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Mid-year population estimates, South Africa
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SUMMARY

- This release uses the cohort-component methodology to estimate the 2004 mid-year population of South Africa.

- The mid-2004 population is estimated at approximately 46,6 million. Africans are in the majority (nearly 37 million) and constitute 79,3% of the total South African population. The white population is estimated to be 4,4 million, the coloured population 4,1 million and the Asian population 1,1 million.

- Fifty-one per cent (approximately 23,6 million) of the population is female.

- The provincial estimates show that KwaZulu-Natal has the largest share of the population (20,7%), followed by Gauteng (19,0%) and Eastern Cape (15,2%). The Northern Cape remains the province with the smallest share of the population, 1,9% of the total population.

- There has been much concern about the effect of HIV on fertility in South Africa. There is evidence that being HIV-positive lowers fecundity. There are also arguments that behavioural changes among persons who are HIV-positive could lead to either lower or higher fertility. Because fertility in South Africa has declined significantly from the mid-1980s to the mid-1990s, the overall impact of HIV on the level of fertility is unlikely to be large in comparison with other factors influencing fertility in South Africa.

- It is estimated that the HIV-positive population in 2004 is approximately 3,83 million, which relates to an HIV-prevalence rate of 15,2% of the adult population. The accumulated AIDS deaths up to 2004 were estimated to be 1,49 million.

Mid-year estimates for South Africa by population group and sex, 2004

Population group	Male		Female		Total	
	Number	% of total pop	Number	% of total pop	Number	% of total pop
African	18 254 444	39,2	18 679 737	40,1	36 934 181	79,3
Coloured	2 004 048	4,3	2 082 742	4,5	4 086 790	8,8
Indian/Asian	554 119	1,2	577 223	1,2	1 131 342	2,4
White	2 174 799	4,6	2 259 495	4,9	4 434 294	9,5
Total	22 987 410	49,3	23 599 197	50,7	46 586 607	100,0

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27 July, 2004

1. INTRODUCTION

Statistics South Africa (Stats SA) subscribes to the specification of the IMF's Special Data Dissemination Standard (SDDS) and publishes the population estimates for the country as a whole and the nine provinces annually. This release uses the cohort-component methodology to estimate the mid-year population. The estimates cover all the residents of South Africa at the 2004 mid-year.

Since the last mid-year population estimates were released, Stats SA has embarked on a detailed substantive analysis of census data that has more adequately informed the production of population projections and mid-year estimates. This release is part of a larger project on population dynamics in South Africa. In the light of this continued analysis, the estimates given here may be subject to change as new data and information become available.

The quality of population estimates is determined by their internal validity, i.e. whether they accurately and consistently model relations among demographic variables. One obvious criterion for choosing an estimation method is that it should have internal validity, i.e. obey demographic accounting principles. We should also select a model that incorporates as many relevant relationships as possible with due consideration as to the purpose of the projection. Population projection methodology can therefore be divided into two main categories:

- procedures for estimating the population considering mortality, fertility and migration, by age and sex (cohort-component method); and
- procedures for estimating the population using mathematical functions applied to population figures but not to each of the components.

This release is designed to provide estimates of the mid-year population of South Africa for 2004. It is intended specifically for reseachers, policy analysts and decision-makers in government and non-governmental organisations. The release is suited for use either as a reference, or for analytical purposes.

The release is organised in five main sections. The next section provides an overview of the estimation methodology at national and sub-national levels. This is followed in Section 3 by a detailed description of the method of estimating the South African mid-year population for 2004. To this end, the release focuses on the construction of the base population, as well as the fertility, mortality and migration assumptions used for this estimate. Specific reference is made of the impact of HIV on population estimates in South Africa. Section 4 provides the result of the mid-year estimates for 2004 at the national level. The estimates for the population groups by sex are presented first. This is followed by a presentation of the distribution of the mid-year population by age and sex. Section 5

provides a detailed description of the methodology used for estimating the provincial population estimates. The computational procedure using a multi-regional approach is shown. The provincial assumptions for fertility, mortality and migration are discussed. Finally, the estimated provincial distribution by age and sex for mid-2004 is presented.

2. ESTIMATION METHODOLOGY

Methodology for national population estimates

The choice of estimate methodology implies a set of necessary projection inputs and achievable outputs. One should select a methodology that will provide the desired level of detail in the output. One should also select a methodology whose data requirements can be met. This criterion might conflict with the goal of incorporating relevant relationships. More sophisticated projection methodologies will typically be more demanding of data. The gains in using a more realistic model of population dynamics might sometimes be outweighed by the loss introduced by error in the additional data required.

In a projection, the size and composition of the future population of an entity, such as a country, is estimated. Although there are crude estimation methods, such as inflating the total or sub-populations at one date by an assumed overall mean annualised growth rate, most serious estimation efforts such as the mid-year estimates produced by Stats SA use a cohort-component approach. In such an approach, agreed fertility, mortality and migration schedules are used as input.

The inputs for a cohort-component method of estimation are derived from detailed substantive analyses of the trends in fertility, mortality and migration. This requires an intensive interrogation of the data and depends on the availability of professional personnel and the quality of the data. Often life tables are generated through this process. For example, this approach adjusts for reported fertility and transforms the parities to age-specific fertility rates (ASFRs), which in turn are used as input for estimating the average annual number of births. The estimation of mortality and additional deaths due to HIV also require multiple iterations and would be time-consuming, as controls for the adjustment of sero-prevalence data are needed to make the data applicable to the whole population.

In the cohort-component method, a base population is estimated that is consistent with known demographic characteristics of the country. Levels of mortality, fertility and migration are estimated for the base year and projected to future years. The cohort base population is projected into the future according to the projected components of change. The cohort-component method of projecting a population follows a cohort of people of the same age throughout their lifetime according to their

exposure to mortality, fertility and migration. Starting with a base population by sex and age, the population at each specific age is exposed to the chances of dying as determined by the projected mortality levels and patterns by sex and age. Once the number of deaths are estimated, they are subtracted from the surviving population and those remaining alive become older. Fertility rates are projected and applied to the female population in childbearing ages to estimate the number of births every year. Each cohort of children born is also followed through time by exposing it to mortality. The cohort-component method also incorporates migration into the estimation procedure. Migrants are added or subtracted from the population at each specific age. The procedure is repeated for each year of the projection period, resulting in the projected population by age and sex, as well as crude death and birth rates, rates of natural increase, and rates of population growth. This estimate specifically takes the impact of HIV into account. Given an assumption about HIV prevalence, the future number of HIV infections, AIDS cases and HIV deaths can be projected.

In 2001 and 2002 the mid-year estimates were determined by using the cohort-component approach (Statistics South Africa, 2001, 2002). However, in 2003 it was decided to use mathematical functions (Stats SA 2003: 2). Statistics South Africa has therefore 'produced population estimates for 2003 with the specific proviso that the estimates are provisional, and that the estimates would be re-worked once the agreed upon fertility, mortality and migration schedules are available' (Stats SA, 2003: 3). The 2003 mid-year estimates have therefore been revised in the light of information provided in this release. The revised mid-year population estimates for will be published shortly.

For the 2004 mid-year estimates, the cohort-component method is used by applying the Spectrum Policy Modelling System. The integration is based on DemProj, which is used to create the population projections that support many of the calculations in the other components – FamPlan, Benefit-Cost, AIM and RAPID (Stover, 2003: 2). In this analysis DemProj and AIM are used. Demproj is used to make the demographic projection, while AIM is used to incorporate the impact of HIV on fertility and mortality. The *Epidemiology* section of AIM calculates the number of HIV infections, AIDS cases and HIV deaths (Stover, 2003: 5).

Methodology for sub-national estimates

The cohort-component procedure described above is also used for sub-national projections, provided that information on mortality, fertility and migration is available for each of the provinces. The most important difference between sub-national and national projections is that both internal and international migration should be taken into account. International migration is treated in the same way as for a national projection. Internal migration, on the other hand, requires information on the regions of origin of the in-migrants and regions of destination of the out-migrants. If the projection is made for urban and rural areas, the procedure is straightforward and several computer programs are available to carry it out. For a larger number of regions, it is more difficult, but not impossible, to

project them all simultaneously (Willekens & Rogers, 1978). Information about flows of migrants by sex, age, place of origin and place of destination is seldom published.

Regional population projections, when summed to obtain the population for the whole country, may produce some inconsistent trends of mortality and fertility at the national level. To avoid this, it has been suggested to first make a population projection for the whole country to serve as a control total for the sum of the regions. Arguments have been presented both in favour of and against this procedure. Arguments in favour of a control total contend that information for the whole country is frequently of better quality than information for each of the regions because vital events may be recorded by place of registration rather than by place of occurrence. Such misplacement of vital events may result in a distorted estimate of the components of growth of each region and hence their sum may not reflect the proper total for the country. An argument against a control total is that, if vital registration is reliable, whatever happens in a country will be the result of what happens in each of the regions.

For the few countries that produce regional population projections, there is usually a projection for the whole country serving as a control and the regional projections are adjusted to this national total. It is advantageous to compare the sum of the regional projections with the total derived independently for the whole country. A small difference produces confidence in the regional projections in relation to what is expected for the whole country, while a large difference indicates that there were inconsistencies between the assumptions made for the regional projections and those made for the national projections. The latter situation calls for a revision of the assumptions. Once revised, projections result in small differences.

For developing countries where information on interregional migration flows may not be available or reliable, regional projections can still be produced by using net migration flows. If, in addition, mortality and fertility can be estimated for each region based on vital registration data or indirectly from census data, then it is feasible to make regional population projections. In this case, a comparison of the sum of the regions with the country total is a requirement and the adjustment of the regional or sub-national projections to the country total is also highly recommended.

3. METHODOLOGY FOR POPULATION ESTIMATES IN SOUTH AFRICA

Base population by population group and sex

A cohort-component projection requires a population properly distributed by sex and age to serve as the base population for the starting date of the projection. Reliable estimates of the levels of mortality, fertility and migration are required for the same year. Usually, the base population is taken from the latest available census. However, the reported data on the population age and sex structure may be affected by underenumeration in certain ages as well as by age misreporting. During the first years of the projection period, errors in the age and sex composition of the base population may have a large impact on the projected population. As noted above, the component method projects the base population by following cohorts of persons throughout their lifetimes. Thus, if the projection starts with errors in the base year, such errors will be carried throughout the projection period and will have an impact on the projected number of births as well. Suppose, for example, that children aged 0-4 years were undercounted in the base population. Then in the projection, not only would the surviving cohorts of these children be smaller than they should be, but when the female cohorts reach reproductive ages, the number of births they have would be underestimated.

Consequently, before accepting a population to serve as a base for the projections, an evaluation of the completeness of enumeration and the extent of age misreporting should be undertaken and adjustments made as required. Information from post-enumeration surveys also will help in evaluating the quality of the base population data.

In this analysis, it was decided to project the four population groups from 1970 (the last census before 1996 that covered the whole of South Africa) by using fertility, mortality and migration rates. Table 1 shows the adjusted age structure of the South African population in 1970. The DemProj program in the Spectrum system was used for this projection from 1970 to 2010 and the calculations are based on the standard cohort-component projection modified to produce a single-year projection.

The total fertility rates (TFRs) and life expectancies that were applied to the base population were obtained from several projections for the period 1970 to 2001. In the absence of HIV/AIDS before 1990, the TFRs of all population groups were following a down trend, while the life expectancy at birth increased as expected. Table 2 shows the time series of the total fertility rates from the period 1970-2004. As already mentioned, DemProj is projecting by single calendar years, and the TFR and life expectancy at birth (e_0) must be given in the same way.

Table 1: Age structure of the South African population, 1970

Age	African		Coloured		Indian/Asian		White	
	Male	Female	Male	Female	Male	Female	Male	Female
0-4	1 295 000	1 288 000	182 170	183 060	45 870	45 330	213 330	204 440
5-9	1 134 000	1 128 000	161 860	162 750	43 330	43 060	200 150	191 480
10-14	1 001 700	1 001 000	137 530	137 840	40 710	40 250	193 050	188 200
15-19	816 200	813 000	110 930	111 080	38 120	37 670	175 200	167 500
20-24	642 300	647 000	88 980	90 300	34 170	33 710	167 160	162 230
25-29	539 200	551 000	70 910	70 540	27 950	27 420	156 430	148 700
30-34	468 600	480 000	62 750	64 420	23 260	22 940	137 200	129 900
35-39	404 000	411 000	53 310	54 840	18 490	18 410	115 200	112 450
40-44	345 300	346 000	42 750	43 250	15 300	15 480	108 260	108 000
45-49	276 100	281 000	34 130	33 860	12 050	11 950	100 320	100 770
50-54	215 400	227 000	27 780	28 260	9 480	9 230	87 180	91 900
55-59	163 200	179 000	22 210	23 660	7 460	7 050	82 770	88 280
60-64	130 400	150 000	16 860	19 190	5 170	4 800	68 600	76 800
65-69	97 800	119 000	13 070	13 930	3 090	2 850	43 040	51 900
70-74	59 600	79 000	7 460	8 460	1 870	1 350	27 790	40 090
75-79	33 300	47 000	4 280	5 230	740	840	17 700	27 360
80+	38 000	61 000	3 480	5 940	880	730	14 470	19 550
Total	**7 660 100**	**7 808 000**	**1 040 460**	**1 056 610**	**327 940**	**323 070**	**1 907 850**	**1 909 550**

Fertility assumptions

Table 2 shows the fertility assumptions used in this projection. The set of TFRs in the table have been constructed in such a way as to reach the 2001 adjusted census population estimate. The TFRs obtained in this way are then compared with other estimates.

In the case of the African population, the fertility rates in Table 2 compare very well with estimates from other sources. Using the 1996 adjusted census as base and performing a reverse projection, Van Aardt and Van Tonder (1999) estimated the African TFR as 6,64 for the period 1971-1976 and a TFR of 5,6 for the period 1976-1981. The latter TFR is equal to the estimate of Sadie (1993) for that period and about the same for the average TFR used in this projection. The average TFR assumption for the period 1991-1996 in this projection is lower than the 3,96 estimate done by Sadie. From analyses of the 1996 census (Moultrie & Timaeus, 2003) the TFR was estimated as 3,49 and from the 2001 census a rate of 3,04 was calculated (Moultrie & Dorrington, 2004). Phillips et al. (2004)

estimated a TFR of 3,09 for Africans using the Brass PF ratio method and 3,27 based on the relational Gompertz method.

Using a relational Gompertz model applied to the national fertility information collected from the 2001 census, Udjo (2004a) estimated the TFR of the African population to be 3,2, which is 5% higher than the estimate done by Moultrie and Dorrington (2004). The estimates done by Udjo for the other population groups were also higher. The estimates done by Udjo (2004a) must be viewed in the context of the lower population estimates by the same author for 1996 and 2001, namely 30,8 million and 32,1 million (taking migration and HIV into consideration) respectively (Udjo, 1999, 2003b). The estimate by this author based on the 2001 census is about three million less than the adjusted 2001 census results (see Udjo, 2003b). If one therefore takes into account Udjo's TFR of 3,2 and also the higher TFRs used in this projection, it would imply a large outmigration of the African population or that mortality was much higher than demographers thought. Preliminary modelling suggests that even if HIV-prevalence rates were 40% in 2001 an estimate of 32,1 million would not be plausible. It was therefore decided not to use the higher Udjo estimates, but rather assume the Moultrie and Dorrington (2004) estimates in this projection, which seems consistent with previous estimates.

Table 2: Total fertility rate assumptions, 1970-2004

	African	Coloured	Indian/Asian	White	South Africa
1970	6,64	6,00	3,62	2,59	5,75
1975	5,99	5,00	3,47	2,36	5,19
1980	5,34	4,00	3,32	2,13	4,62
1985	4,68	3,00	3,10	1,90	4,03
1990	4,03	2,84	2,80	1,84	3,58
1991	3,90	2,80	2,75	1,84	3,49
1995	3,38	2,67	2,51	1,80	3,10
1996	3,25	2,64	2,45	1,78	3,00
2000	3,05	2,46	2,07	1,74	2,86
2001	3,00	2,41	1,98	1,74	2,80
2004	2,93	2,37	1,90	1,74	2,77

For the coloured population, Sadie (1993) estimated an implied TFR of 2,21 for the period 1996 to 2001. This was lower than the estimated TFR of 2,5 based on the 1998 Demographic and Health Survey (DHS) (Department of Health 1999) and the estimate based on the 1996 census (2,64). Udjo (2004a) estimated a TFR of 2,6 in comparison with a TFR of 2,41 estimated by Moultrie and Dorrington (2004) based on an analysis of the 2001 census. Estimates by Phillips et al. (2004) revealed a TFR of 2,48 based on the Brass PF ratio method and 2,68 based on the relational Gompertz method. The same discussion as in the case of the African population is also applicable

here. A TFR of 2,41 would result in a 2001 population that was slightly less than the adjusted 2001 census.

Regarding the TFR of the Asian population, there seems to be a disagreement on the level in the earlier years of the projection. Estimates obtained from the reverse projection of the 1996 adjusted census figures revealed a TFR of 3,84 (Van Aardt & Van Tonder, 1999). Most researchers estimated a sharp decline in TFR during the period 1970-1985. Estimates from the 1996 census indicate a TFR of 2,45 (Moultrie & Timaeus, 2003). Udjo's (2004a) estimate for the Asian population is 2,6, in comparison with a TFR of 1,98 estimated by Moultrie and Dorrington (2004). This high TFR by Udjo (2004a) also suggests higher rates in the previous years, which would have resulted in a much higher 2001 census population. The author's mid-2001 estimate is, however, only higher by 17 000 than the adjusted 2001 census results (Udjo, 2003b). One would have expected a higher figure with these high suggested TFRs. The TFRs were therefore adjusted to the set of TFRs presented in Table 2. This resulted in a total mid-2001 population figure for Asians that was slightly lower than the 2001 adjusted census figures.

The estimated TFRs for the white population appear inconsistent, especially for the earlier years. According to Van Aardt and Van Tonder (1999) the estimated TFR for the white population was 2,59. In a later projection that Sadie carried out for the period 1991-2011 (Sadie, 1993), his estimates were considerably lower for the periods 1985-1991 (1,81) and 1991-1996 (1,73). Moultrie and Dorrington (2004) estimated a TFR of 1,82 for the white population based on the 2001 census. The estimate done by Udjo (2003b, 2004a, 2004c) for 2001 is slightly higher (1,9). Phillips et al. (2004) estimated the white population fertility to be 1,87 based on Census 2001. The TFRs are therefore higher than rates already assumed by researchers in the period before 1990. One would have expected that estimates made before 1990 would have been fairly good, as they were based on reliable vital statistics for the white population. The set of TFRs in Table 2 for the white population projected a total population of 4,55 million in mid-2001, assuming the migration patterns and trends shown in Table 9 below.

Mortality assumptions

Population projections using the 1991 or previous census populations (Sadie, 1993; Mostert & Van Tonder, 1982) did not take HIV/AIDS into account. It was therefore relatively easy to project the future cause of mortality. In all cases, an upward trend in life expectancy at birth was assumed and the only problem was to decide how fast the life expectancy would increase. Some researchers tried to incorporate the impact of HIV in their projections using the 1996 census as a base, but it was only when the Metropolitan-Doyle model and the models of the Actuarial Society of South Africa (ASSA)

were developed that a clearer picture was given. Since the early 1990s, population estimates have considered the impact of HIV/AIDS on population size and composition in South Africa.

Stats SA (2000) calculated life tables for the four population groups from 1985 to 1994 and 1996. Except for African males, the life expectancies used in this projection are nearly identical to those estimates. In the case of African males, life expectancies at birth were about 12 years shorter than for African females (period 1985-1996) and 9,5 years shorter for 1996. An adjusted e_0 for the African male population was used in this projection. The life expectancies after 1995 are largely influenced by the HIV-prevalence assumptions made since 1990 in the SPECTRUM program. Tables 3 and 4 show the detailed mortality assumptions used in this analysis. The assumptions of life expectancy at birth closely match those estimates calculated by Udjo (2003b, 2004a, 2004c). The estimated national life expectancies assumed in this document are higher than those estimated by other sources (see for example the UNDP, 2004; World Health Organisation, 2002).

The impact of HIV on population estimates

The AIDS impact model (AIM) is used to project the consequences of the AIDS epidemic and requires that a demographic projection be prepared first. Assumptions were made with regard to:

- the impact of HIV on infant and child mortality
- the adult HIV-prevalence rate
- the time lapse between becoming HIV-positive and death
- the age and sex distribution of those infected with HIV
- the impact of HIV on fertility in South Africa.

There has been some concern about the effect of HIV on the survival of infants and children. The mother-to-child transmission rate is the proportion of babies born to HIV-positive mothers who will also become HIV-positive. The mother-to-child transmission rate for HIV-positive mothers has been estimated as between 13% and 32% in developed countries and between 25% and 48% in developing countries (Bryson, 1996; Dabis et al, 1993). For those infected from birth, studies have estimated the average time to AIDS to be from 1 to 6,3 years (Auger et al., 1988; Commenges et al., 1992; Downs et al., 1995, 1992; Pliner et al., 1996.). The use of anti-retroviral drugs during delivery by an HIV-positive mother could greatly reduce mother-to-child transmission of HIV. However, a substantial proportion of babies would still be infected (WHO, 2001). This projection assumes a mother-to-child transmission rate of 0,32.

Table 3: Assumptions regarding expectation of life at birth for the 2004 mid-year estimates

	African			Coloured			Asian			White			South Africa		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1970	52,0	59,1	-	50,5	57,0	-	56,9	64,1		65,2	70,6	-	-	-	-
1975	54,0	60,6	-	52,6	58,9	-	57,1	64,6		65,5	71,0	-	-	-	-
1980	56,0	62,0	-	54,8	60,4	-	57,8	65,8		65,8	71,5	-	-	-	-
1985	58,0	63,5	60,7	56,0	61,6	58,7	59,4	66,5	62,7	66,1	71,9	68,8	59,1	64,7	61,8
1991	60,1	65,4	62,7	57,2	63,3	60,1	60,6	67,3	63,8	66,5	72,4	69,3	60,8	66,2	63,5
1996	57,6	63,3	60,4	56,8	63,0	59,8	61,1	67,8	64,3	65,3	71,3	68,1	58,6	64,4	61,4
2001	50,0	54,7	52,3	54,9	60,4	57,6	60,8	67,1	63,8	62,4	67,6	64,9	51,8	56,7	54,2
2004	47,8	50,7	49,2	54,1	58,4	56,2	61,1	66,0	63,5	61,7	65,6	63,6	49,9	52,9	51,4

The adult HIV-prevalence rate refers to the proportion of adults aged 15 to 49 years who are infected with HIV. Table 4 shows the adult HIV-prevalence rates.

Table 4: Estimated adult HIV-prevalence rates

	African	Coloured	Indian/Asian	White	South Africa
1991	0,93	0,39	0,13	0,38	0,83
1992	1,23	0,50	0,18	0,40	1,06
1993	2,21	0,89	0,32	0,69	1,96
1994	4,35	1,68	0,60	1,36	3,82
1995	6,00	2,29	0,82	1,88	4,94
1996	8,20	3,09	1,13	2,57	7,32
1997	9,85	3,79	1,36	3,09	8,88
1998	13,15	3,60	1,80	4,06	11,70
1999	12,99	4,89	1,79	4,00	11,86
2000	14,21	5,39	1,96	4,41	13,05
2001	14,50	5,50	2,00	4,50	13,42
2002	15,40	5,80	2,12	4,79	14,30
2003	15,72	6,31	2,41	5,19	14,79
2004	16,04	6,84	2,70	5,58	15,20

There has been much concern about the effect of HIV on fertility in South Africa. There is evidence that being HIV-positive lowers fecundity. There are also arguments that behavioural changes among persons who are HIV-positive could lead to either lower or higher fertility. Based on a number of studies in Africa, HIV-positive women appear to have lower fertility by 25%-40% in comparison with HIV-negative women (United Nations, 2002a; Zaba & Gregson, 1998). The United Nations (2002a) further argues that a 25% national adult HIV-prevalence rate translates into a 10% reduction in the total fertility rate. Given that fertility in South Africa declined from the mid-1980s to the mid-1990s by an average of 15% per year (United Nations 2002b), the overall impact of HIV on the level of fertility is unlikely to be large in comparison with other factors influencing fertility in South Africa. For the current estimates, it is assumed that the fertility among women aged 20-49 years is 30% lower among HIV-positive women than HIV-negative women.

Another issue in population estimates is the progression from being HIV-positive to death. The progression period refers to the time lapse from becoming HIV-positive until death due to AIDS. In this projection the default fast patterns for both males and females were used (see Table 5). However, there remains an ongoing debate about the levels and trends of mortality in South Africa for the period 2000-2001 as well as its future prospects within a context of HIV (see for example Dorrington et al., 2004; Udjo, 1999, 2003a, 2004b, 2004c).

Table 5: Proportional progression from HIV infection to death, by time since infection

	Years since birth		
	Adults		
Years since infection	Men	Women	Children
1	0,00	0,00	0,34
2	0,03	0,01	0,49
3	0,07	0,03	0,55
4	0,12	0,07	0,59
5	0,19	0,12	0,61
6	0,27	0,19	0,65
7	0,36	0,27	0,71
8	0,45	0,36	0,77
9	0,54	0,46	0,84
10	0,62	0,56	0,90
11	0,69	0,65	0,95
12	0,76	0,73	0,98
13	0,82	0,81	0,99
14	0,86	0,86	1,00
15	0,90	0,91	1,00
16	0,93	0,94	1,00
17	0,95	0,96	1,00
18	0,97	0,98	1,00
19	0,98	0,99	1,00
20	0,99	0,99	1,00

Source: Stover (2003)

To calculate HIV incidence from the prevalence input, the AIM software requires information on the distribution of infection by age and sex. The information is provided through two editors, one for the ratio of prevalence at each age group to prevalence in the 25-29 year age group, and one for the ratio of female to male prevalence (Stover, 2003). The latter was taken as 1,2 for the period 1990-2004 (see Table 6).

Table 6: Ratios of HIV prevalence by age and sex

Age	Male	Female
0-4	0,00	0,00
5-9	0,00	0,00
10-14	0,00	0,00
15-19	0,15	0,48
20-24	0,39	0,90
25-29	1,00	1,00
30-34	1,30	0,81
35-39	1,34	0,57
40-44	1,13	0,39
45-49	0,92	0,24
50-54	0,49	0,15
55-59	0,22	0,10
60-64	0,10	0,04
65-69	0,05	0,02
70-74	0,00	0,00
75-79	0,00	0,00
80+	0,00	0,00

Source: Stover (2003)

Summary of fertility and mortality assumptions

Table 7 presents a summary of the major fertility and mortality assumptions made by Stats SA in this release. These estimates and assumptions are compared to estimates derived from the 2001 census. As shown, life expectancy is assumed to have declined from an overall 54 years in 2001 to an estimated 52 years in 2004. Women are expected to have an average of approximately 2,8 children in their lifetime. The total population in 2004 is estimated at approximately 46,6 million, compared to the 44,8 million enumerated in the 2001 census.

Table 7: Summary of selected fertility and mortality assumptions

	Estimates in June 2004	Estimates based on Census 2001
Total population in millions	46,6	44,8
$e_{0\ male\ and\ female}$	52	54
$e_{0\ male}$	50	52
$e_{0\ female}$	53	57
Infant mortality rate per 1000 live births	43	44
Total fertility rate (TFR)	2,77	2,80
Birth rate	23,4	25,6

Table 8 compares the assumptions and results from selected population estimates. Differences between the Stats SA and other estimates may be related to differences in assumptions about the rapidity with which the HIV epidemic will spread and the future of South African society. Some models (such as Dorrington et al., 2001) predict an extremely high impact of the HIV epidemic. According to the ASSA 2000 model, the HIV-positive population will increase from 1,2 million in 1995 to 5,26 million in 2000. This reflects an increase of 267% between 1995 and 2000. Whilst the ASSA 2000 model's estimate of the HIV-positive population in 1995 was about 60 000 more than the estimate by Stats SA, the difference between the two estimates for 2000 was more than 2 million. In this projection the HIV-related deaths in 2005 are estimated to be lower than both the ASSA and HSRC estimates. Furthermore, although the HSRC study indicates a lower life expectancy at birth than the ASSA models, the total number of deaths of the ASSA models are higher than those in the HSRC model.

As a result of the higher HIV/AIDS assumptions in both the HSRC and ASSA projections, the life expectancy at birth was higher in the Stats SA estimates than in other estimates. The HIV assumptions in the recently released ASSA 2002 model have been considerably revised. While they are still different from the Stats SA assumptions, the ASSA 2002 HIV-related assumptions are more consistent with current and past assumptions made by Stats SA. It should also be noted that the Stats SA assumptions with relation to HIV/AIDS may change with the completion of the study on the causes of death currently underway.

Table 8: Comparison of Stats SA population estimates with other estimation models

	Model	1985	1990	1995	2000	2005
Total population (millions)	ASSA 2000*	32,42	35,78	40,41	45,08	47,49
	ASSA 2002**	32,63	35,54	40,15	43,96	45,99
	ASSA 2002***	32,63	35,54	40,15	43,97	46,16
	Stats SA	**33,53**	**37,45**	**41,15**	**44,51**	**47,08**
	HSRC	32,67	36,29	39,87	43,13	45,07
Life expectancy at birth	ASSA 2000*	-	61,40	61,40	56,40	46,10
	ASSA 2002**	60,80	61,50	61,10	55,10	46,50
	ASSA 2002***	60,80	61,50	61,10	55,50	49,90
	Stats SA	**61,80**	**63,30**	**62,40**	**55,60**	**50,70**
	HSRC	57,60	59,90	59,30	50,40	45,20
Infant mortality rate	ASSA 2000*	-	51,80	50,70	57,60	58,40
	ASSA 2002**	57,00	51,00	54,00	66,00	68,00
	ASSA 2002***	57,00	51,00	54,00	63,00	52,00
	Stats SA	**50,88**	**45,61**	**44,32**	**44,64**	**42,48**
	HSRC	83,30	71,70	65,80	65,50	56,20
Birth rate	ASSA 2000*	-	28,1	26,6	25,3	23,0
	ASSA 2002**	27,8	28,1	28,4	24,8	22,4
	ASSA 2002***	27,9	28,1	28,4	24,8	22,3
	Stats SA	**31,4**	**28,9**	**26,1**	**25,6**	**23,6**
	HSRC	32,4	29,1	27,2	25,9	23,5
Total annual births (millions)	ASSA 2000*	-	1,00	1,07	1,14	1,09
	ASSA 2002**	0,91	1,00	1,14	1,09	1,03
	ASSA 2002***	0,91	1,00	1,14	1,09	1,03
	Stats SA	**1,05**	**1,08**	**1,07**	**1,14**	**1,11**
	HSRC	1,06	1,05	1,08	1,12	1,06
Total annual deaths (millions)	ASSA 2000*	-	-	0,36	0,53	0,91
	ASSA 2002**	0,33	0,34	0,39	0,55	0,84
	ASSA 2002***	0,33	0,34	0,39	0,54	0,75
	Stats SA	**-**	**0,29**	**0,32**	**0,46**	**0,64**
	HSRC	0,33	0,33	0,36	0,55	0,78
Number of AIDS-related deaths (thousands)	ASSA 2000*	0,00	0,28	12	139	510
	ASSA 2002**	0,00	0,53	19	163	450
	ASSA 2002***	0,00	0,53	19	155	356
	Stats SA	**0,00**	**0,00**	**22**	**158**	**326**
	HSRC	-	-	-	220	451
Percentage of AIDS deaths	ASSA 2000*	0,0%	0,1%	3,5%	26,4%	55,8%
	ASSA 2002**	0,0%	0,2%	5,2%	29,7%	53,5%
	ASSA 2002***	0,0%	0,2%	5,3%	28,6%	45,4%
	Stats SA	**0,0%**	**0,1%**	**6,8%**	**34,4%**	**50,8%**
	HSRC	-	-	-	40%	57,8%

Table 8: Comparison of Stats SA population estimates with the other estimation models (continued)

	Model	1985	1990	1995	2000	2005
Cumulative AIDS deaths (millions)	ASSA2000*	0,00	0,00	0,02	0,38	2,11
	ASSA2002**	0,00	0,00	0,00	0,49	2,16
	ASSA2002***	0,00	0,00	0,00	0,47	1,90
	Stats SA	**0,00**	**0,00**	**0,04**	**0,50**	**1,82**
	HSRC	-	-	-	0,71	2,56
HIV-positive population (millions)	ASSA2000*	0,00	0,05	1,20	5,26	7,59
	ASSA2002**	0,00	0,04	0,95	4,11	5,91
	ASSA2002***	0,00	0,04	0,94	3,73	5,17
	Stats SA	**0,00**	**0,05**	**1,14**	**3,11**	**3,99**
	HSRC	-	-	-	4,46	4,58

* ASSA 2000. No change scenario (see http//www.assa.org.za)
** ASSA 2002. Results from running ASSA2002_lite_040701 with no interventions (see http//www.assa.org.za)
*** ASSA 2002. Results from running ASSA2002_lite_040701 with "yes" to all interventions (see http//www.assa.org.za)
HSRC: Rehle & Shisana (2003)

Migration assumptions

It is often difficult to make plausible migration assumptions (Bah, 1999). This estimate incorporates migration assumptions for the white population only using published and adjusted migration data. Due to inadequate data, migration assumptions were not incorporated in this estimate for the other population groups.

Data on South African emigrants recorded by the five major recipient countries suggested that a total of 233 609 South Africans migrated to the USA, Australia, the United Kingdom, Canada and New Zealand during the period 1989-1997 (Kaplan et al., 1999). Moreover, these authors claim that their study accounted for only about three-quarters of all South African emigrants. It can therefore be assumed that a further 77 800 persons emigrated to the five major recipient and other countries. This translates to approximately 38 934 migrants per year for the period 1989-1997. This number could be higher still if we assume that it is not always professional and technical people that emigrate, although they form the largest proportion of the emigrants (Bah, 1999). Table 9 shows the migration assumptions used in this projection.

Table 9: Migration assumptions for the South African white population

	Male	Female	Total
1970	17 141	15 228	32 369
1971	14 777	12 769	27 546
1972	13 017	11 506	24 523
1973	9 289	8 437	17 726
1974	14 923	13 712	28 635
1975	22 008	18 708	40 716
1976	15 765	14 894	30 659
1977	-857	63	-794
1978	-1 092	-421	-1 513
1979	1 418	1 943	3 361
1980	9 931	9 168	19 099
1981	17 981	28 648	46 629
1982	20 523	18 947	39 470
1983	11 909	10 946	22 855
1984	10 813	9 933	20 746
1985	2 947	2 936	5 883
1986	-3 378	-3 339	-6 717
1987	-2 054	-2 128	-4 182
1988	-5 000	-4 000	-9 000
1989	-5 000	-4 000	-9 000
1990	-10 000	-8 000	-18 000
1991	-10 500	-8 500	-19 000
1992	-26 000	-26 000	-52 000
1993	-26 000	-26 000	-52 000
1994	-26 000	-26 000	-52 000
1995	-26 000	-26 000	-52 000
1996	-26 000	-26 000	-52 000
1997	-26 000	-26 000	-52 000
1998	-26 000	-26 000	-52 000
1999	-26 000	-26 000	-52 000
2000	-26 000	-26 000	-52 000
2001	-21 000	-20 750	-41 750
2002	-16 000	-15 500	-31 500
2003	-11 000	-10 250	-21 250
2004	-6 000	-5 000	-11 000

Sources:
Data for 1970-1989. Various Migration reports of Stats SA
Data for 1990-1993. Van Aardt & Van Tonder (1999)
Data for 1994-2004. Adjusted from Stats SA Report 03-51-03 (2002)

4. COUNTRY ESTIMATES, 2004

Table 10 shows the mid-year estimates for 2004 by population group and sex. This table shows that the mid-year population is estimated at approximately 46,6 million. Africans are in the majority (nearly 37 million) and constitute 79,3% of the total South African population. The white population is estimated to be 4,4 million, the coloured population 4,1 million and the Asian population 1,1 million. Fifty-one per cent (approximately 23,6 million) of the population is female.

Table 10: Mid-year estimates for South Africa by population group and sex, 2004

Population group	Male		Female		Total	
	Number	% of total pop	Number	% of total pop	Number	% of total pop
African	18 254 444	39,2	18 679 737	40,1	36 934 181	79,3
Coloured	2 004 048	4,3	2 082 742	4,5	4 086 790	8,8
Indian/Asian	554 119	1,2	577 223	1,2	1 131 342	2,4
White	2 174 799	4,6	2 259 495	4,9	4 434 294	9,5
Total	22 987 410	49,3	23 599 197	50,7	46 586 607	100

Table 11 shows the mid-year estimates by population group, age and sex without taking into account deaths due to HIV/AIDS. This table suggests that the total population in mid-2004 would have been approximately 48,3 million in the absence of HIV.

Table 12 shows the mid-year population by age, sex, and population group explicitly taking HIV into account. There are approximately 15,3 million children (33%) aged 0-14 years and approximately 2,9 million people older than 60 years (6%) in the population. Of those younger than 15 years, the overwhelming majority is African (approximately 12,9 million). When comparing figures in this table with those in Table 11, it can be seen that the age group 20-54 years is the most affected by HIV.

It should be noted that the differences between the two tables also reflect improvements in the completeness of the vital registration system as well as the impact of HIV/AIDS.

Table 11: Mid-year estimates by population group, age and sex, without considering HIV, 2004

Age	African			Coloured			Indian/Asian			White			Total			Age
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
0-4	2 371 205	2 321 553	4 692 758	214 250	210 236	424 486	45 181	43 931	89 112	131 329	126 512	257 841	2 761 965	2 702 232	5 464 197	0-4
5-9	2 237 070	2 195 548	4 432 618	215 175	212 840	428 015	50 014	49 047	99 061	151 225	146 337	297 562	2 653 484	2 603 772	5 257 256	5-9
10-14	2 126 639	2 094 097	4 220 736	209 573	208 268	417 841	53 072	52 382	105 454	169 861	164 810	334 671	2 559 145	2 519 557	5 078 702	10-14
15-19	2 061 556	2 040 829	4 102 385	191 317	190 832	382 149	54 610	54 175	108 785	169 531	165 251	334 782	2 477 014	2 451 087	4 928 101	15-19
20-24	1 973 539	1 967 426	3 940 965	190 247	191 558	381 805	53 998	54 113	108 111	159 168	158 443	317 611	2 376 952	2 371 540	4 748 492	20-24
25-29	1 849 254	1 855 348	3 704 602	195 412	198 834	394 246	49 308	50 040	99 348	140 249	139 157	279 406	2 234 223	2 243 379	4 477 602	25-29
30-34	1 589 288	1 617 585	3 206 873	186 466	192 194	378 660	43 926	44 821	88 747	143 544	141 884	285 428	1 963 224	1 996 484	3 959 708	30-34
35-39	1 149 514	1 176 307	2 325 821	158 431	164 949	323 380	41 502	42 569	84 071	176 214	173 512	349 726	1 525 661	1 557 337	3 082 998	35-39
40-44	985 496	1 016 384	2 001 880	135 600	142 196	277 796	38 278	39 737	78 015	184 808	184 510	369 318	1 344 182	1 382 827	2 727 009	40-44
45-49	823 546	864 683	1 688 229	107 934	114 774	222 708	34 371	36 124	70 495	180 672	184 258	364 930	1 146 523	1 199 839	2 346 362	45-49
50-54	618 686	663 693	1 282 379	79 890	87 684	167 574	29 918	32 348	62 266	162 813	165 168	327 981	891 307	948 893	1 840 200	50-54
55-59	441 249	500 163	941 412	56 802	65 896	122 698	23 782	26 809	50 591	142 912	150 449	293 361	664 745	743 317	1 408 062	55-59
60-64	318 862	391 730	710 592	38 445	47 143	85 588	16 516	19 870	36 386	110 939	121 668	232 607	484 762	580 411	1 065 173	60-64
65-69	218 853	295 881	514 734	26 527	37 091	63 618	10 858	14 501	25 359	76 720	92 546	169 266	332 958	440 019	772 977	65-69
70-74	136 273	205 456	341 729	15 832	24 779	40 611	6 281	9 577	15 858	48 743	69 129	117 872	207 129	308 941	516 070	70-74
75-79	75 582	125 665	201 247	8 111	13 883	21 994	3 400	5 913	9 313	29 968	50 212	80 180	117 061	195 673	312 734	75-79
80+	54 946	104 230	159 176	6 164	11 425	17 589	2 470	4 544	7 014	28 106	56 199	84 305	91 686	176 398	268 084	80+
Total	19 031 558	19 436 578	38 468 136	2 036 176	2 114 582	4 150 758	557 485	580 501	1 137 986	2 206 802	2 290 045	4 496 847	23 832 021	24 421 706	48 253 727	Total

Table 12: Mid-year population estimates by population group, age and sex, considering HIV, 2004

Age	African			Coloured			Asian			White			Total			Age
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
0-4	2 234 141	2 187 428	4 421 569	209 401	205 486	414 887	44 790	43 552	88 342	128 182	123 485	251 667	2 616 514	2 559 951	5 176 465	0-4
5-9	2 171 271	2 130 969	4 302 240	213 022	210 714	423 736	49 783	48 821	98 604	149 864	145 021	294 885	2 583 940	2 535 525	5 119 465	5-9
10-14	2 114 019	2 081 692	4 195 711	209 066	207 765	416 831	52 994	52 305	105 299	169 405	164 368	333 773	2 545 484	2 506 130	5 051 614	10-14
15-19	2 060 274	2 038 269	4 098 543	191 278	190 745	382 023	54 600	54 167	108 767	169 499	165 160	334 659	2 475 651	2 448 341	4 923 992	15-19
20-24	1 955 976	1 919 996	3 875 972	189 690	189 896	379 586	53 937	53 922	107 859	158 752	157 041	315 793	2 358 355	2 320 855	4 679 210	20-24
25-29	1 798 216	1 732 713	3 530 929	193 586	194 058	387 644	49 133	49 559	98 692	139 018	135 306	274 324	2 179 953	2 111 636	4 291 589	25-29
30-34	1 486 196	1 476 569	2 962 765	182 355	186 014	368 369	43 555	44 249	87 804	140 674	136 833	277 507	1 852 780	1 843 665	3 696 445	30-34
35-39	1 036 199	1 079 393	2 115 592	153 052	159 966	313 018	40 979	42 062	83 041	171 319	168 342	339 661	1 401 549	1 449 763	2 851 312	35-39
40-44	878 996	953 225	1 832 221	130 503	138 929	269 432	37 748	39 380	77 128	179 335	180 533	359 868	1 226 582	1 312 067	2 538 649	40-44
45-49	742 227	827 582	1 569 809	104 214	112 944	217 158	33 936	35 898	69 834	175 723	181 467	357 190	1 056 100	1 157 891	2 213 991	45-49
50-54	568 462	644 707	1 213 169	77 618	86 762	164 380	29 607	32 214	61 821	159 119	163 492	322 611	834 806	927 175	1 761 981	50-54
55-59	416 094	491 453	907 547	55 697	65 469	121 166	23 611	26 742	50 353	140 644	149 508	290 152	636 046	733 172	1 369 218	55-59
60-64	310 528	387 268	697 796	38 091	46 944	85 035	16 461	19 837	36 298	110 113	121 173	231 286	475 193	575 222	1 050 415	60-64
65-69	216 090	293 863	509 953	26 410	36 996	63 406	10 840	14 486	25 326	76 447	92 320	168 767	329 787	437 665	767 452	65-69
70-74	135 463	204 926	340 389	15 799	24 755	40 554	6 276	9 573	15 849	48 660	69 065	117 725	206 198	308 319	514 517	70-74
75-79	75 364	125 471	200 835	8 103	13 875	21 978	3 399	5 912	9 311	29 942	50 185	80 127	116 808	195 443	312 251	75-79
80+	54 928	104 213	159 141	6 163	11 424	17 587	2 470	4 544	7 014	28 103	56 196	84 299	91 664	176 377	268 041	80+
Total	18 254 444	18 679 737	36 934 181	2 004 048	2 082 742	4 086 790	554 119	577 223	1 131 342	2 174 799	2 259 495	4 434 294	22 987 410	23 599 197	46 586 607	Total

5. METHODOLOGY FOR SOUTH AFRICAN PROVINCIAL ESTIMATES

Overview of provincial estimation methodology used in South Africa

When projections for all the regions of a country are desired and the appropriate data are available, a multi-regional approach should be considered, as this is the only way to guarantee that the total migration flows between regions will sum to zero, or to the assumed level of international migration (United Nations, 1992). Multi-regional methods for projection have been developed by Willekens and Rogers (1978) and have been used by demographers in several European countries in conducting population projections. These methods have not been widely used in developing countries, largely due to the lack of adequate migration data and the difficulty of applying these methods.

Multi-regional methods require the estimation of separate age-specific migration rates between every region of the country and every other region and such detailed data are rarely available. Although it is possible to estimate some of the missing data (see Willekens, Por & Raquillet, 1979), the task of preparing data can become overwhelming if there are many regions. For example, a country with 30 regions would require estimating migration rates by age and sex for 30 times 29, or 870 migration streams. If there are only a few streams, however, the multi-regional method is the best method to use. In South Africa, 576 (9x8x4x2) migration streams are derived if the multi-regional model is applied in calculating migration streams by population group and sex for each of the nine provinces.

The approach followed in deriving the estimates in this publication is presented below. The calculations necessary for each province are set out. This is followed by a detailed description of the fertility, mortality and migration assumptions used in deriving the provincial population estimates for 2004.

Five main steps may be identified in deriving provincial mid-year population estimates for South Africa. These are:

- Calculate the number of out-migrants;
- Calculate the number of survivors by province;
- Calculate the number of in-migrants;
- Sum the number of survivors and in-migrants to obtain the population aged 5 years and older;
- Calculate the number of births and survivors aged 0-4 years.

Calculating provincial population estimates for South Africa

Step 1: Calculate of the number of out-migrants

Whereas a projection for a single region involves multiplying the population at the first time-point in each five-year age group by a survival rate to obtain the survivors to the next five-year age group at the second time point, a multi-regional projection involves a compound survival rate which specifies the probability of surviving and being in a particular region at the second time-point. A compound survival rate is the product of the survival rate and the out-migration rate(s) to each of the other provinces. The number of out-migrants from province A to each of the other provinces (B to I) is then defined as:

$$OUT^{AB}_{t+5,x+5} = P^{A}_{t,x} * S^{A}_{t,x} * MR^{AB}_{t,x}$$
$$OUT^{AC}_{t+5,x+5} = P^{A}_{t,x} * S^{A}_{t,x} * MR^{AC}_{t,x}$$
$$\bullet$$
$$\bullet$$
$$OUT^{AI}_{t+5,x+5} = P^{A}_{t,x} * S^{A}_{t,x} * MR^{AI}_{t,x}$$

Where:

$S^{A}_{t,x}$ is the survival ratio of province A, age group x, first projection period; $MR^{AB}_{t,x}$ is the migration rate of province A to province B, age group x, first projection period; $MR^{AC}_{t,x}$ is the migration rate of province A to province C, age group x, first projection period; and $MR^{AI}_{t,x}$ is the migration rate of province A to province I, age group x, first projection period. The migration rate is defined as the number of migrants per thousand of the population in a specific age group.

Step 2: Calculate the number of survivors by province

For survival in the same province, the compound rate is the survival rate times one minus the sum of the out-migration to the other provinces. That is, the survivors (those that have not died or migrated) for people in age group x+5 and period t+5 of province A is obtained by the following formula:

$$SUR^{A}_{t+5,x+5} = P^{A}_{t,x} * S^{A}_{t,x} * (1 - MR^{AB}_{t,x} - MR^{AC}_{t,x} - MR^{AD}_{t,x} - \ldots\ldots\ldots MR^{AI}_{t,x})$$

Where:

$P^{A}_{t,x}$ is the population of province A, age group x, first time period; and the other symbols are defined as before. The number of survivors in each of the other provinces is calculated in the same way.

Step 3: Calculate the number of in-migrants

The number of in-migrants to province A is obtained by adding the out-migrants from the other provinces (B to I) to province A, that is:

$$IN_{t+1,x}^{A} = OUT_{t+1,x}^{BA} + OUT_{t+1,x}^{CA} + OUT_{t+1,x}^{DA} + \ldots\ldots\ldots + OUT_{t+1,x}^{IA}$$

Step 4: Sum the survivors and in-migrants to obtain the population aged 5 years and older

The projected provincial population of A in each age group aged 5 years and over is simply the sum of the survivors in province A and the number of in-migrants to province A, namely:

$$P_{t+1,x}^{A} = SUR_{t+1,x}^{A} + IN_{t+1,x}^{A}$$

Step 5: Calculate the number of births and survivors aged 0-4 years

Annual births are estimated by applying the age-specific birth rates assumed for each province to the number of women in each of the reproductive age groups. This step is done separately for 1996 and 2001; the results are averaged and then multiplied by five to obtain the total number of births in the specific province for the first five-year projection interval. The total number of births is multiplied by the assumed sex ratio at birth to obtain the number of male births. As in the previous steps indicated, the survivors and out-migrants for the 0-4 years group are calculated by applying the relevant survival ratio and migration rates. This projection process can be repeated for further time intervals and the assumed levels of mortality, fertility and migration can be altered for each projection period, if desired.

Assumptions of the provincial mid-year population estimates

Base population by province, population group and sex

The 2001 provincial base populations were constructed using three sources:

- the adjusted 2001 census population by age and sex for each of the nine provinces;
- the 2001 mid-year estimate population by age and sex; and
- an estimate of the total population in each province by sex.

In this projection the estimates of the Bureau of Market Research (Steenkamp, 2003) were used to determine the proportional distribution of each province. The base populations were then determined by using a series of iteration processes in order to ensure that for each sex and age group the sum of the provincial population is equal to the total population in Table 12.

Fertility assumptions

The age-specific fertility rates and TFRs for each province were obtained from the fertility analyses of the 2001 population census (Moultrie & Dorrington, 2004). To determine if the suggested rates generate the same number of births as were obtained from the total population, the age-specific fertility rates were applied to provincial female populations in the age groups 15-49 years. The number of births obtained in this way was less than the total births. Age-specific fertility rates were therefore adjusted by a factor of 1,0287 and are shown in Table 13.

Table 13: Age-specific fertility rates and TFRs per province

	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape
15-19	0,0617	0,0576	0,0494	0,0792	0,0874	0,0905	0,0627	0,0638	0,0514
20-24	0,1399	0,1214	0,1111	0,1389	0,1615	0,1409	0,1224	0,1306	0,1132
25-29	0,1666	0,1348	0,1348	0,1492	0,1749	0,1502	0,1306	0,1420	0,1399
30-34	0,1450	0,1070	0,1121	0,1306	0,1481	0,1286	0,1080	0,1173	0,1080
35-39	0,1008	0,0658	0,0627	0,0823	0,1049	0,0864	0,0555	0,0761	0,0566
40-44	0,0442	0,0257	0,0226	0,0329	0,0504	0,0360	0,0154	0,0319	0,0175
45-49	0,0165	0,0082	0,0072	0,0113	0,0165	0,0113	0,0031	0,0072	0,0051
TFR	3,37	2,6	2,5	3,12	3,72	3,22	2,49	2,84	2,46

Mortality assumptions

In their analysis of mortality in the 2001 census, Dorrington, Moultrie and Timaeus (2004) concluded that it is not possible to construct life tables from these data. It was therefore decided to use the mean life expectancy at birth for the period 2001-2006 as assumed in the ASSA 2000 as a first estimate of the mortality of the provinces. Using the MATCH and LIFTB procedures in MORTPAK, adjustments to the initial mortality estimates were made separately for males and females. These were as follows:

- generating life tables from the initial life expectancies at birth for each province;
- applying the age-specific mortality formula ($_nm_x$) to the province census population data to obtain the number of deaths;
- comparing the sum of the provincial deaths with the total deaths. For males, 10 981 more deaths and 7 498 more female deaths were obtained by applying the age-specific mortality formula to the provincial data. The numbers of provincial deaths were reduced by factors 0,97 and 0,98 for males and females respectively; and
- constructing revised sets of $_nm_x$-values to calculate revised life tables.

The revised life expectancies at birth were noted and the survival ratios ($_nS_x$) were then used for the projections. Tables 14 and 15 show the $_nS_x$ values obtained by applying the above procedure. These $_nS_x$ values were then used to generate the mid-year provincial population estimates.

Table 14: Male survival ratios by province for the period 2001-2006

	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape
Birth	0,8929	0,8810	0,8972	0,8602	0,8962	0,8721	0,9070	0,8874	0,9414
0-4	0,9648	0,9590	0,9669	0,9487	0,9664	0,9546	0,9717	0,9621	0,9856
5-9	0,9853	0,9830	0,9861	0,9788	0,9859	0,9813	0,9879	0,9842	0,9935
10-14	0,9839	0,9817	0,9847	0,9776	0,9846	0,9799	0,9866	0,9829	0,9925
15-19	0,9753	0,9720	0,9765	0,9660	0,9762	0,9694	0,9793	0,9738	0,9881
20-24	0,9688	0,9647	0,9703	0,9573	0,9699	0,9615	0,9737	0,9668	0,9847
25-29	0,9639	0,9592	0,9656	0,9509	0,9652	0,9557	0,9695	0,9617	0,9821
30-34	0,9550	0,9495	0,9571	0,9396	0,9565	0,9452	0,9617	0,9524	0,9771
35-39	0,9400	0,9333	0,9424	0,9218	0,9418	0,9283	0,9479	0,9369	0,9674
40-44	0,9191	0,9113	0,9220	0,8981	0,9212	0,9055	0,9284	0,9154	0,9525
45-49	0,8884	0,8795	0,8917	0,8647	0,8909	0,8730	0,8990	0,8842	0,9287
50-54	0,8496	0,8399	0,8533	0,8241	0,8524	0,8329	0,8609	0,8450	0,8958
55-59	0,7949	0,7844	0,7989	0,7676	0,7979	0,7770	0,8067	0,7898	0,8472
60-64	0,7161	0,7044	0,7206	0,6861	0,7194	0,6963	0,7288	0,7105	0,7767
65-69	0,6276	0,6152	0,6325	0,5960	0,6313	0,6066	0,6407	0,6217	0,6945
70-74	0,5336	0,5215	0,5384	0,5028	0,5372	0,5131	0,5457	0,5278	0,6015
75-79	0,4403	0,4297	0,4445	0,4136	0,4435	0,4225	0,4497	0,4352	0,5012
80+	0,3022	0,2965	0,3044	0,2877	0,3039	0,2926	0,3049	0,2994	0,3341
e_0	49,2	47,1	50	43,7	49,7	45,6	51,8	48,2	59,1

Table 15: Female survival ratios by province for the period 2001-2006

	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape
Birth	0,9036	0,8943	0,9085	0,8715	0,9081	0,8833	0,9233	0,8999	0,9491
0-4	0,9685	0,9634	0,9710	0,9502	0,9709	0,9570	0,9784	0,9665	0,9889
5-9	0,9887	0,9869	0,9897	0,9819	0,9896	0,9845	0,9923	0,9880	0,9961
10-14	0,9859	0,9836	0,9871	0,9773	0,9870	0,9806	0,9904	0,9850	0,9952
15-19	0,9755	0,9714	0,9776	0,9602	0,9774	0,9661	0,9835	0,9739	0,9918
20-24	0,9684	0,9632	0,9710	0,9495	0,9708	0,9567	0,9784	0,9663	0,9890
25-29	0,9630	0,9574	0,9659	0,9426	0,9657	0,9504	0,9741	0,9608	0,9863
30-34	0,9574	0,9515	0,9604	0,9364	0,9602	0,9442	0,9692	0,9550	0,9828
35-39	0,9500	0,9441	0,9531	0,9293	0,9528	0,9369	0,9623	0,9477	0,9772
40-44	0,9386	0,9325	0,9419	0,9177	0,9416	0,9253	0,9516	0,9362	0,9685
45-49	0,9191	0,9122	0,9228	0,8959	0,9225	0,9042	0,9340	0,9163	0,9545
50-54	0,8898	0,8816	0,8942	0,8626	0,8938	0,8722	0,9078	0,8864	0,9337
55-59	0,8493	0,8397	0,8546	0,8177	0,8541	0,8287	0,8709	0,8454	0,9034
60-64	0,7957	0,7849	0,8017	0,7605	0,8012	0,7726	0,8206	0,7913	0,8597
65-69	0,7246	0,7126	0,7312	0,6862	0,7307	0,6992	0,7523	0,7196	0,7984
70-74	0,6333	0,6200	0,6407	0,5914	0,6401	0,6055	0,6645	0,6278	0,7188
75-79	0,5232	0,5103	0,5305	0,4828	0,5299	0,4962	0,5539	0,5178	0,6106
80+	0,3303	0,3237	0,3341	0,3096	0,3338	0,3165	0,3451	0,3276	0,3741
e_0	52,8	50,6	54	45,7	53,9	48,2	57,8	51,9	65,0

Migration assumptions

The migration-related questions asked in the 2001 census enabled researchers to determine migration streams between the different provinces. The migration questions differ from those used in the 1996 census and the calculations to determine the migration streams were more complicated. The way the questions were phrased made it possible to determine if a person was a migrant in the five years before the census.

The results of the analysis and the migration assumptions used in this projection are given in Tables 16 to 18. Gauteng, Western Cape and North West had a positive net migration rate. There seems to be a high migration movement between Gauteng and North West. The provinces with the highest outflow of people were Eastern Cape and Limpopo. The tables also suggest a slightly higher migration for men than women.

Table 16: Assumed migration streams for males, 2001-2006

Origin	Did not migrate	Migration to									Total out-migration	Net migration
		Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape		
Eastern Cape	3 319 079	-	11 055	53 643	36 943	3 958	7 026	3 084	15 343	87 474	218 526	-153 348
Free State	1 401 147	7 117	-	37 066	5 764	3 071	4 795	4 546	13 987	8 350	84 696	-29 619
Gauteng	4 297 661	19 509	16 332	-	29 297	27 398	23 083	4 532	35 208	35 435	190 794	246 347
KwaZulu-Natal	4 639 758	11 487	5 601	81 837	-	4 924	12 207	1 248	5 778	15 440	138 522	-45 260
Limpopo	2 674 555	1 960	2 834	115 374	3 790	-	25 424	1 082	15 128	3 446	169 038	-107 564
Mpumalanga	1 548 018	2 417	3 867	57 196	7 312	11 524	-	1 003	7 880	3 785	94 984	-15 083
Northern Cape	420 025	2 055	5 167	6 936	1 294	1 193	1 047	-	5 037	13 190	35 919	-3 140
North West	1 860 819	3 509	6 826	64 742	2 969	7 689	4 117	10 675	-	4 516	105 043	41 074
Western Cape	2 199 135	17 124	3 395	20 347	5 893	1 717	2 202	6 609	2 447	-	59 734	111 902
Total in-migration		**65 178**	**55 077**	**437 141**	**93 262**	**61 474**	**79 901**	**32 779**	**100 808**	**171 636**		

Table 17: Assumed migration streams for females, 2001-2006

Origin	Did not migrate	Migration to									Total out-migration	Net migration
		Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape		
Eastern Cape	3 608 782	-	10 165	57 986	38 321	4 418	6 229	2 396	12 641	87 992	220 148	-162 622
Free State	1 443 142	5 195	-	36 217	5 074	2 806	4 004	3 691	11 282	7 739	76 009	-27 589
Gauteng	4 062 693	16 747	13 631	-	24 524	22 374	19 255	3 679	28 469	32 472	161 151	247 555
KwaZulu-Natal	4 919 856	11 632	5 180	75 291	-	3 999	10 741	1 060	4 113	14 095	126 111	-39 474
Limpopo	3 010 949	1 784	2 454	95 262	3 055	-	23 725	864	12 401	3 036	142 582	-88 483
Mpumalanga	1 589 049	2 011	3 366	51 746	6 467	10 953	-	837	6 452	3 379	85 211	-14 880
Northern Cape	421 205	1 809	4 625	7 159	1 169	1 036	834	-	4 603	13 507	34 743	-6 912
North West	1 794 094	2 565	5 908	65 805	2 446	6 922	3 638	9 148	-	4 024	100 456	26 615
Western Cape	2 218 321	15 783	3 091	19 240	5 581	1 591	1 905	6 156	2 049	-	55 395	110 849
Total in-migration		**57 526**	**48 420**	**408 706**	**86 637**	**54 099**	**70 331**	**27 831**	**82 010**	**166 244**		

Table 18: Assumed migration streams for the total population, 2001-2006

Origin	Did not migrate	Migration to									Total out-migration	Net migration
		Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpumalanga	Northern Cape	North West	Western Cape		
Eastern Cape	6 927 861	-	21 220	111 629	75 264	8 376	13 255	5 480	27 984	175 466	438 674	-315 970
Free State	2 844 289	12 312	-	73 283	10 838	5 877	8 799	8 237	25 269	16 089	160 705	-57 208
Gauteng	8 360 354	36 256	29 963	-	53 821	49 772	42 338	8 211	63 677	67 907	351 945	493 902
Kwazulu-Natal	9 559 614	23 119	10 781	157 128	-	8 923	22 948	2 308	9 891	29 535	264 633	-84 734
Limpopo	5 685 504	3 744	5 288	210 636	6 845	-	49 149	1 946	27 529	6 482	311 620	-196 047
Mpumalanga	3 137 067	4 428	7 233	108 942	13 779	22 477	-	1 840	14 332	7 164	180 195	-29 963
Northern Cape	841 230	3 864	9 792	14 095	2 463	2 229	1 881	-	9 640	26 697	70 662	-10 052
North West	3 654 913	6 074	12 734	130 547	5 415	14 611	7 755	19 823	-	8 540	205 499	67 689
Western Cape	4 417 456	32 907	6 486	39 587	11 474	3 308	4 107	12 765	4 496	-	115 129	222 751
Total in-migration		**122 704**	**103 497**	**845 847**	**179 899**	**115 573**	**150 232**	**60 610**	**182 818**	**337 880**		

6. MID-YEAR PROVINCIAL ESTIMATES, 2004

In this section the detailed provincial mid-year estimates for 2004 are presented in Tables 19 and 20. These tables explicitly take HIV into account. For these estimates, it was assumed that the proportion of the population by sex and gender in each province corresponds to that of the national population. Where reconciliation was necessary, it was done separately for males and females. The population totals by sex and age presented in this section therefore correspond with the totals presented in Section 4.

Table 19 shows the percentage of the total population residing in each of the provinces. The provincial estimates show that KwaZulu-Natal has the largest share of the population (20,7%), followed by Gauteng (19,0%) and Eastern Cape (15,2%). Nearly 10% of the population live in the Western Cape. The Northern Cape has the smallest population, with 1,9% of the total population. Mpumalanga has the second smallest share of the South African population, with 7% of the total population residing in this province. Table 20 shows the detailed provincial mid-2004 population estimates by age and sex.

Table 19: Percentage provincial share of the total population, 2004

Province	Percentage share of the total population in 2004
Eastern Cape	15,2
Free State	6,3
Gauteng	19,0
KwaZulu-Natal	20,7
Limpopo	11,9
Mpumalanga	7,0
Northern Cape	1,9
North West	8,2
Western Cape	9,8
Total	**100,0**

Table 20: Provincial mid-year population estimates by age and sex, considering HIV, 2004

Age	Eastern Cape			Free State			Gauteng			KwaZulu-Natal			Limpopo			Age
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
0-4	405 800	395 088	800 888	149 828	147 147	296 975	440 741	430 124	870 864	565 700	553 687	1 119 387	375 295	371 888	747 183	0-4
5-9	433 784	420 359	854 143	155 233	152 150	307 382	373 768	369 579	743 347	575 513	565 124	1 140 638	370 611	368 153	738 764	5-9
10-14	466 782	455 060	921 842	155 913	152 558	308 470	330 463	328 445	658 907	567 195	557 793	1 124 989	384 301	382 240	766 541	10-14
15-19	438 583	431 474	870 058	158 127	154 685	312 812	345 676	344 181	689 857	543 652	539 253	1 082 905	360 904	357 864	718 768	15-19
20-24	343 012	343 276	686 288	148 604	146 313	294 917	467 285	435 546	902 831	496 451	499 886	996 337	284 951	294 431	579 383	20-24
25-29	255 366	269 959	525 325	132 437	133 200	265 637	565 240	481 845	1 047 086	429 608	437 321	866 929	207 518	225 918	433 436	25-29
30-34	198 906	232 519	431 424	116 128	120 834	236 962	511 023	432 327	943 350	346 658	372 659	719 317	153 567	172 715	326 282	30-34
35-39	152 649	192 248	344 897	93 803	98 361	192 164	374 416	328 781	703 197	249 537	288 478	538 015	112 959	131 411	244 370	35-39
40-44	141 933	187 822	329 755	84 190	88 425	172 615	314 689	290 606	605 295	215 678	262 499	478 177	97 433	114 928	212 361	40-44
45-49	132 028	177 623	309 650	73 923	78 539	152 462	261 052	252 049	513 101	185 746	228 568	414 314	84 508	99 744	184 252	45-49
50-54	109 459	145 050	254 509	58 877	64 159	123 036	195 819	193 605	389 424	153 093	187 364	340 457	70 506	81 556	152 062	50-54
55-59	87 577	118 023	205 599	44 415	50 348	94 763	141 264	145 630	286 895	119 854	153 134	272 988	55 570	64 061	119 631	55-59
60-64	73 785	105 140	178 925	32 334	38 089	70 423	96 428	103 677	200 105	87 852	119 459	207 311	43 877	52 033	95 910	60-64
65-69	59 912	92 595	152 507	21 951	28 849	50 800	59 076	68 407	127 483	59 015	90 921	149 936	33 018	42 342	75 359	65-69
70-74	40 261	65 882	106 143	13 597	20 539	34 136	33 443	44 940	78 383	35 931	65 861	101 792	22 756	30 740	53 496	70-74
75-79	22 731	40 859	63 590	7 151	12 142	19 292	18 294	28 768	47 062	20 429	42 360	62 789	14 256	18 755	33 011	75-79
80+	17 380	35 624	53 004	5 657	12 157	17 814	14 183	26 371	40 553	15 291	34 304	49 595	12 888	18 264	31 152	80+
Total	3 379 948	3 708 599	7 088 547	1 452 166	1 498 495	2 950 661	4 542 859	4 304 881	8 847 740	4 667 203	4 998 672	9 665 875	2 684 919	2 827 044	5 511 962	Total

Table 20: Provincial mid-year population estimates by age and sex, considering HIV, 2004 (continued)

Age	Mpumalanga			Northern Cape			North West			Western Cape			All provinces			Age
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	
0-4	196 152	193 065	389 217	44 998	43 903	88 901	203 484	198 745	402 229	234 517	226 303	460 820	2 616 514	2 559 951	5 176 465	0-4
5-9	195 728	194 040	389 768	50 039	48 227	98 265	207 994	203 432	411 426	221 272	214 461	435 732	2 583 940	2 535 525	5 119 465	5-9
10-14	188 368	186 926	375 294	46 720	45 345	92 065	200 988	196 968	397 957	204 755	200 794	405 549	2 545 484	2 506 130	5 051 614	10-14
15-19	181 232	179 118	360 351	44 415	43 154	87 569	194 432	190 376	384 808	208 630	208 235	416 864	2 475 651	2 448 341	4 923 992	15-19
20-24	163 638	161 319	324 957	41 144	39 221	80 365	187 219	176 113	363 332	226 051	224 750	450 801	2 358 355	2 320 855	4 679 210	20-24
25-29	144 218	144 506	288 724	39 714	37 229	76 943	180 216	165 002	345 218	225 636	216 656	442 292	2 179 953	2 111 636	4 291 589	25-29
30-34	121 241	127 375	248 616	36 693	35 006	71 699	161 671	149 901	311 572	206 893	200 329	407 221	1 852 780	1 843 665	3 696 445	30-34
35-39	92 560	98 754	191 314	29 725	29 351	59 076	131 586	118 285	249 871	164 315	164 093	328 408	1 401 549	1 449 763	2 851 312	35-39
40-44	81 573	85 743	167 316	26 518	27 093	53 611	121 310	106 159	227 468	143 258	148 793	292 051	1 226 582	1 312 067	2 538 649	40-44
45-49	69 815	72 730	142 545	24 002	25 172	49 173	104 405	93 349	197 753	120 622	130 119	250 741	1 056 100	1 157 891	2 213 991	45-49
50-54	54 668	57 658	112 326	19 756	21 042	40 798	77 619	73 763	151 382	95 008	102 978	197 986	834 806	927 175	1 761 981	50-54
55-59	39 451	43 028	82 479	15 487	17 128	32 615	58 175	58 731	116 907	74 253	83 089	157 341	636 046	733 172	1 369 218	55-59
60-64	28 475	33 166	61 641	11 969	13 344	25 313	43 782	47 015	90 797	56 693	63 298	119 990	475 193	575 222	1 050 415	60-64
65-69	18 733	25 269	44 002	8 477	9 673	18 150	29 224	34 393	63 617	40 381	45 218	85 598	329 787	437 665	767 452	65-69
70-74	11 580	18 178	29 758	5 202	6 615	11 817	18 222	24 326	42 549	25 206	31 238	56 443	206 198	308 319	514 517	70-74
75-79	7 031	11 722	18 753	2 762	4 111	6 873	10 385	16 153	26 538	13 769	20 573	34 342	116 808	195 443	312 251	75-79
80+	6 224	11 022	17 246	2 137	3 978	6 116	8 201	15 844	24 046	9 703	18 813	28 515	91 664	176 377	268 041	80+
Total	1 600 686	1 643 620	3 244 306	449 757	449 592	899 349	1 938 913	1 868 556	3 807 469	2 270 959	2 299 738	4 570 696	22 987 410	23 599 197	46 586 607	Total

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