intensified migration into the urban areas particularly the migration of women (Ross 1999).

Fertility decline of the black/African population can be explained from the following:

1. The reduction in infant mortality rate which increased survival of infants into adulthood. Mostert *et al* (1998) estimate that infant mortality declined from 182.5 per 1000 of the population between 1945 and 1950, to 60.6 per 1000 in 1985.

2. The increased rate of urbanization among black/African women of reproductive age. According to Mostert *et al* (1998), the urban black/African population increased from 10% in 1904 to 32% in 1960 and 35% in 1991. However the apartheid government prevented mass urbanization of black/Africans by passing restrictive legislation on urbanisation like the Urban Labour Preference Policy (Ross 1999). Urbanization is associated with adoption of new and 'Western' lifestyles associated with low levels of fertility (Mostert et al 1998, Caldwell 1976).

3. Increased education amoung women. Literacy levels increased from 38% in 1960 to 68% in 1991 (Mostert *et al* 1998)

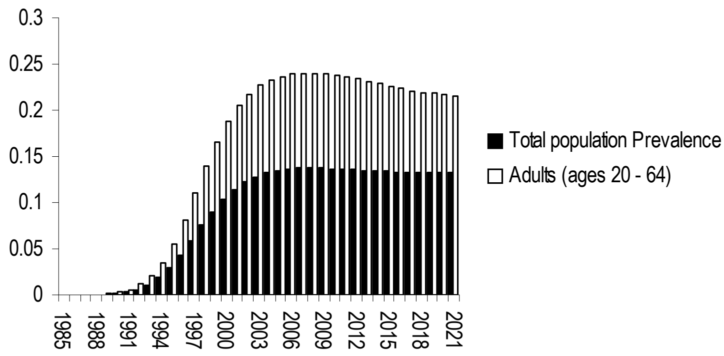
4. Male labour migration affected fertility patterns by disrupting marriage patterns and causing marital instability (Mostert *et al* 1998, Swartz 2003).

5. The launch of the National Family Planning Programme in 1974 by the apartheid government provided free contraception to the population. However with the politics of contraception at play during the apartheid era the question remains why contraception use increased amoung black/Africans. Mostert *et al* (1998) estimate contraception at below 10% in 1950, which increased to 58.6% according to the South African Demographic Health Survey in 1998 (Swartz 2003). Swartz (2003) states as the only breadwinners due to the migrant labour system; women were forced to use contraception. At the same time, agents of diffusion like the radio, television, printed media and the transport infrastructure may have contributed to the uptake of contraception amoung black/African women (Mostert *et al* 1998).

HIV prevalence projections

The ASSA2002 model projects that HIV prevalence amoung the total black/African population will increase to levels of 13.73% in 2008 and thereafter HIV prevalence is estimated to decline. Adult prevalence however is projected at much higher levels relative to total prevalence, estimated at a peak of 24% in 2007 and 2008 (Figure 2).

Figure 2: ASSA2002 projected HIV prevalence amoung the black/African population



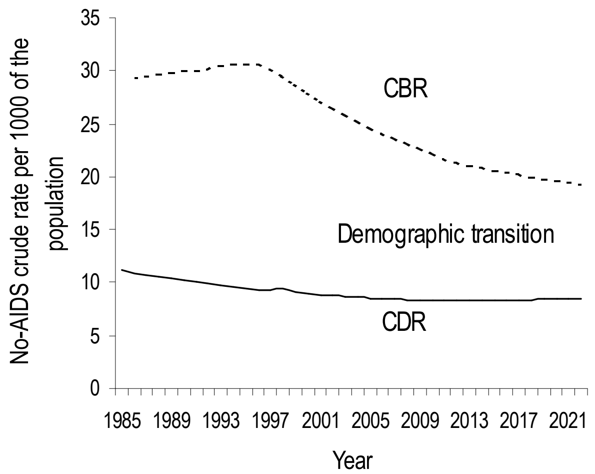
The AIDS Transition

Under a no AIDS assumption crude birth and death rates are projected to have kept declining in accordance with the classic demographic transition with crude mortality rates projected at 8.50 per 1000 of the population in 2021, and crude fertility of 19.48 live births per 1000 of the population (Figure 4).

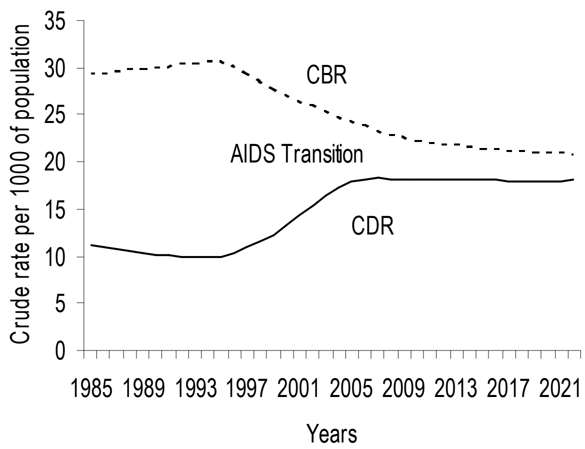
However, under the realistic assumption of HIV/AIDS, mortality rates are projected to increase to 18.02 per 1000 of the population in 2021, whilst fertility rates are projected at 21.01 live births per 1000 of the population (Figure 4). Crude fertility is projected to be slightly higher than under the no AIDS scenario due to the reduced total population, total fertility is however expected to decrease. Total fertility is projected at 2.21 children per average woman compared to a no-AIDS scenario of 2.27 in 2021. The increased mortality and slight reduction in total fertility due to the impact of HIV/AIDS calls for a more appropriate and relevant term to explain the projected demographic phenomenon in high HIV prevalence transitional populations including the black/African South Africans: the AIDS transition.

Figure 4: Projected no-AIDS and AIDS transition from 1985 to 2021: ASSA2002

No AIDS transition



AIDS transition



Characterized by mortality patterns similar to those observed in the population in the 1950s, and fertility rates of a population nearing post-transition, the AIDS transition is a paradox. One of the identifiers of modernization is attained in the form of fertility decline and another, an indicator of a reversal in modernization in the form of mortality incline.

An annual growth rate of 0.3% is projected for 2021 compared to growth of 1.1% under a no-AIDS scenario. An over 250% decline in population growth is anticipated as a result of the pandemic. Therefore the issue of population growth that has occupied the spotlight in the past decades will be ironically solved (albeit temporarily) by the impact of the HIV/AIDS pandemic. The demographic gap of the classic demographic transition model will be closed by HIV related mortality increase and the slight reduction in total fertility.

There are determinants of the AIDS transition that influence the prevalence of HIV in populations and thus the impact of HIV/AIDS. The determinants may be broadly classified into direct and indirect determinants. The direct determinants are affected by indirect determinants through prevalence factors. Prevalence factors either facilitate or mitigate the spread of HIV in the population. However prevalence factors can also influence indirect determinants. Johnson and Budlender (2002) in a review of demographic, socio-economic, biomedical and behavioural determinants of HIV prevalence in South Africa identified significant determinants and those applicable have been classified into indirect determinants and prevalence factors of the AIDS transition model (Figure 5).

Figure 5: Determinants of the AIDS transition model

Indirect Determinants ↔ Prevalence Factors → Direct Determinants

Indirect Determinants

Individual level
- Socio-economic status
- Health care seeking behaviour
- Individual risk profile
- Sexual partner(s) risk profile
- Cultural and traditional norms

Government level
- Health care provision and the cost of health care
- HIV prevention and treatment education
- Macroeconomic policies
- Sustainable development
- International migration policies

Prevalence Factors

- Knowledge on HIV prevention translated into behaviour
- Voluntary counseling and testing
- Antiretroviral treatment
- STI prevalence
- Migration patterns

Direct Determinants

- Sexual transmission
- Mother-to-child transmission
- Transfusion of HIV infected blood or blood products
- Intravenous injection with HIV contaminated objects

***Indirect determinants at an individual level*:**

(a) Socio-economic status: low socio-economic status can affect exposure to risks of HIV infection, for example engaging in sex work. However increased socio-economic status might be an incentive to have numerous sexual partners. Socio-economic status also determines affordability to treat diseases like STDs whose non-treatment increase the likelihood of HIV infection.
(b) Health care seeking behaviour: particularly of STDs, since STD's increase the risk of HIV infection.
(c) Individual risk profile: individual behaviour that exposes individuals to the risk of HIV infection.
(d) Sexual partner(s) risk profile: the behaviour of sexual partner(s) that expose both the individual and their sexual partner(s) to risk of HIV infection.
(e) Cultural and traditional norms: for example the practice of circumcision which has been associated with reduced chances of HIV infection and cultural practices of widow inheritance reported on the decrease due to HIV/AIDS (Mukiza-Gapera and Ntozi 1995)

Indirect determinants at the government level:

(a) Health care provision and the cost of health care.
(b) HIV prevention and treatment education.
(c) Macroeconomic policies: macroeconomic policies of a government have an effect on economic growth and on per capita economic output. However per capita growth translates into individual socio-economic growth to the extent that there is equal access and distribution amoung the population.
(d) Sustainable development: to the extent that the government engages in development which is sustainable and which can allow the population to maintain itself in the face of adverse circumstances like the HIV/AIDS pandemic.
(e) International migration policies: for instance policies on HIV positive individuals to travel for treatment and policies on control of cross-border movements.

Prevalence factors

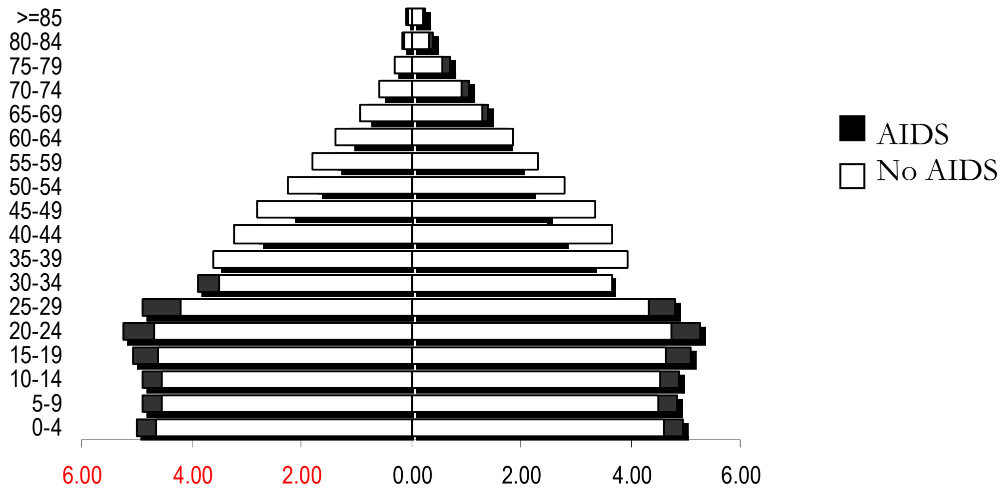
(a) Knowledge on HIV prevention and transmission translated into behaviour: this results in practices like condom use and non-sharing of needles.
(b) Voluntary counseling and testing: the use of voluntary counseling and testing facilities to ascertain HIV status and undergo counseling. This can have an effect on for instance pregnancy decisions and sexual behaviour.
(c) Antiretroviral treatment: reduces the viral load and thus reduces infectivity of individuals and the occurrence of AIDS related diseases. However an improved health status may result in some individuals engaging in risky behaviour that may expose other individuals to HIV infection.
(d) STD prevalence: STDs have been associated with increased risk of HIV infection.
(e) Migration patterns: Migrants and migrant workers have been shown to be at high risk of HIV infection.

The ***direct determinants*** of the pandemic are the ways in which the virus is transmitted in populations (Palloni 1996, Schoub 1994):

(a) Sexual transmission: vaginal, oral or anal sexual intercourse with an infected partner
(b) Mother-to-child transmission either intrauterine, perinatally or through breastfeeding
(c) Transfusion of HIV infected blood or administering HIV infected blood products
(d) Intravenous injection with HIV contaminated needles, syringes or sharp objects

Demographic effects of the AIDS transition

Figure 6: Projected population pyramids for the black/African population: 2021 (Percentage of total population).



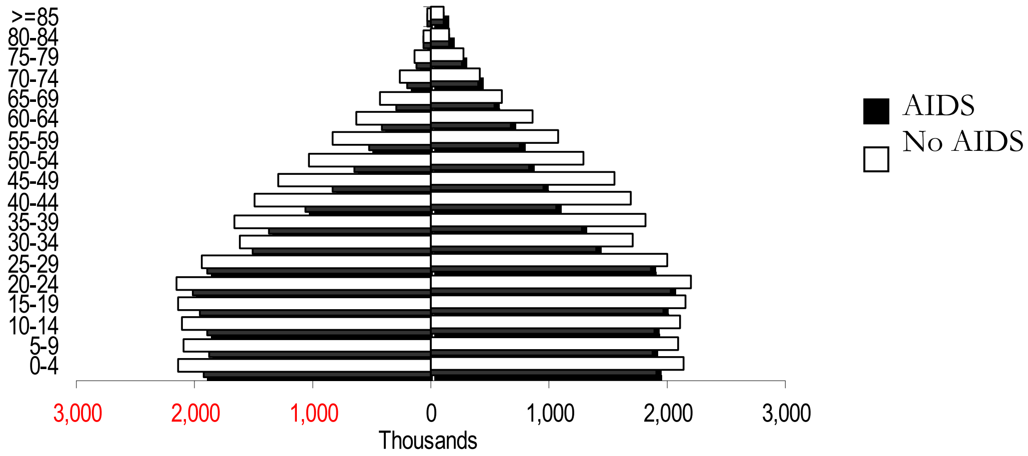
Higher proportions of males and females below the age of 30 are projected in 2021 relative to a no AIDS scenario. Males 30 to 34 years are also projected at a higher proportion. Adult AIDS deaths will lead to a lower proportion of females aged 30 to 65 years and males aged 35 to 70 years in 2021. The reduced adult population from the impact of HIV/AIDS will result in a younger population reflected in the higher proportion of children and young adults (Figure 6). A median age of 24.94 is projected in 2021 relative to a no-AIDS median age of 27.31.

The proportion of the young (aged below 15) is projected to be 29.47% (11,385,920) in 2021, compared to a no-AIDS scenario of 27.38% (12,674,257). The potentially economically active group aged 15 to 64 years will comprise 64.88% (25,061,639) in 2021 relative to a proportion of 67.27% (31,140,518) in the absence of HIV/AIDS. The old age group 65 years and older is projected at a higher percentage of 5.65% (2,182,690) compared to a no-AIDS scenario of 5.35% (2,478,381).

Deaths amoung potentially economically active individuals will impact on the age dependency ratio. The dependency ratio is computed from the total of persons aged 15 years and younger with those 65 years and older, divided by those aged 15 to 64. The age dependency ratio is projected to be 0.54 in 2021 compared to 0.49 in a no-AIDS scenario, an increased age dependency of 10% due to HIV/AIDS.

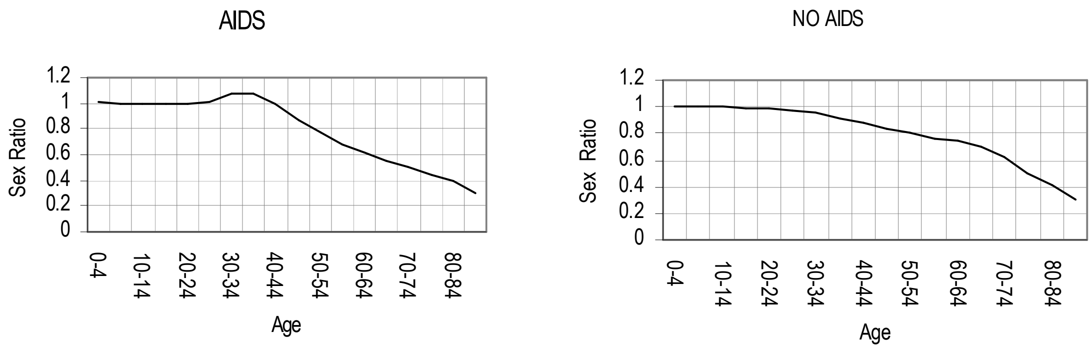
The demographic impact of HIV/AIDS is evident from the reduced population (dark bars) at all ages except persons 65 years and older since the ASSA2002 model assumes no HIV infections above the age of 60 (Figure 7). Females aged 28 to 34 are projected to have the highest AIDS deaths in the range of 166,063 to 184,503. Male adult deaths in contrast are projected to peak in an older age range between the ages of 34 to 36 years with total deaths ranging from 140,589 to 142,000 by 2021.

Figure 7: Projected population pyramids for the black/African population: 2021 (Population totals).



Differences in the AIDS impact across males and females will affect the sex composition of the population. The higher impact of AIDS mortality among females of reproductive age will result in more males projected in the age group 20 to 44 years, reflected in a sex ratio greater than one in the ages 20 to 44 years (Figure 8).

Figure 8: Five-year age group sex ratios for black/Africans projected for 2021.



Source: ASSA2002

Implications for the future demographic transition

The approximating fertility and mortality rates at the end of the AIDS transition resemble the pre-transitional stage of the classic demographic transition model, prompting the question of expected trends in fertility and mortality rates in the aftermath. What implications does the AIDS transition have (if any) on the future pattern of the classic demographic transition of the black/Africans?

As HIV prevalence recedes in the population, AIDS related mortality will consequently decline (assuming the absence of significant secondary epidemics of HIV/AIDS). Therefore with mortality levels expected to decline, it is the implications of the AIDS transition on future fertility trends that will be explored.

The impact of HIV/AIDS on future fertility trends of the black/African population in South Africa needs to be understood within the dynamics of an on-going fertility transition. Fertility rates amoung black/African women have been on the decline since the 1960s (Moultrie and Timæus 2002). Total fertility is projected at 2.21 children per average woman in 2021 (ASSA2002). Furthermore, the inevitable demographic 'gravity' is fertility decline (Dyson 2001). Whatever impact the AIDS transition may have on the fertility transition (if any), ultimately fertility levels will assume a downward trend. As Kirk (1996: 386) noted, "They may accelerate or delay the transition, but the transition itself is inescapable". Therefore this discussion will be centred around possible secondary effects of the AIDS transition on fertility trends.

Secondary effects of the AIDS transition are separate from the direct effects of HIV infection on fertility. Secondary effects are implications of the impact of HIV/AIDS assumed to work through HIV negative females of current and future reproductive age. Secondary effects of the AIDS transition can either have a negligible role on the demographic transition, or have a large enough effect to affect the demographic transition. The AIDS transition is expected to influence the demographic transition in the following possible ways:

1. ***A continued demographic transition***: A continuation of the fertility decline, which coupled with declining mortality, will result in the progression of the black/African population to post-transitional levels.

2. ***A stalled fertility transition***: institutional and diffusion effects of the on-going fertility transition advocating for a continued fertility decline may be cancelled out by fertility rise effects of the AIDS transition resulting in stalled fertility levels.

3. ***A second demographic transition***: A post-AIDS baby boom may increase fertility levels which coupled with decreasing mortality rates (from the receding pandemic) could result in a second demographic transition where fertility levels will eventually decline to fluctuate around low levels of mortality.

Several factors are attributed for the fertility decline of the black/African population. The discussion on the impact of the AIDS transition is however limited by the fact that other factors will be operating simultaneously with effects of the AIDS transition in affecting fertility rates, thus making it difficult to fully isolate AIDS and non-AIDS impacts. The likely impact of HIV/AIDS on factors of the fertility decline is provided below:

Mortality decline: Reductions in infant mortality rates (IMR) contributed to the fertility decline amoung the black/African population. HIV/AIDS is projected to increase infant mortality rates. Based on this reasoning would an increase in the IMR trigger a fertility rise? Mackenzie (2000), in his fertility rise theory, raises the possibility of fertility rates rising to compensate increased death rates to avoid extinction. However in a population projected at 38,630,248 in 2021 compared to a population of 46,293,156 in the absence of HIV/AIDS, the threat of extinction seems unlikely. Furthermore, a positive growth of 0.3% is projected for the black/African population in 2021, thus removing any threats of extinction.

Contraception use: Contraception use is on the rise in South Africa including condom use advocated for its dual purpose of preventing STIs like HIV infection and at the same time preventing pregnancy. Condom use increased from 4.6% between 1987 and 1989 to 22.2% between 1996 and 1999 (Du Plessis 2003).

Urbanization: Although HIV prevalence is higher in the urban areas relative to the rural areas, the impact of how HIV/AIDS will affect urbanization is not clear, although there are indications HIV/AIDS will slow down urbanization (Dyson 2003).

Education: Formal education is the type of education mainly associated with fertility decline. Parent's mortality has been shown to negatively affect education attainment of children particularly maternal deaths (Case and Ardington 2004). Therefore increased AIDS related mortality projected higher amoung females is set to disrupt education attainment of future reproductive individuals. Furthermore, maternal education is a "powerful predictor of the educational outcomes of children, after controlling for family and community resources" (Thomas 1999: 173).

Marriage: Marriage has become less significant in determining fertility trends in South Africa with non-marital fertility similar to marital fertility (Chimere-Dan 1999 cited in Swartz 2003). A high proportion of female-headed households and teenage pregnancies contribute to the non-marital fertility (Swartz 2003). Declines in non-marital fertility appear to be the driving force behind fertility decline South Africa (Swartz 2003).

Secondary effects of the AIDS transition

The AIDS transition appears to be significantly affecting contraception use and education levels. Increased contraception use is contributing to the on-going fertility decline. However it is the negative impact of HIV/AIDS on education that may result in secondary effects of the AIDS transition affecting the demographic transition. Increased education levels amoung women have been identified as significant for the fertility transition in South Africa, although males appear to also influence fertility in South Africa (Thomas 1999). At the same time demographic impacts of the AIDS transition will result in a higher proportion of males to females between the ages of 20 years to 44 years. Therefore secondary effects of the AIDS transition will be based on the impact of the AIDS transition on education and on the age and sex structure of the black/Africans projected for 2021.

The extent of the impact of HIV/AIDS on education attainment will determine whether or not these effects will be translated into population level effects of enough significance to impact the fertility transition. High enrolment ratios observed in countries of high HIV prevalence have been attributed to a strong schooling culture (Bennell *et al* 2002). Does the black/African population have a strong schooling culture enough to avert or lessen the negative impact of HIV/AIDS on education attainment?

The 'Bantu' education system introduced for black/Africans during apartheid with scant resource allocation limited education training and skills (Maharaj *et al* 2000, Ross 1999). Maharaj *et al* (2000: 9) argue, "Education thereafter [after the introduction of 'Bantu' education] became a focal point of violence and disruption in the struggle to end apartheid. The 1976 Soweto uprising is one of the most infamous…" Slogans like 'liberation now, education later' were common (Nkomo 1990 cited in Maharaj *et al* 2000: 9). Therefore political unrest in the apartheid era disrupted education attainment.

However in the post apartheid era, improvements were noted in participation rates of black/African learners, as the Department of Education (2002) notes:

> "In the years following the democratic elections in 1994, declining levels of disruption and political unrest resulted in an increase in enrolment from the levels in the late 1980s. This expansion in enrolment was mainly to the result of African learners' entering the system in large numbers. Since then, policies, programmes and funding arrangements have been established to ensure that these gains in participation are sustained" (2002:22)

A review of gross enrolment ratios between 1994 and 2001 indicate possible effects of HIV/AIDS. A gross enrolment ratio (GER) is defined as "The number of students enrolled in a level of education, regardless of age, as a percentage of the population of official school age for that level" (Statistics South Africa 2001: 24). A GER of more than 100% indicates more learners than the official school age, indicating the presence of under-aged and/or over-aged learners. On the other hand a GER of less than 100% indicates fewer learners than the official school age, implying dropouts among official age learners.

Gross enrolment ratios (GERs) for secondary enrollers estimated at 46.19% in 1985, increased to 90% in 1996. The GER stagnated at 90% from 1996 to 1998 and thereafter started declining to a rate estimated at 87% in 2000. Primary gross enrolment ratios, which had been declining since 1995 as official ages were implemented and rates of repetition, re-entry and late entry into primary school declined, increased from an estimated 100% in 2000 to 116% in 2001 (Department of Education 2002). The decreasing enrolment ratios of secondary learners might be a result of dropouts, whilst the increasing GER of primary learners might reflect increased repetition and over-aged learners: possible effects of the AIDS transition. Hence it might be satisfactorily hypothesised that schooling culture among black/Africans may not be strong enough to mitigate the impact of HIV/AIDS, as the pandemic is negating improvements in education attainment in South Africa.Unless effective interventions are implemented, the impact of the AIDS transition might affect education attainment significantly.

Maternal orphans were found to be a quarter of a year behind in school with reduced spending on their education of 10% when compared to non-orphans in the same household (Case and Ardington 2004). The highest proportion of orphaned children who have lost either a mother or both parents is projected in 2016 where 13.63% (1,593,847) of black/African children under the age of 15 will be orphans, decreasing to 13.16% (1,498,446) by 2021 (ASSA2002). At the same time AIDS related deaths are projected higher amoung females (including mothers) compared to males. Therefore if loosing a mother is associated with reductions in current education attainment, high AIDS deaths projected amoung potential mothers will result in reduced education attainment of their children. These children are the future reproductive individuals.

Although the study by Case and Ardington (2004) did not show females to be at a significantly higher risk of disruption in education attainment relative to males, the relationship of female education to fertility has been found to be stronger relative to that of male education (Singh and Casterline 1985). Cohorts of females born between 1972 and 2006 will be aged 15 to 49 years in 2021. The older cohorts commenced their reproductive period at the time that HIV was still emerging within the black/African population, whilst the younger cohorts were born in a period of higher HIV prevalence and hence worse effects of the pandemic. Females of future reproductive age (below 15 years) in 2021 will be born during a period of almost plateauing female AIDS deaths (ASSA2002). All things being equal, the higher the AIDS deaths amoung parents, the worse the impact of HIV/AIDS on current education attainment of their children. Will future fertility levels be affected with reductions in current education attainment of orphans, particularly females due to impacts of the AIDS transition?

The mortality decline of the demographic transition results in the 'feminisation' of the population due to higher survival amoung adult females relative to adult males. According to Dyson (2001), this 'feminisation' of the population contributed to political and gender equality. Dyson boldly concludes that, "…the more adults and women there are in society, the more their voice will come to be heard, eventually" (2001: 17). Does the reduced number of adult women (aged 20 to 44 years) imply possible reversals in gains in gender relations? With reversals in gender relations, women's autonomy may be compromised and thus fertility decisions.

As education is associated with fertility decline, the disruption of current education of both male and particularly female black/Africans may prompt a rise in future fertility trends. Education is associated with fertility reducing outcomes like late age at marriage, small desired family size, and increased use of modern contraception. The disruptive effect of HIV/AIDS on school attainment of orphans might encourage early age at marriage, with higher fertility desires resulting in increased fertility in the cohorts affected by the AIDS transition.

However the AIDS transition is occurring parallel to the fertility transition, thus diffusion forces and institutional forces of fertility decline will also affect fertility desires of reproductive women. Therefore will the currently on-going fertility transition influence the fertility choices of males and females whose education has been disrupted by the impact of HIV/AIDS? Which dominant force will influence the fertility transition between secondary effects of the AIDS transition and fertility decline institutional and diffusion forces, bearing in mind that ultimately fertility levels will decline?

Whilst the negative impact of the AIDS transition on education attainment may have fertility rise consequences, it is the extent of the impact within the general population (which can be reduced by effective intervention), that will determine the overall outcome. However an attempt to answer the question of which force will be dominant at the end of the AIDS transition would be to assume that education attainment is the only factor to affect the fertility transition. Education is a single variable out of possible secondary effects of the AIDS transition, which may have an effect on the fertility transition. There is need to investigate the impact of the AIDS transition on the current socio-economic status of individuals affected by HIV/AIDS as this discussion looked at education as a proxy for future income. In addition, there are current psychological effects of the pandemic that may also affect the fertility of cohorts born during the AIDS transition. Effective government intervention may mitigate any secondary effects to insignificant levels. In their study Case and Ardington (2004) found foster care grants and school fees waiver interventions to not be as effective at the time of study.

Conclusion

The AIDS transition was introduced as a more appropriate model to be included in the trend of mortality and fertility rates of high HIV prevalence populations. Determinants of the AIDS transition can be categorised into indirect determinants and direct determinants. Indirect determinants are characteristic at the individual and government level, whilst direct determinants are the biological modes of HIV transmission. Indirect determinants affect direct determinants through prevalence factors that facilitate or mitigate the spread of HIV in a population and can also influence indirect determinants.

The similar levels of mortality and fertility rates at the end of the AIDS transition prompted the question of how future fertility trends would react given a receding pandemic and consequently declining mortality. However the ultimate trend in fertility rates is fertility decline and therefore secondary effects of the AIDS transition on fertility decline would determine any deviation from the 'gravity'.

This paper highlighted the negative impact of the AIDS transition on education attainment of orphans and how this may indicate towards a rise in fertility rates, as education is associated with fertility decline. As this discussion was limited to the impact on education attainment, more evidence on other factors being simultaneously affected by HIV/AIDS is required to project the likely trend in fertility rates following the AIDS transition.

However the question of how trends in fertility will behave has important implications in so far as the demographic transition is used in population projections and policy making. Population policies in the post AIDS era will depend on the pattern of fertility expected based on the whether secondary impacts of the AIDS transition will be significant or not. Thus forces of the downward trend in fertility will be operating within the population simultaneously with potentially fertility rise effects. Fertility levels might continue declining, increase initially then assume a downward trend later or fertility levels might remain constant.

Demographic effects of the pandemic also indicated towards a possible reversal in gender relations due to the higher AIDS deaths projected for women resulting in more males in the age group 20 to 44 years.

Therefore more research is needed to fully ascertain possible impacts of the AIDS transition and subsequent effects on future fertility, in the midst of an on-going fertility transition.

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Appendix: Brief structure and assumptions of the ASSA2002 model summarized from the ASSA2002 User Guide (Dorrington, Johnson and Budlender 2004).

The ASSA2002 model splits the population by sex and by age into a young population (aged 0 to 13 years), an adult population (aged 14 to 59 years) and an old population (60 years and older).

The adult population (aged 14-59) is divided into four risk groups according to their risk of contracting the HIV through heterosexual activity. Dorrington, Johnson and Budlender (2004) define each risk group as follows:

PRO: "Individuals whose level of sexual activity is such that it is similar to that of commercial sex workers and the level of condom usage and infection with STDs is similar to that of the STD group."

STD: "Individuals whose level of sexual activity is such that their HIV prevalence is similar to someone regularly infected with STDs."

RSK: "Individuals with a lower level of sexual activity, but who are still at risk from HIV in that they have, on average, one new partner per annum and sometimes engage in unprotected sex."

NOT: "Individuals who are not at risk of HIV infection" (2004: 6).

RSK group individuals do not by definition engage into sex with individuals in the PRO group. The NOT group individuals only have sex with persons in the NOT group and if they have sex with individuals from the other groups then they always take "effective precautions" (Dorrington, Johnson and Budlender 2004: 6). The adult population classification into the PRO, STD and RSK groups is subdivided according to an individual's duration since HIV infection.

Individuals in the young population (aged 0 to 13) are allocated to the NOT adult group on their 14th birthday and thereafter allocated to the other three adult groups (PRO, STD and RSK) according to their level of sexual experience until the age of 25. At 25 years and older, individuals are allocated to the four risk groups according to proportions stated in table A.1.

Table A.1: Proportions of risk group allocations of black/Africans

RISK GROUP	PERCENTAGE OF MALE POPULATION	PERCENTAGE OF FEMALE POPULATION
PRO	1.2%	1.2%
STD	25.0%	25.0%
RSK	25.0%	25.0%
NOT	48.8%	48.8%
TOTAL	100.0%	100.0%

Source: Dorrington, Johnson and Budlender (2004)

The percentage of the NOT group determines to a large extent the level at which the HIV/AIDS pandemic plateaus (Dorrington, Johnson and Budlender 2004: 25).

The adult population (aged 14 to 59) is allocated to the OLD group on their 60th birthday. Individuals are still subdivided by the duration since HIV infection except that ASSA2002 assumes no further HIV infections after the age of 60 years. An assumption of no fertility beyond the age of 60 is also made for females in the OLD group. No individual is assumed to live beyond the age of 90.

At the start date of the model on 1 July 1985, the population is assumed to be free of HIV. HIV is introduced into the population through male and female HIV infected 'imports', who are classified into the PRO risk group and are used to infect their partners thereby creating HIV prevalence within the population and starting the epidemic. ASSA2002 assumes 322.1 males and 322.1 females as the imported infectivity into the black/African population. The model assumes that the transition from an HIV positive status (HIV infected status) to an HIV negative status in impossible.

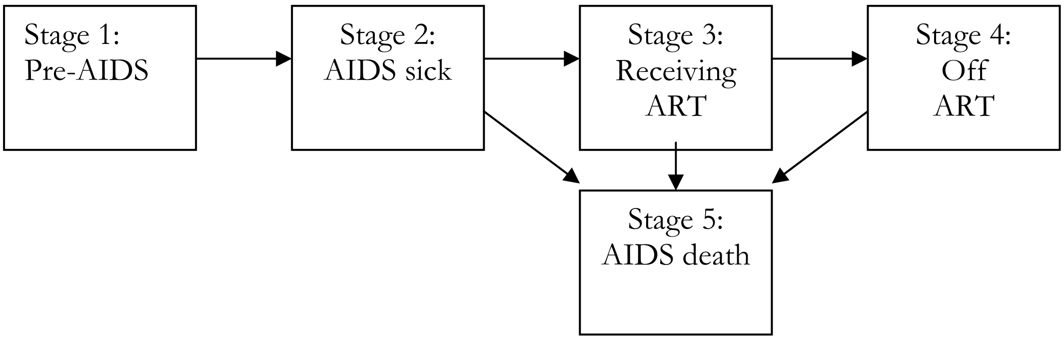
The rate of HIV infection is controlled by assumptions about two important factors: the amount of sexual activity and the probability of infection, both of which are determined by other factors. Male sexual activity is a function of female sexual activity and the age of their female partners

An individuals' sexual behaviour and hence probability of infection is modelled considering the following factors and respective probabilities for the various combinations of risk groups (where appropriate):

- The probability that a partner (male or female) is from a particular risk group:
- Male-to-female and female-to-male transmission probabilities per sexual contact for the various combinations of risk group contacts
- The probabilities of transmission provided separately for the period without interventions and the period with interventions. Probabilities of male-to-female and female-to-male transmission are calculated per sexual contact based on the combinations of the risk group contacts. The ASSA2002 assumes no sexual contact between the RSK group and the PRO group and further assumes that no HIV transmission can occur to individuals in the NOT group (hence the NOT group has not been included in the tables).
- The number of new partners per year
- The contacts per new partner per year
- The effectiveness of condoms used is assumed to be 95%. Relative frequencies of sex, frequencies of condom non-usage and HIV infectiousness based on an individuals' stage of HIV disease is provided in table 9 with the initial multipliers provided for the no intervention period and the current multipliers for the period with interventions.
- Condom usage for each risk group by age. Condom usage was provided for the period with and without interventions.

Survival of HIV positive individuals aged 0 to 13 in the absence of antiretroviral treatment (ART) is split into two stages, pre-AIDS and AIDS. On initiation of ART two additional stages are added: receiving ART and off ART stages. The ASSA2002 model assumes that ART reduces the frequency of AIDS-defining illnesses in children by approximately 75%. The last stage is the AIDS death stage, which follows from the AIDS sick, receiving ART or off ART stages. The stages of paediatric survival can be organized into five stages as provided in figure A.1 below.

Figure A.1: HIV infection progression in children (aged 0 to 13)



Source: Dorrington, Johnson and Budlender (2004)

The median survival time of black/Africans children with ART is 1.91 years for those infected at birth whilst children infected through breastfeeding have a median survival of 9.83 years. No child with perinatal infection is assumed to survive to the age of 14.

In the absence of anti-retroviral treatment adult survival is classified into four stages corresponding to the World Health Organization (WHO) Clinical Staging System (HIV stages 1 to 4 in Table A.2). Individuals die after reaching the AIDS stage (stage 4). ART is modeled into adult survival by the inclusion of a further two stages: one stage accounting for individuals receiving anti-retroviral treatment and another stage for those individuals who subsequently discontinue ART (HIV stages 5 and 6 in Table A.2).

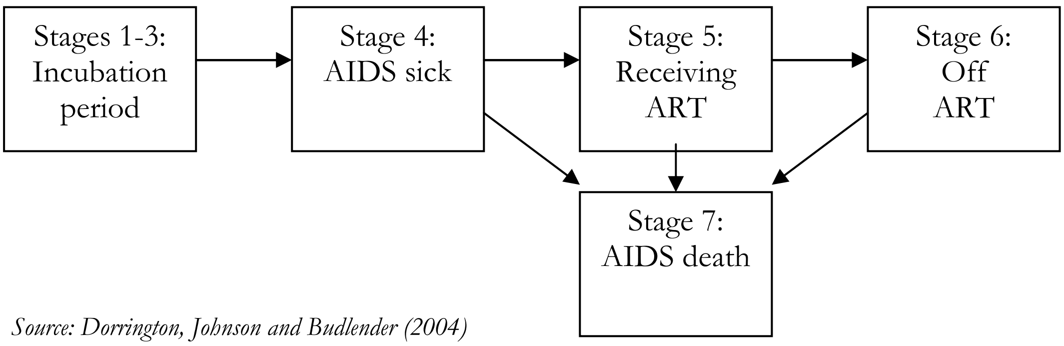
Table A.2: World Health Organization (WHO) clinical staging systems adjusted to incorporate antiretroviral treatment (ART).

HIV STAGE	DESCRIPTION
1	WHO stage 1: Acute HIV infection
2	WHO stage 2: Early disease
3	WHO stage 3: Late disease
4	WHO stage 4: AIDS
5	Receiving anti-retroviral treatment
6	Discontinued anti-retroviral treatment

Source: Dorrington, Johnson and Budlender (2004)

Individuals are assumed to start ART at the time they experience their first AIDS-defining illness. The ASSA2002 model assumes that ART reduces the frequency of AIDS-defining illnesses in adults by approximately 75%. Therefore people either die from AIDS, whilst receiving ART, or after having discontinued ART (Figure A.2).

Figure A.2: HIV infection progression in adults



Source: Dorrington, Johnson and Budlender (2004)

Adult survival is assumed to vary by age and is categorised into three groups: 14 to 24, 25 to 34 and 35 or older. Median survival time for those in the age group 14 to 24 is 13.42 years, for the age group 25 to 34 is 12.40 years and for those 35 or older is 10.84 years. The model assumes that no HIV infections occur after the age of 60 years.

Interventions and behaviour change

Five types of interventions were modelled into the ASSA2002 model during the period 1994 to 2001. The interventions include prevention and treatment programmes of the following nature:

- Information and education campaign (IEC) and social marketing introduced in 1994.
- Improved treatment for sexually transmitted diseases introduced in 1994.
- Voluntary counselling and testing (VCT) phased-in in 1995
- Anti-retroviral treatment (ART) initiated in 2000
- Mother-to-child transmission prevention (MTCTP) modelled in 2001

The interventions are phased-in into the population at an increasing rate from year one to year nine with constant subsequent rates thereafter of 50% for ART, 50% for VCT, 90% for MTCTP, 95% for the treatment of STD's and 95% for IEC and social marketing. The rates can be taken as the proportions of the population that have access to the interventions.

The interventions are modelled to have an effect on sexual risk behaviors, probabilities of HIV transmission and HIV survival (Table A.3).

Table A.3: Interventions modelled into the ASSA2002 model and affected factors

INTERVENTIONS	FACTORS AFFECTED BY INTERVENTIONS
IEC and social marketing	Condom usage
Improved STD treatment	Probability of sexual transmission
Voluntary counselling and testing	Condom usage and frequency of sex
Mother-to-child transmission prevention	Condom usage, frequency of sex and the probability of mother-to-child transmission
Anti-retroviral treatment	Condom usage, frequency of sex, the probability of mother-to-child transmission and survival with HIV infection.

Source: Dorrington, Johnson and Budlender (2004)