

5

**Completeness of death registration in Cape Town and  
its health districts, 1996-2004**

**By**

**Nesbert Zinyakatira**

**Thesis submitted to the Faculty of Commerce in partial fulfillment for  
the Degree of Master of Philosophy in Demography  
University of Cape Town  
July 2007**

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

## **Abstract**

It is important for health planners to have timeous and accurate data on deaths. The Department of Home Affairs is responsible for the registration of deaths and the City of Cape Town has a well established system of collating the death statistics based on vital registration, but the completeness of the death registration has not been assessed previously.

The completeness was assessed for the City of Cape Town by comparing their statistics with an estimate based on data obtained from adult deaths reported in the 2001 census. A second approach assessed the trend in completeness between 1996 and 2004 by identifying three rates of mortality considered to be stable over time (non-lung and non-oesophageal cancers, the 10-14 age group and the 60+ age group) and inspecting to observe whether there was any trend apparent over time.

Since deaths in most cases are under reported, and the under reporting usually differs in completeness between children and adults, child deaths from the ASSA model projection assuming that they are more complete were compared with the child deaths from the vital registration between 1996 and 2004 to check for completeness of the child vital registration data in Cape Town and its eight health districts

The results show high levels of completeness in the adult deaths for Cape Town as a whole in 2001, around 95 per cent, but varying levels in the health districts. The completeness of reporting of male deaths in Cape Town declines with age, whilst completeness for females is fairly level with respect to age, with similar trends being observed in the health districts. Completeness of child (0-4) death registration averaged around 60 per cent, about 35 per cent lower than the completeness of adult deaths in Cape Town. Cape Town as a whole and most of its health districts revealed two levels of completeness in

the registration of deaths, 1996-1999 and 2001-2004 with 2000 sometimes consistent with the first and sometimes with the second period or different from either period in some of the health districts.

In conclusion the completeness estimates obtained are more rigorous from 2001 onwards suggesting that they can be reliably used to monitor trends in the levels of mortality in the city of Cape Town.

## Acknowledgements

First and foremost I am greatly indebted to my supervisor Professor Rob Dorrington, for his patience, tireless efforts, invaluable ideas and insightfulness. I would like to thank Dr Tom Moultrie and Dr Ravayi Marindo for the knowledge they imparted to me through my studies.

From the Medical Research Council Burden of Disease Research Unit I would like to thank Professor Debbie Bradshaw and Pam Groenewald, for providing the data, and the useful insights and comments along the journey. I would like to thank all my family and friends who helped in all their weird and wonderful ways, special thanks to Artwell and Leonard and to the rest who endured my pestering.

Finally I am eternally grateful to the Andrew Mellon Foundation for making a financial contribution towards my studies.

## Table of Contents

<b>Abstract</b> .....	<b>ii</b>
<b>Acknowledgements</b> .....	<b>iv</b>
<b>Table of Contents</b> .....	<b>v</b>
<b>List of Tables</b> .....	<b>viii</b>
<b>List of Figures</b> .....	<b>ix</b>
<b>Chapter 1 Introduction</b> .....	<b>1</b>
1.1 Introduction .....	1
1.2 Statement of the problem.....	2
1.3 Aim and Objectives.....	2
1.4 Justification of the study.....	3
1.5 Structure of the thesis .....	3
<b>Chapter 2 Literature Review</b> .....	<b>5</b>
2.1 Indirect techniques of estimating completeness of death registration	5
2.1.1 Brass Growth Balance method.....	6
2.1.2 Generalized Growth Balance (GGB) method.....	7
2.1.3 Preston and Coale method.....	8
2.1.4 Bennett and Horiuchi (SEG) method.....	9
2.2 Completeness of death registration in South Africa .....	12
2.3 Mortality in South Africa.....	16
2.4 Causes of death in South Africa .....	19
2.5 Mortality in the Provinces .....	21
2.6 Mortality in Western Cape .....	23
2.7 Cape Town profile .....	24
2.7.1 Age distribution of population in Cape Town.....	24

2.7.2	Mortality in Cape Town.....	26
2.7.3	Health districts in Cape Town.....	27
2.7.4	Population in the health districts.....	28
<b>Chapter 3</b>	<b>Methodology .....</b>	<b>32</b>
3.1	Data sources and assessment of the death data.....	32
3.2	Cape Town Population.....	34
3.3	Population estimates for the health districts.....	35
3.4	Completeness.....	36
3.5	Completeness trends.....	38
3.6	Mortality rates .....	38
<b>Chapter 4</b>	<b>Completeness.....</b>	<b>39</b>
4.1	Completeness of vital registration in adults.....	39
4.1.1	Completeness in Cape Town.....	40
4.1.2	Completeness by age in the health districts .....	42
<b>Chapter 5</b>	<b>Trends in Completeness .....</b>	<b>46</b>
5.1	Indicators of completeness trends in adults: Mortality rates of non-lung and non-oesophageal cancers, the 10-14 age group and the 60+ age group	46
5.1.1	Trends in completeness: Cape Town.....	47
5.1.2	Comparison of vital registration (injury) with NIMSS deaths .....	49
5.1.3	Trends in completeness: Health districts.....	50
5.2	Estimation of completeness over time.....	53
5.3	Completeness of vital registration in children (0-4).....	55
5.3.1	Completeness in Cape Town.....	57
5.3.2	Completeness in the health districts.....	58
5.4	Comparison of adult and child completeness over time.....	60
<b>Chapter 6</b>	<b>Mortality rates .....</b>	<b>62</b>

6.1	Cape Town mortality rates .....	62
6.2	Cause specific mortality rates in Cape Town.....	64
6.2.1	Communicable mortality rates .....	64
6.2.2	Non-communicable mortality rates .....	66
6.2.3	Injury mortality rates .....	67
6.2.4	Ill-defined mortality rates .....	68
6.3	Mortality rates in the health Districts .....	69
<b>Chapter 7 Discussion and Conclusions .....</b>		<b>73</b>
7.1	Adult death registration .....	73
7.2	Trends of completeness over time.....	74
7.3	Completeness of child death registration .....	77
7.4	Overall conclusion .....	78
<b>References .....</b>		<b>82</b>
<b>Appendix: Adult mortality estimates in the health districts ..</b>		<b>89</b>
A4.1	Central health district.....	89
A4.2	Eastern health district .....	90
A4.3	Khayelitsha health district .....	91
A4.4	Klipfontein health district.....	92
A4.5	Mitchell's Plain health district.....	92
A4.6	Northern Panorama health district.....	93
A4.7	Southern health district.....	94
A4.8	Tygerberg health district.....	95

## List of Tables

Table 2.1 Old health districts in the current health districts .....	28
Table 2.2 Population group distribution in the 2001 census.....	29
Table 4.1 Completeness of vital registration, Cape Town.....	41
Table 4.2 Overall completeness of death registration, Health districts .....	45
Table 6.1 Comparison of the mortality rates ( ${}_{45}m_{15}$ ) per 1000.....	63

## List of Figures

Figure 2.1 Cape Town population distribution 1996 and 2001 .....	25
Figure 2.2 Map of the current health districts of Cape Town .....	30
Figure 4.1 Completeness of vital registration, Cape Town .....	41
Figure 4.2 Completeness by age in the health districts, 2001 .....	42
Figure 5.1 Mortality ratios for non-lung and non-oesophageal cancers, the 10-14 age group, the 60+ age group and the weighted index 1996-2004: Cape Town, Females .....	48
Figure 5.2 Mortality ratios for non-lung and non-oesophageal cancers, the 10-14 age group, the 60+ age group and the weighted index, 1996-2004: Cape Town, Males .....	48
Figure 5.3 All cause crude death rates unadjusted for incompleteness.....	49
Figure 5.4 Injury deaths versus NIMMS injury deaths, completeness.....	50
Figure 5.5 Weighted index ratios, 1996- 2004: Health districts .....	52
Figure 5.6 Completeness of vital registration, infants (0) and children (0-4): Cape Town .....	57
Figure 5.7 Infant and child completeness by health district.....	59
Figure 6.1 Age specific mortality rates per 1000, 1996, 2000 and 2004: Cape Town .....	62
Figure 6.2 Age specific communicable mortality rates per 1000, 1996-2004: Cape Town .....	65
Figure 6.3 Selected age specific mortality rates ( $\zeta m_x$ per 1000), 1996-2004: Communicable diseases, Cape Town.....	66
Figure 6.4 Female non-communicable mortality rates 1996-2004: Cape Town .....	67

Figure 6.5 Age specific injury mortality rates per 1000, 1996-2004: Cape Town .....	68
Figure 6.6 Female ill-defined mortality rates 1996-2004: Cape Town .....	69
Figure 6.7 Adult mortality rates ( $_{45}m_{15}$ per 1000): Females .....	70
Figure 6.8 Adult mortality rates ( $_{45}m_{15}$ per 1000): Males .....	71

# Chapter 1 Introduction

## 1.1 Introduction

In this time of rapidly growing and severe HIV/AIDS epidemic in South Africa, reliable estimates of mortality are vital. Reliability of mortality estimates depends to a large extent on the accuracy and reliability of the death data. The registration system in South Africa has the main objective of providing reliable estimates of births and deaths at national and sub-national levels, and the vital registration system provides a source of demographic data that is independent of the census. Although vital registration systems may cover the whole country, not all deaths are registered and this is the scenario faced by most developing countries with registration of deaths being substantially defective.

Although these vital registration systems provide a source of mortality estimates, in most cases mortality rates are estimated from censuses and surveys using indirect techniques, because the level of completeness of the vital registration is too low. In addition the level of completeness of death reporting from these various sources is usually unknown and this can be expected to lead to under-estimation of mortality rates unless the enumeration of the population is less complete than the registration of deaths. Further, mortality decline in period of improving registration will be under-estimated unless the number of deaths are corrected for under-registration (Horiuchi 1989). This makes it imperative to examine past and current levels of completeness of adult death registration before mortality estimates are derived as the completeness estimates assist in adjusting the mortality levels closer to the real levels.

Infant and child mortality rates are generally subject to errors due to two related factors, omission of infant and child deaths and omission of births.

Both births and deaths are omitted because of failure of the registering agencies to reach all localities or by outright concealment or delay in registration and these factors distort infant and child mortality rates. In some instances under-registration of births somewhat compensates for the under registration of infant and child deaths, but in most cases, however, the omission of infant births is less pronounced than that of infant and child deaths, and this will result in underestimation of infant and child mortality (Palloni 1981), however, one cannot be sure. Due to the incompleteness of infant child deaths in censuses and vital registration data, coupled with flawed surveys, most infant and child mortality estimates are evaluated using indirect techniques and models.

Thus the primary purpose of this research was to derive adjustment factors for incompleteness of the vital registration of deaths, including possible over-reporting, so that the adjusted deaths are as close as possible to the actual number of deaths that occurred in Cape Town. This research makes use of the vital registration data collected in Cape Town between 1996 and 2004.

## **1.2 Statement of the problem**

To estimate and interpret the levels and patterns of completeness in Cape Town and its eight health districts over time between 1996 and 2004.

## **1.3 Aim and Objectives**

The overall aim of this research is to investigate the completeness of the vital registration of deaths in Cape Town and its eight health districts.

The main objectives were to:

1. Compare the registered deaths with those reported by households in the 2001 census.
2. Evaluate levels and trends in adult completeness through trends in specific mortality rates expected to be stable.
3. Estimate the levels of child death registration completeness in Cape Town and its eight health districts.
4. Interpret the trends in the completeness of child and adult death registration in Cape Town and its eight health districts and describe the variations being observed in the trends and patterns.

#### **1.4 Justification of the study**

Completeness of vital registration has been analysed at national level by Statistics South Africa, but no analysis has been done at sub-national level recently. Estimates of mortality at this level of desegregation are very useful for the management of health and as indicators of local development. Since the determination of mortality rates is usually hampered by incomplete registration of deaths, this makes it very important to estimate the completeness levels that can be used to adjust for this incompleteness in death registration.

#### **1.5 Structure of the thesis**

The thesis is structured as follows. **Chapter 2** focuses on indirect methods of estimating completeness and reviews past studies in South Africa on mortality that have been carried out at national and sub-national level. **Chapter 3** describes the data cleaning and analysis process in addition to the method used in the projection of the population of Cape Town and its health districts.

In **Chapter 4** adult completeness in 2001 of the vital registration data in Cape Town and its health districts is estimated relative to the household deaths from the 2001 census.

In **Chapter 5** the trends in completeness in Cape Town and the health districts over time are evaluated by looking at some causes of death and age-specific mortality rates that are not expected to change over time. Completeness of the vital registration of child deaths is also estimated relative to the child deaths from the ASSA model in each year between 1996 and 2004.

**Chapter 6** combines the results derived in **Chapter 4** (completeness by age) and **Chapter 5** (completeness trends) to adjust the vital registration deaths in each year in Cape Town and each of the health districts. Mortality estimates are then derived from the adjusted vital registration deaths.

**Chapter 7** then wraps up with a discussion of the results and conclusions. This is followed by an **Appendix** which includes more detail on the results obtained in the research.

## **Chapter 2      Literature Review**

This chapter reviews the indirect techniques for estimating completeness of death reporting and gives an overview of past studies of mortality that have been conducted in South Africa at national and sub-national level.

### **2.1 Indirect techniques of estimating completeness of death registration**

In many developing countries deaths are under-registered and this makes it problematic to derive mortality rates directly for these populations, as the rates will be underestimated. Various indirect methods of estimating mortality (United Nations 1997) have been developed and refined to correct for the under-reporting of death registration from vital registration or of deaths reported by households in censuses and surveys, relative to population counts. In essence these methods all do so by comparing the reported number of deaths against an expected number of deaths usually derived using the population to be used as the denominator. Earlier methods relied on the strong assumption of a stable and closed population whilst later methods have relaxed the stability assumption with some of the methods adapted to allow for the estimation of the level of migration.

Unfortunately these indirect techniques are not suitable for evaluating the completeness of reporting of infant and child deaths. More often than not an independent estimate of the number of births is used to estimate the completeness of infants and child deaths, but this is usually not available or incomplete. Sometimes the assumption is made that child and adult deaths are equally complete, but sadly this has been observed to be inappropriate in most populations as child deaths have been found usually to be far much less

complete than adult deaths (Preston and Hill 1980). In this chapter we will only discuss the more widely used methods.

### 2.1.1 Brass Growth Balance method

This approach relies upon a comparison of the age distribution of the population with that of deaths. The Growth Balance method was proposed by Brass in 1975 (Brass 1975) and this method uses the relation from stable population theory that for any open ended age group  $a+$  of a closed population the entry rate is equal to the growth rate of the stable population plus the departure rate of the of the open ended age group,

$$b(a+) = r + d(a+),$$

where  $b(a+)$  is the entry rate into the age range  $a+$ ,  $r$  is the growth rate (constant for all ages since the population is stable) and  $d(a+)$  is the departure rate from the age interval  $a+$ . If the entry rate is calculated from a population age distribution alone, any coverage error that is invariant with age cancels out, whereas the death rate, calculated from both deaths by age and population by age, will be affected by any differential coverage between population and deaths (Hill 2001).

This method requires three major assumptions: that population is closed and stable; that completeness of registration of the population and deaths is invariant with age; and that age is accurately reported for both population and deaths. In a stable population the growth rate is constant at all age groups, thus the entry rate and the exit rate are linearly related and the slope of the line relating the entry rate to the exit rate will estimate the completeness of population recording relative to death recording, and provide a potential adjustment factor for the deaths. This method only requires a single population age distribution and the distribution of deaths by age. The Brass

Growth Balance method is less vulnerable to age exaggeration than the Preston and Coale method discussed below, although it has been shown to be more sensitive to the effects of destabilization resulting from a rapid mortality decline (Martin 1980), and significant migration.

### 2.1.2 Generalized Growth Balance (GGB) method

The stable population assumption is often inappropriate in many contexts because of changing fertility and mortality levels and non-negligible levels of migration. The Brass growth balance method can be generalized for non-stable populations and negligible level of migration when two census distributions and a distribution of the inter-censal deaths are available (Hill 1987), in the Generalized Growth Balance method (GGB),

$$b(a+) = r(a+) + d(a+),$$

where  $b(a+)$  is the entry rate,  $r(a+)$  is the growth rate and  $d(a+)$  is the departure rate. This formulation allows for the estimation of the differential completeness of enumeration between the two censuses. This method assumes that the completeness of death reporting and population enumeration in the two censuses is invariant with age and that the population is closed to migration. The relationship of the entry rate minus the growth rate to the death rate estimates an intercept, that captures any age-invariant change in census coverage between the two censuses, and a slope, that estimates the (the reciprocal of the) completeness of death recording relative to an average of the coverage of the two censuses.

The Generalized Growth Balance method was reformulated so as to allow for migration in addition to the changing age structure of the population, with a new procedure for line fitting also developed to minimise the effects of

its sensitivity to age misreporting errors (Bhat 2002), being further generalised as:

$$r(a+) = b(a+) - d(a+) + nm(+),$$

where  $nm(a+)$  is the net migration rate for the population aged  $a$  and over. (Bhat 2002) suggested use of a standard pattern of migration since data on inter-censal migration are rarely available.

Hill and Queiroz (2004) extended this adaptation of the GGB to estimate the level of migration as well as deaths, similar to the one proposed by Bhat (2002), but introduced a two step iterative approach that first estimates the level of net migration, and then allows for it in the GGB method, with observed death rates over successive ages compared against residual estimates made up of the entry rate plus the net migration rates minus the growth rate. This method was predicated on the observation that migration rates have a different age pattern than death rates and it is only when this condition is true that net migration and deaths can be distinguished (Hill and Queiroz 2004). The authors noted that the method worked reasonably well in populations with good data and high net migration rates, but not when deaths are high in the age range where migration is high (e.g. HIV/AIDS affected ages) since the method interprets deaths as emigrants. The method also may not work in populations where the migration pattern is extreme.

### **2.1.3 Preston and Coale method**

This method is based on the notion that the number of persons at a particular age at a point in time will be equal to the total number of deaths arising from this population from that time until the last survivor has died. The Preston and

Coale method (Preston, Coale et al. 1980) derives its equation from the stable population theory that relates the population at age  $x$  to the deaths over age  $x$  expanded by the series of factors incorporating the stable growth rate (Preston, Coale et al. 1980). Given the deaths by age  $D(x)$  and the population by age  $N(x)$  at the mid point of the period,  $\check{N}(x)$ , estimates the size of the population from the registered deaths aged  $x$  at last birthday, and compares these to the population  $N(x)$ , with the ratios  $\check{N}(x)/N(x)$  indicating the relative completeness of death registration.

The Preston and Coale method assumes a stable and closed population and that the degree of completeness of death registration is more or less the same at all adult ages. This method is fairly robust to departures from stability particularly recent declines in fertility and gradual decline in mortality but not HIV/AIDS and it is more sensitive to age-misreporting and differential under-registration of deaths by age.

#### **2.1.4 Bennett and Horiuchi (SEG) method**

The Bennett and Horiuchi method also known as the Synthetic Extinct Generation (SEG) method proposed by Bennett and Horiuchi (1981) is a generalisation of the Preston and Coale method where the concept of variable growth rate over ages is introduced relaxing the assumption of stability, making it applicable to any closed population. When a population deviates from stability the growth rate is no longer a constant but rather varies with age and in such cases the total population growth rate is often a poor approximation for the age specific growth rates (Bennett and Horiuchi 1981). Hence, the Bennett and Horiuchi method (SEG) modifies the equation and uses the concept of differential growth rate within a population. The method uses two census populations and a distribution of deaths by age.

In a closed population with accurate recording of deaths, the population aged  $a$  at time  $t$  can be estimated by accumulating the deaths to that cohort after time  $t$  until the cohort becomes extinct. Bennett and Horiuchi (1981) generalised the method to non-stable populations by using age-specific growth rates. The population aged  $a$  can be estimated from the deaths at all ages  $x$  above that age  $a$  by applying exponential summed age-specific growth rates from  $a$  to  $x$  to allow for the demographic history of the population (Bennett and Horiuchi 1981; Bennett and Horiuchi 1984). The ratio of the population aged  $a$  estimated in this way from the deaths to the observed population age  $a$  estimates the completeness of death recording which is assumed to be constant at all ages relative to census coverage.

The SEG method is much more sensitive to any changes in census coverage that distort the growth rates whilst the GGB method is more sensitive to age misreporting errors (Hill 2001), thus Hill and Choi (2004) suggested a two stage process by which the GGB method is first applied to estimate any change in census coverage, and then applying the SEG method after adjusting the census for possible coverage changes. Allowing the SEG to incorporate migration causes the two stage process to become redundant.

The above methods are designed to work in situations where, by and large, migration is insignificant and the deaths reported are those arising from the population of interest. Unfortunately as one considers lower levels of desegregation, such as province or city, migration becomes increasingly more significant and deaths are increasingly likely to be registered at a place outside the area of residence. Using data on deaths reported by households in a census could get around this problem; however, data on deaths reported by households from the census are also problematic in a number of respects. In

particular completeness of reporting cannot be assumed to be constant for all ages, in particular because households may disintegrate on a death, leaving no one to report the death in the census. Thus on their own these sources of data and methods cannot be used to estimate completeness of mortality in a city let alone its health district.

Dorrington, Moultrie and Timæus (2004) resorted to an innovative alternative method to produce adjustment factors and mortality rates at national and provincial level in South Africa for each of the sexes and each of the population groups. They first estimated the completeness of registration of deaths in these groups nationally by using the Generalized Growth Balance method (GGB) (Hill 1987) to correct the census populations for relative under-coverage, then applied the Synthetic Extinct Generation method (SEG) (Bennett and Horiuchi 1981) to the registered deaths and the estimates of the population. Estimates of mortality of parents (confined to the older ages to avoid impact of HIV/AIDS on the method) were derived using the orphanhood method (Brass and Hill 1973) as a check to the reasonableness of the estimates derived above. These estimates were then compared with similar estimates derived from the rates produced from the registered deaths. The expected numbers of deaths that occurred in the year preceding the 2001 census corrected for under registration were then derived. These were then divided by the number of deaths reported by households in the census to have occurred in the 12 months prior to the census in 2001 to produce factors by population group, sex and age group to be used to correct the numbers of deaths reported by households to national estimates. These adjustment factors thus indicate the extent of under-reporting (or over-reporting) of deaths by respondents in the household questionnaire. These adjustment factors were then applied to deaths from the 2001 census reported by households by

province on the assumption that after allowing for population group and sex, the extent of reporting should not be dependant on the provincial location of the household, produce adult mortality rates by province, population group, sex and age. For the population groups other than African the data were too scanty to assert different patterns and levels of mortality by province and thus the rates were assumed to be the same for all the provinces for each group. As a final check the orphanhood method first proposed by Brass was again applied to the provincial data from the census to check the rates of survival produced against those produced by their method.

As is explained in the next chapter the results obtained from the method by Dorrington, Moultrie et al. (2004) can be used to estimate the completeness of vital registration of deaths in Cape Town and its health districts.

## **2.2 Completeness of death registration in South Africa**

Various studies have been undertaken which have sought to assess the completeness of death reporting in censuses, surveys and the vital registration system at national level over the years. Completeness of adult (15 years and older) death registration in South Africa improved from around 50 per cent in the early 1990s (Timaues, Dorrington et al. 2002) to around 85 per cent if not more by the turn of the century (Dorrington, Moultrie et al. 2004). According to Statistics South Africa (2001) in 1996, 67 per cent of all deaths were estimated to be registered in South Africa, with the registration of deaths increasing from around 63 and 73 per cent in females and males respectively in 1998 to around 87 and 90 cent in females and males respectively in 2003,

before declining<sup>1</sup> in 2004 to around 82 per cent and 87 per cent in females and males respectively, with childhood deaths (under 15) noted as being less complete than adult deaths (15+) in all the years (Statistics South Africa 2006).

These estimates were lower than the completeness estimates by Anderson and Phillips (2006), who noted completeness to be varying between 78 and 80 per cent in males and 78 and 83 per cent in females between 1997 and 2004, but also noted that registration of child deaths was much less complete than adult deaths. They estimated 84 per cent of female deaths and 92 per cent of male deaths aged 15 to 64 to have been registered in 1997, with registration declining in both sexes to 82 and 80 per cent in females and males respectively by 2004. However, only about 45 and 41 per cent of female and male deaths respectively were registered in the children aged 0 to 14 in 1997 with registration of deaths increasing to 60 and 57 per cent in females and males respectively in 2004. The estimated completeness of deaths of those aged 65 and above was found to be much higher, with estimates of 93 and 94 per cent in females and males respectively in 1997 increasing to 102 and 90 per cent in female and male respectively by 2004, with estimates in most of the years, especially in females, greater than 100 per cent, and this was attributed to age exaggeration and undercounts in the censuses.

The differences in completeness between Statistics South Africa (2006) and Anderson and Phillips (2006) are due to the methods that were used, with Statistics South Africa using the Preston and Hill method which they noted to produce implausibly high estimates in South Africa because the assumptions, particularly that the population is stable and closed to migration, are violated

---

<sup>1</sup> The decline was said to be due to late registration of deaths in 2004, with probable outstanding death certificates which had not reached Statistics South Africa by the time of publication of the report (Statistics South Africa 2006).

in practice. Anderson and Phillips (2006) compared the vital registration deaths with deaths derived from the Spectrum projections, which uses modelling assumptions which may not be appropriate to the South African context, especially the use of the model life table (UN East Asian pattern) which has an inappropriate assumption of non-AIDS mortality. They noted that their method leads to higher estimates of mortality than those based on completeness estimates from the Growth Balance method.

Statistics South Africa noted that the introduction of a new death certificate in 1998 improved the information on population group. Prior to this, about one third of death certificates collected by the department of Home Affairs did not have information on the population group of the deceased, but after 1999 around 75 per cent of the certificates captured the information. In 2003 and 2004, apart from having the highest number of deaths, Africans were the only population group<sup>2</sup> that increased in the number of registered deaths, whilst the Coloured, Asian and White population experienced a decline in the number of registered deaths (Anderson and Phillips 2006).

Statistics South Africa (2005) also noted the completeness of death registration to be varying by year and province of death between 1997 and 2003 with the death register being more complete for 2002 than for 1997 (less complete in 2003 because some death certificates were yet to be processed), with deaths being reported by the province in which the death took place, and not by the province of residence. The numbers of death certificates were more than the number of deaths recorded in the population register in each of the years between 1997 and 2003. This is the result of people without ID numbers not

---

<sup>2</sup> The results on population group have to be treated with caution as 25 per cent of the deaths had unknown population group (Statistics South Africa 2006).

being recorded on the population register, and hence their deaths also not being recorded. However, in 2004 there were fewer death certificates received than deaths recorded in the population register, and this was attributed to delays in sending death certificates from provinces to the head office, thus making the death data in 2004 incomplete (Statistics South Africa 2006).

They also found the number of child deaths recorded on the population register to be much lower than the number of death certificates of the children. This is because many of the births are not registered on the population register until the children are older, thus should they die before they are registered their death records will not appear on the population register, in addition a number of child deaths are not captured by the Home Affairs Department as they are buried without obtaining a death certificate (Statistics South Africa 2006).

Provincial completeness of vital death registration in 1996 indicated relatively high levels of registrations (over 100 per cent) in the Western Cape, Gauteng, Northern Cape, Free State and North West (Dorrington, Timaeus et al. 2004). Low levels were observed in the Eastern Cape, KwaZulu-Natal, Mpumalanga and Limpopo. The authors suggest that the high levels in the Western Cape, Gauteng and Northern Cape were probably due to some deaths of people living in other provinces being recorded in these provinces. Whilst the high levels in the Free State and North West were attributed to incompleteness of census coverage relative to death registration in these provinces.

Apart from incompleteness, mortality data also suffer from misclassification of the causes of death this can bring considerable uncertainty about the extent of some cause specific mortality, especially HIV/AIDS mortality (Bradshaw,

Nannan et al. 2006; Statistics South Africa 2006). In addition the reporting of cause of death is poor because many of the deaths that are registered are not certified medically, and deaths from HIV/AIDS are particularly likely to be reported as being from other diseases.

Groenewald, Nannan et al. (2005) note that in cases where access to medical care is difficult or the HIV status of the deceased is unknown, misclassification of the immediate cause of death, in particular tuberculosis, pneumonia and diarrhoea, often occurs. In addition, doctors are often reluctant to state HIV/AIDS as a cause of death on the death certificate because of concerns about the maintenance of confidentiality, and the potential impact on bereaved families in terms of social stigma and the loss of funeral policy or life insurance benefits (Groenewald and Bradshaw 2005; Statistics South Africa 2006). Unlike some other communicable diseases HIV/AIDS is not a notifiable disease in South Africa, thus this further aggravates its misclassification (although notification could well drive acknowledgement further underground). It is likely that a large proportion of deaths registered as due to 'parasitic diseases and opportunistic infections', 'certain disorders' of 'the immune mechanism and maternal conditions' are actually due to HIV/AIDS (Anderson and Phillips 2006).

### **2.3 Mortality in South Africa**

Mortality indicators provide a means of deciding whether the adjustment factors being used are producing expected levels and trends of mortality when compared with existing ones. A review of the mortality estimates that are already in existence at national and sub-national level give a rough idea of what to expect. Average life expectancy in South Africa at birth in 1997 was estimated to be around 58 and 54 for females and males respectively, with

distinct differences among the population groups. The life expectancy for White women was 77 years, exceeding that of some women in European nations, and 22 years higher than the life expectancy of African women at 55 years, with women outliving men by about 6 years in all the population groups (Kinsella and Ferreira 1997). The low level of life expectancy at birth for the African population was said to be a reflection of the growing impact of HIV/AIDS mortality which greatly impacts on infants, young and middle aged adults. Kinsella and Ferreira (1997) noted that among persons who survived to age 60, the remaining years of life expectancy were fairly similar in all the population groups, with women retaining their life expectancy advantage over men.

Adult mortality rates in South Africa were found to be high relative to the rates in the region even prior to the impact of HIV/AIDS epidemic, especially for males where the probability of a 15 year old male dying before age 60 was 38 per cent in the mid-1980s, whilst for females it was around 25 per cent (Bradshaw, Dorrington et al. 1992). The higher survival probability in females was attributed to lower maternal mortality levels in the country. Little change in adult mortality was observed during the 1990s despite the spread of HIV/AIDS, but the impact of the HIV/AIDS epidemic was noticeable towards the end of the decade, with levels of young adult mortality about 2.5 and 1.5 times higher in the year 2000 from 25.4 and 35.4 per cent (probability of 15 year old dying by age 60) in the past decade for women and men respectively (Bradshaw, Schneider et al. 2006).

Changes in mortality rates in South Africa were also found to be varying by age and sex between 1997 and 2004 in the studies conducted by Statistics South Africa. There was an increase in the number of male and female deaths

between 1997 and 2004, with the increase being more pronounced in the females<sup>3</sup> in each year, however, there were more male deaths than female deaths overall (Statistics South Africa 2006). The age and sex pattern of deaths were noted to have changed over time, with a shift of deaths from older ages to younger ages in both sexes.

Mortality rates between the age of 15 and 64 were observed to have increased substantially between 1997 and 2004 in both sexes, with female survival greater than male survival in the whole period, though the traditional female survival advantage was observed to be declining in the period (Anderson and Phillips 2006). They noted an increase of about 2.4 and 1.8 times in the age standardised deaths rates<sup>4</sup> of females and males respectively aged between 15 and 64 in the period 1997 to 2004, with the most significant increase in the mortality rates being observed in the young to middle age range, with female rates between age 20 and 39 more than tripling (peak at 30-34 in 2004), whilst the male rates between the ages of 30 and 44 doubled.

In the ASSA projection of mortality rates in South Africa, Dorrington, Johnson et al. (2006) observed a similar increase in adult mortality ( $_{45}q_{15}$ )<sup>5</sup> between 1996 and 2004, with male adult mortality increasing by almost 1.5 times whilst female adult mortality doubled in the period. According to the ASSA model, infant and child mortality rates in South Africa rose significantly from 51 and 69 deaths per thousand live births respectively in 1996 to a peak

---

<sup>3</sup> The sex ratios of deaths were shown to have decreased with time, an indication of a higher increase in the number of female deaths than male deaths (Statistics South Africa 2006).

<sup>4</sup> An increase from 6.0 to 14.5 female deaths per thousand and 9.5 to 16.7 male deaths per thousand between 1997 and 2004 (Anderson and Phillips 2006).

<sup>5</sup> An increase in adult mortality from 39 to 58 per cent in males, and 23 to 47 per cent in females between 1996 and 2004 (Dorrington, Johnson et al. 2006), with male and female adult mortality difference narrowing with time (female survival declining).

of 60 and 89 deaths per thousand respectively in 2001 before dropping<sup>6</sup> to 54 and 84 deaths per thousand respectively in 2004 Ibid.

#### **2.4 Causes of death in South Africa**

It is important to look at the causes of death patterns that are already in existence, as this will help in making comparisons with the Cape Town cause profile giving an idea of the patterns to expect. This will also help to validate our results in terms of the data quality that is in the vital registration system on whether the patterns in the country are found in Cape Town. The global burden of disease approach divides mortality into three broad groups of causes of deaths useful for the assessments of the cause profile. The causes of death are grouped as follows. Group I are the pre-transitional causes, which consists of communicable, maternal, perinatal conditions and nutritional diseases. HIV/AIDS, as a communicable disease also falls into this group but is kept separate in the South African Burden of Disease shortlist due to the magnitude of its contribution to the burden in South Africa. Group II are the non-communicable diseases. Group III are both intentional and unintentional injuries. The remaining, ill-defined causes form a group of their own. These are natural conditions where the exact cause of death is not clearly specified on the death certificate and therefore does not fit into any of the above three groups of causes. Ill-defined causes arise when the medical practitioner does not have access to the full medical record for certification; when the diagnostic tests have not been done prior to the death; or when the autopsy has not been done (Bradshaw, Schneider et al. 2002).

---

<sup>6</sup> The decline could in part be a result of the Prevention of Mother to Child Transmission (PMTCT) programme assumed in the ASSA model Ibid.

As the level of mortality changes in a country the cause of death structure also changes (although some would argue that it is the other way around<sup>7</sup>), with rising life expectancy accompanied by a shift in the distribution of causes of death away from acute infectious diseases towards more chronic degenerative diseases (Preston, Heuveline et al. 2001). Age patterns of mortality, despite distinct differences in causes of death, do not significantly change with an increase or decrease in life expectancy with the exception of HIV/AIDS which has caused an increase in young adult mortality.

The health of the South African population has declined rapidly in the last decade as evidenced by a decreasing life expectancy. The HIV/AIDS epidemic<sup>8</sup> has fuelled the TB epidemic and also resulted in increased deaths due to pneumonia, diarrhoea and other indicator conditions of HIV/AIDS, which has led to an increase in child and young adult mortality (Bradshaw, Bourne et al. 2003; Bradshaw, Groenewald et al. 2003; Bradshaw, Groenewald et al. 2003). The rise in the number of young adult deaths between 1997 and 2004 highlighted a changing age pattern of deaths in South Africa which is consistent with heterosexual HIV/AIDS epidemic (Statistics South Africa 2006).

The MRC Burden of Disease Research Unit showed that the death profiles in South Africa had changed significantly between 1996 and 2000. While infectious diseases were a major cause of mortality for both men and

---

<sup>7</sup> Age patterns of mortality shift within populations as mortality levels fall, although the changes are greater in age groups experiencing the most rapid decline in mortality (Himes 1994).

<sup>8</sup> South Africa has experienced one of the worlds most rapidly spreading HIV epidemics (Nannan, Bradshaw et al. 2000), and according to the most recent ASSA projection, 11 per cent of the South African population HIV positive in the middle of 2006, with about 1.3 per cent having full blown AIDS (Dorrington, Johnson et al. 2006).

women in 1996, the contribution of AIDS, non-communicable diseases, and injuries increased their contribution to the years of life lost for both sexes by the year 2000, with more dramatic changes in the death profile being observed in women. The death profiles also varied according to age, with non-communicable diseases a major contributor among older people, infectious diseases the main cause of years of life lost among children and injuries a particularly serious problem among young adult males (Bradshaw, Groenewald et al. 2003; Groenewald and Bradshaw 2005; Groenewald, Nannan et al. 2005).

MRC Burden of Disease Research Unit study in 2003 noted a rapid increase in infant and child mortality in South Africa with an increase in infant mortality from 45 per thousand live births in 1998 to 60 per thousand live births in 2000 whilst under five mortality was estimated as 95 per thousand children in 2000 (Bradshaw and Nannan 2004), whilst the South African Demographic Health survey in 2003 estimated infant and child (under five) mortality to be 43 and 58 deaths per thousand live births respectively 10 years prior to the 2003 survey, although the report warns that some results are suspect due to deficiencies in the survey data (Department of Health 2004).

## **2.5 Mortality in the Provinces**

The mortality data presented by Statistics South Africa between 1997 and 2004 in the nine provinces shows that while all provinces have experienced an increase in the number of deaths over the period, the increase has been largest in KwaZulu-Natal. This, being the most populous province, is also the province with the largest number of deaths in the country in each of the years between 1997 and 2004, followed by Gauteng, the second most populous province (Statistics South Africa 2006). Analysis of the mortality data demonstrated that a rapid health transition was already underway with

existence of clear disparities in health status by population group and province (Statistics South Africa 2005). Life expectancy in 2000 ranged from 63 in the Western Cape to 52 in KwaZulu-Natal (Bradshaw, Nannan et al. 2006), and the ASSA estimates in 2006 ranged from an average of 62 in Western Cape to 44 in KwaZulu-Natal (Dorrington, Johnson et al. 2006). The variation in life expectancies by province is strongly conditioned by the population group composition of the provinces.

Mortality rates varied in the provinces, with the highest rates in KwaZulu-Natal and Mpumalanga, with lowest mortality rates in the Western Cape in the year 2000 (Bradshaw, Nannan et al. 2006). This is also further supported by the ASSA model projection of mortality rates in the nine Provinces between 1990 and 2015 where KwaZulu-Natal consistently had the highest mortality rates and Western Cape had the lowest mortality rates from 1999 onwards, prior to that Eastern Cape and Gauteng had the highest and lowest mortality rates respectively (Dorrington, Johnson et al. 2006). These variations between the provinces in levels of mortality can be attributed to a wide range of factors which include varying levels of wealth and development, population group differences, demographic features of the province, geographical differences, environmental exposures and public access to health services and other basic services.

The MRC Burden of Disease Research Unit study in 2000 revealed that all provinces in South Africa were experiencing the quadruple burden of disease to varying degrees. HIV/AIDS was the leading cause of death in all the provinces except the Western Cape where most deaths were due to injury. The most urbanised provinces of Western Cape and Gauteng had the highest injury mortality rates (with male rates approximately double female rates in all

provinces) whilst pre-transitional diseases<sup>9</sup> were more prominent in the less developed provinces of Eastern Cape, Free State, Limpopo and North West (Bradshaw, Nannan et al. 2006).

## **2.6 Mortality in Western Cape**

The probability that people aged 15 will die before they reach age 60 appears to have increased steadily from about 35 per cent in 1996 to about 40 per cent in 2004 in males and from 22 per cent in 1996 to 30 per cent in 2004 in females in the Western Cape, with male adult mortality consistently higher than female adult mortality in all the years (Dorrington, Johnson et al. 2006).

According to the ASSA model, infant and child mortality in the Western Cape has risen significantly from 28 and 38 deaths per thousand live births respectively in 1996 to a peak of 34 and 48 deaths per thousand respectively in 2001 before dropping to 30 and 44 deaths per thousand respectively in 2004. The decline is mainly due to the impact of the PMTCT (prevention of mother to child transmission) programme assumed in the model.

The estimates of mortality for the Western Cape from the National Burden of Disease (NBD) study in the year 2000 displayed similar proportions of communicable and HIV/AIDS deaths between men and women. However, the proportion of deaths from injuries in males was more than double that for females and the non-communicable causes were more prominent in women than in men. The study also found over half the deaths in infants to be due to communicable causes, and about sixteen per cent due to HIV/AIDS.

---

<sup>9</sup> These are conditions associated with poverty and under-development and they include other infectious (excluding HIV) and parasitic diseases, perinatal and maternal conditions, and malnutrition (Bradshaw, Groenewald et al. 2001).

In children between the ages of one and four the leading cause of death was HIV/AIDS. The cause of death pattern differed in the young adult males and females, with very high numbers of deaths resulting from injuries in the young men and HIV/AIDS predominating in the young women. Non-communicable diseases were the leading cause of death in adults of 60 years and older (Bradshaw, Nannan et al. 2004).

The NBD study in the year 2000 also revealed the Western Cape to have experienced the lowest mortality in comparison with the other eight provinces. Although there was evidence of the quadruple burden of disease, the Western Cape had the lowest mortality from HIV/AIDS and other communicable diseases. Non-communicable diseases accounted for a larger proportion of deaths in Western Cape (58 per cent) than nationally (38 per cent) and this was attributed to the population in Western Cape being older than the national population, however injury deaths were slightly higher as a proportion in Western Cape (17 per cent) compared with national overall of 12 per cent (Bradshaw, Nannan et al. 2004).

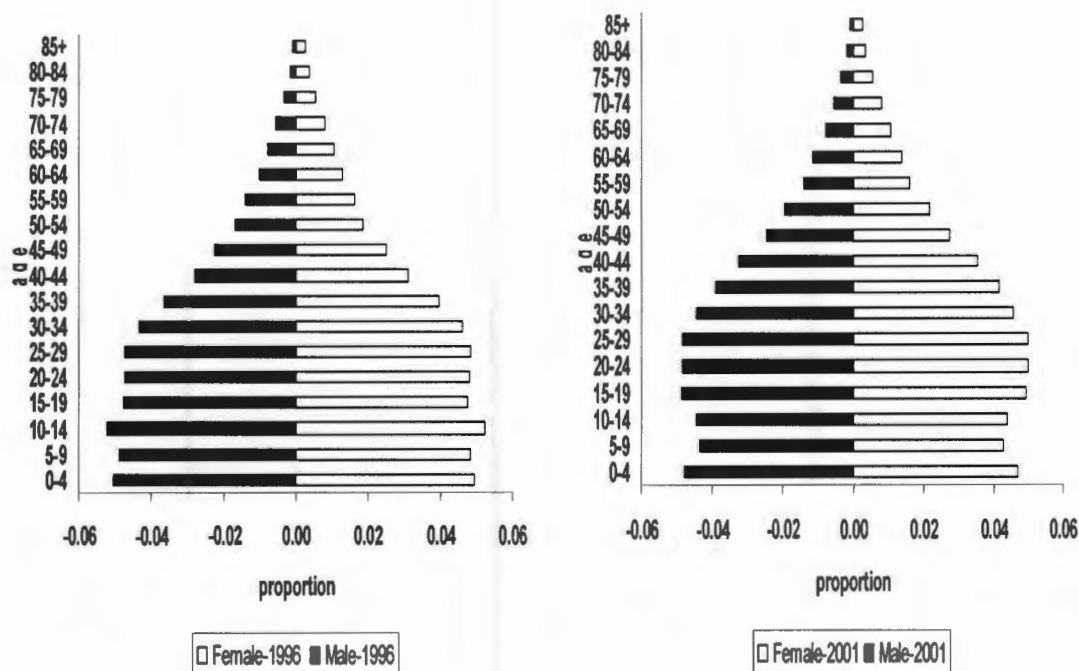
## **2.7 Cape Town profile**

### **2.7.1 Age distribution of population in Cape Town**

Cape Town had a population of approximately 2.99 million in 2001<sup>10</sup>, up from 2.66 million recorded in 1996, with a sex ratio of 95 males to every 100 females.

---

<sup>10</sup> The census figures have been estimated and corrected for undercount and other deficiencies by Professor Dorrington for the City of Cape Town.



Source: "Projection of the Population of the Cape Metropolitan Area 1996-2031" by Professor Dorrington, January 2000

**Figure 2.1 Cape Town population distribution 1996 and 2001**

The population structure in Cape Town (Figure 2.1) indicates a population with a large proportion of young adults (about 65 per cent between 15 and 64) and a small proportion (about seven per cent) of older people above age 65, and 28 per cent below the age of 15.

Based on the 2001 census, the population of Cape Town is predominantly Coloured<sup>11</sup> (48 per cent) and African (32 per cent), with the White population making up 19 per cent, with the Indian population being about 1.5 per cent (Statistics South Africa 2003). There are marked differences in the population structures of the four population groups in Cape Town. The African population is generally young with a bulge at the working ages with a rapid fall off towards the older ages, a profile of a relatively recent migrant

<sup>11</sup> Coloured, African, White and Indian population groups are based on self classifications according to the census rather than on the legal definition that was usually used in the past (Statistics South Africa 2003).

population. The Coloured and Indian population is also generally young. A large proportion of their population is in early adulthood (15-64) and there is some evidence of a mortality and fertility decline in these two population groups. The White population is older and aging (a higher proportion in the 60+ age group) with a small proportion of young people as a result of low birth and death rates (Statistics South Africa 2003).

### **2.7.2 Mortality in Cape Town**

According to Bradshaw, Groenewald et al. (2003) Cape Town is facing a quadruple burden of disease comprising a combination of the pre-transitional diseases and conditions related to poverty, the emerging chronic diseases, an extremely high burden of injuries and the HIV/AIDS epidemic. Comparison of the mortality profile in the Western Cape and Cape Town metro-pole in the Burden of Disease Research Unit study in the year 2000 showed similar proportions of broad causes of death. The fifteen top causes of death were the same for the Western Cape and Cape Town metro-pole, with differences in the ranking of the diseases (Bradshaw, Nannan et al. 2004).

The proportions of deaths due to HIV/AIDS in the Western Cape were also similar to those in Cape Town while the national proportion was almost four times that in Cape Town and Western Cape. The majority of deaths in Cape Town, as in the Western Cape, were found to be due to non-communicable diseases, accounting for more than half of the deaths, this differed significantly from the national proportion of 37 per cent, which might be due to the higher impact of HIV/AIDS nationally compared to Western Cape and Cape Town.

There is evidence of a mortality transition taking place in Cape Town with the degenerative diseases being the most prevalent causes of death in

both males and females, with the exception of HIV/AIDS which might be increasing mortality from infectious diseases like TB. The ranking in the causes of death differed between males and females, with the leading cause of death in males being homicide whilst in females it was HIV/AIDS (Groenewald, Bradshaw et al. 2001).

### **2.7.3 Health districts in Cape Town**

The City Cape Town is currently divided into eight health districts (areas for which there are separate systems of primary health care and referral) but the boundaries of these health districts in Cape Town are continually being changed from time to time. They were changed in 2000 from the eleven “old” health districts<sup>12</sup> health districts to the eight current health districts<sup>13</sup>, and they are in the process of being changed to six “new” health districts. Most of the mortality analysis that has been done in Cape Town so far has focused on the old health districts. The old health districts overlap the current health districts in varying proportions (Table 2.1).

---

<sup>12</sup> The eleven old health districts were Athlone, Blaauwberg, Central, Helderberg, Khayelitsha, Mitchell’s Plain, Nyanga, Oostenberg, South Peninsula, Tygerberg East and Tygerberg West.

<sup>13</sup> The eight current health districts are Central, Eastern, Khayelitsha, Klipfontein, Mitchell’s Plain, Northern, Southern and Tygerberg.

**Table 2.1 Old health districts in the current health districts<sup>14</sup>**

<b>Current health district</b>	<b>Old health district</b>
Central	Central, South Peninsula,
Eastern	Helderberg, Oostenberg Tygerberg East,
Khayelitsha	Khayelitsha
Klipfontein	Athlone, Central, Nyanga
Mitchell's Plain	Mitchell's Plain, Nyanga
Northern Panorama	Blaauwberg, Oostenberg, Tygerberg East, Tygerberg West
Southern	Mitchell's Plain, South Peninsula
Tygerberg	Tygerberg East, Tygerberg West

#### **2.7.4 Population in the health districts**

The population group distribution in the health districts differs significantly as can be seen from Table 2.2.

<sup>14</sup> As can be observed from Table 2.1 some of the old health districts fall into more than one new health districts, and also a whole health districts also falls in one new health district.

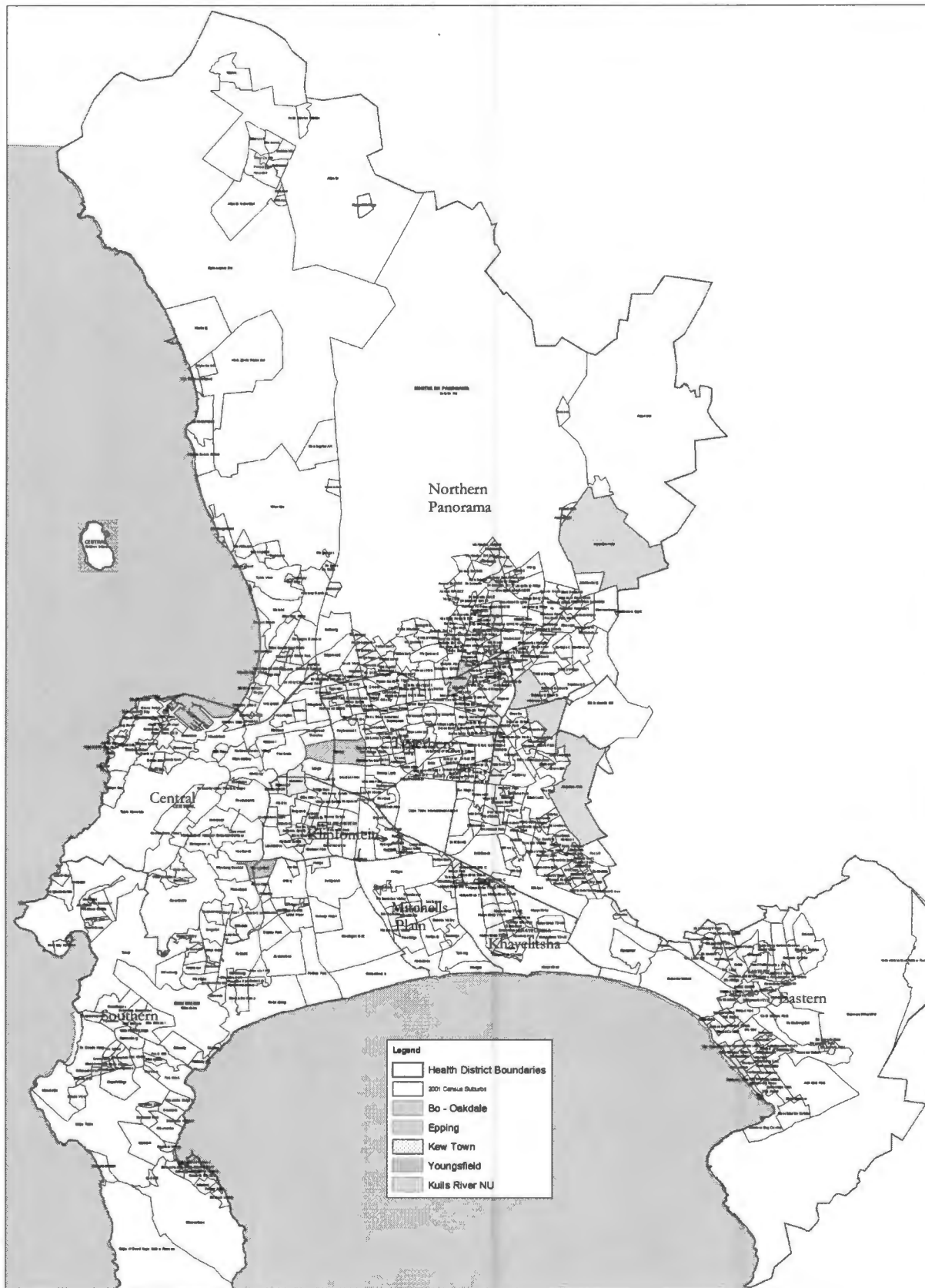
**Table 2.2 Population group distribution in the 2001 census**

	<b>African</b>	<b>Coloured</b>	<b>Indian</b>	<b>White</b>	<b>Population</b>
	<b>%</b>	<b>%</b>	<b>%</b>	<b>%</b>	<b>N</b>
<b>Central</b>	24.66	26.95	2.80	45.60	288 209
<b>Eastern</b>	21.98	60.69	0.60	16.74	404 774
<b>Khayelitsha</b>	99.42	0.54	0.01	0.03	328 991
<b>Klipfontein</b>	41.88	52.62	4.04	1.46	344 860
<b>Mitchell's Plain</b>	40.11	59.23	0.39	0.26	402 598
<b>Northern Panorama</b>	17.39	36.22	0.76	45.62	423 398
<b>Southern</b>	10.49	68.89	1.92	18.70	308 932
<b>Tygerberg</b>	4.53	71.01	1.88	22.58	391 565
<b>Cape Town</b>	31.69	48.02	1.47	18.83	2 893 327

Source: Derived from the 2001 census data for Cape Town provided by Statistics South Africa, extracted by Urban Policy of Strategic Information<sup>15</sup>.

Figure 2.2 below shows the eight health districts of Cape Town and their demarcations.

<sup>15</sup> The Urban Policy of Strategic Information is a branch in the City of Cape Town responsible for supplying information and knowledge to assist in strategic planning in the development process of the city.



Source: Personal communication, Janet Gie, City of Cape Town

Figure 2.2 Map of the current health districts of Cape Town

The populations in the eleven old health districts were shown also to be experiencing a quadruple burden of disease by the MRC Burden of Disease Research Unit in 2000. The Cape Town mortality data which was analysed by the Burden of Disease Research Unit in 2000 illustrated the variations to be found within a single city, with striking differences in the cause of death profiles being noted in the eleven old health districts. Since health or ill-health is mainly determined by broad socio-economic and environmental factors such as income, housing, water and sanitation, rather than the availability of health services (Scott, Sanders et al. 2001), it is not surprising that there are gross health inequities across Cape Town.

## **Chapter 3      Methodology**

This chapter gives a description of the vital registration data and the data cleaning process. It then describes how the population projection in Cape Town and its health districts were undertaken.

### **3.1 Data sources and assessment of the death data**

Death registration data are collected nationally by the Department of Home Affairs, and the city of Cape Town has been copying the certificates before they are forwarded to Pretoria since 1996 and thus has data available for 1996 to 2004 inclusive.

The data have information on the date of entry, date of birth, date of death, name, surname, sex, cause of death, age at death, place of death address, suburb and health district. The underlying cause of death was coded using a shortlist based on ICD-9 from 1996 to mid-year 2000 and ICD-10 from mid-year of 2000. The data has been cleaned of still-births and duplications by the Medical Research Council Burden of Disease Research Unit.

Prior to July 1997, two councils were responsible for coding the death data, the Cape Metropolitan Local Council (CMC) which coded the death data with 5-digit ICD-9 codes and the Cape City Council (CCC) which coded the data with 3-digit ICD-9 codes. Between 1997 and 2000 six local councils were responsible for the coding, of which five of these, Blaauwberg, Helderberg, Oostenberg, South Peninsula and Tygerberg used the ICD-9 5-digit code (the method used by CMC) and the sixth, the Cape Town Administration, used the ICD-9 3-digit code (the method used by CCC). Local Government in Cape Town was restructured into a single structure from the six municipalities that managed the death data in July of 2000. The amalgamated collection unit used the ICD-10 coding system to code for the death data (City of Cape Town

2001; Municipal Demarcation Board 2005). The health districts were then subsequently changed from eleven to eight.

In an effort to standardise the approach to identifying the underlying causes of death and to simplify the coding, the Medical Research Council Burden of Disease Research Unit developed a shortlist of diseases compatible with ICD-10 for coding the cause of death at local levels in Cape Town. This was introduced in July 2000. The shortlist was based on the causes most prevalent in Cape Town and the causes of most public health concern.

In order to prepare the data for this research, the causes of death were converted from the ICD-9 and ICD-10 classification codes to the burden of disease shortlist in order to develop a shortlist coding for each year between 1996 and 2004. In addition we classified the death data according to the broad causes of death so as to make comparisons of trends over time of the data more applicable.

Deaths with missing sex or with cause of death codes which were inappropriate for the age or gender were excluded from further analysis (these reached their highest number in 2003 and 2004, at 35 and 43 respectively). Deaths with unknown ages were redistributed proportionally by age and sex for each cause of death, but these were negligible, and deaths with negative ages were also excluded from further analysis. Ages were calculated from information given on date of birth and date of death in years between 2000 and 2004, whilst the deaths between 1996 and 1999 recorded the ages. Thus negative ages were mostly due to errors in the date of birth, with it being later than the date of death for those who died after 1999. Deaths between 1996 and 1999 data had no negative ages.

The 1996 to 1999 death data recorded either the suburb code or the suburb name of the place of residence of the deceased; whilst the 2000 to 2004 data recorded the suburb name and code of the deceased's place of residence. The address given was the deceased's place of residence. The death data were then allocated to current health districts on the basis of the suburb codes and place names according to the 1996 and 2001 census suburb allocations. The data cleaning and analysis was done in Excel and STATA. The data were analysed for Cape Town and for each of the eight current health districts within Cape Town.

### **3.2 Cape Town Population**

The most recent censuses in South Africa were carried out in 1996 and 2001. Deficiencies, which might be assumed to exist in the population data for Cape Town as well, include under-enumeration of the 0-4 year olds, too few foreigners identified, age misstatement particularly age exaggeration especially across the pension age for both males and females, too few male in-migrants and/or significant male undercount (relative to the number of females) and potential significant undercount of whites (Dorrington 2005).

Dorrington (2005) adjusted for the deficiencies in the Cape Town population and projected the corrected populations by age and sex, from a base year in 1985, to 2021 using the ASSA model, based on estimated migration, fertility and mortality patterns in the region. These estimates of the population in 1996 and 2001 were then apportioned to the eight current health districts using the proportions from the 1996 and 2001 censuses, after which the proportions in each of the remaining years were estimated by interpolating between 1996 and 2001 and extrapolating beyond 2001, assuming an exponential trend in the proportions over time.

### 3.3 Population estimates for the health districts

The population for each of the health districts were obtained from the community profile<sup>16</sup> data sets for the 1996 and 2001 census by age and sex, adjusted for deficiencies incorporated into the population estimates for Cape Town by Dorrington (2005). Unspecified ages by sex in the 1996 census were reapportioned to all the ages above 20, assuming age reporting below 20 to be more accurately and completely reported.

The male and female annual growth rates between 1996 and 2001 in the Central health district were negative which was considered to be implausible given that, if anything there has been densification of housing in the area, whilst growth rates of the other health districts were mostly either too higher or lower in comparison with growth rates derived from Dorrington's (2005) total projected population in the health districts. Thus, it was decided to adjust the 1996 and 2001 health district census populations so that they were consistent with the growth rates produced by Dorrington (2005), adjusting each of the census populations equally (in opposite directions) to produce the required rates.

The proportions of the adjusted population at each age to the total population by sex in each of the health districts were then derived in both censuses. Using the ratio method (Shryock and Siegel 1976), the population distributions by age and sex from the censuses were projected for each health district between 1996 and 2004. The ratio method is mainly based on the relationship between the populations of the health districts by age to the total population by age of Cape Town. We assumed the percent distribution to

---

<sup>16</sup> The 1996 and 2001 census data for Cape Town was provided by Statistics South Africa through the Department of Urban Policy and Strategic Information of the City of Cape Town.

approach a stable condition after 60 years from 2001 (i.e. equilibrium is reached and that there is no further inter-district migration) and an exponential rate of change between the 1996 and 2001 censuses in the method. The distribution of the population by age was projected by interpolating between 1996 and 2001, and extrapolating after 2001.

The population in each year (1996-2004) by sex was then derived by multiplying the population distribution (re-scaled the percents to sum to hundred per cent by age for each sex in each year) in the health districts at each age group by the corresponding projected Cape Town population. We then used the **CTBL32**<sup>17</sup> workbook to pro-rate the population, such that the sum of the projected population by age and sex in the eight current health districts summed to the projected total populations of the current health districts and total Cape Town population by age projected from the ASSA model.

### 3.4 Completeness

Dorrington, Moultrie et al. (2004) estimated the completeness of reporting of deaths by households in the 2001 census by sex and population group. On the assumption that there is no reason to suppose that reporting of deaths by households would differ by geographic location (province or city) for given population groups and sex, the deaths reported by households in Cape Town were adjusted for under- or over-reporting to using estimates of completeness at the national level to produce estimates of the numbers of deaths in Cape Town and in each of the eight health districts by age, sex and population

---

<sup>17</sup> **CTBL32** is a contingency adjustment table for a two variable distribution and adjusts sub-populations (health districts) by age to the total population (Cape Town) by age (a set of desired marginal totals, totals of rows and /or columns) (Arriaga, Johnson et al. 2003).

group. These deaths were compared with the deaths from the vital registration system in 2001 to assess the level of completeness of the vital registration data in Cape Town and its eight health districts.

Variation in completeness of adult deaths was observed between the health districts which might be due to several factors. The appropriateness of the PES weighting factors to adjust for the under-reporting of deaths by households in the health districts might have been thought to be responsible, as they have been derived at provincial level which may have led to distortions of the estimates at health district level, as adjustments at provincial level may not be appropriate for small areas, but analysis of the un-weighted household deaths revealed similar patterns by age to the weighted household deaths in all the health districts and Cape Town overall, only differing in the level of completeness, with the completeness being higher when the un-weighted deaths are used showing that the PES weight had no effect on the final estimates.

Deaths in most cases are under-reported, and the completeness usually differs between children and adults. The 1998 DHS was the last survey that provided reliable statistics on child mortality, since then, the 2001 census and the 2003 DHS have not yielded good quality estimates of child mortality, with post 1998 estimates being based on models with varying assumptions (Abrahams, Berry et al. 2006). Thus child deaths from the ASSA model projection assuming that they are 100 per cent complete were compared with the child deaths from the vital registration between 1996 and 2004 to estimate completeness of the child vital registration data in Cape Town and its eight health districts (see details in Chapter 4).

### **3.5 Completeness trends**

Three mortality rates (of cancer excluding lung and oesophageal cancers, the 10-14 age group and the 60+ age group) which are not expected, on the basis of trends nationally, to change much over time, were estimated and inspected to observe whether there was any trend over time apparent in the health districts. Thus any changing trend in completeness in Cape Town and the health districts would be expected to be reflected as a changing trend in these three mortality rates. A weighted average index of the ratio of the rates in each year to those in 2001 in both sexes was then derived. If there is a distinct pattern this will provide a more robust indicator for adjustment, removing some of the random fluctuations that might be apparent in the three separate series of rates (see Chapter 5 for more details).

### **3.6 Mortality rates**

Completeness ratios in Cape Town and its health districts were estimated by multiplying the weighted average index ratios (smoothed in years where there are marked deviations) in each year by the completeness ratios for 2001 by age and sex. The deaths were then adjusted for incompleteness by dividing the number of deaths at each age group by the corresponding completeness ratios for each year. Mortality rates were then derived using the adjusted deaths and the projected population.

## Chapter 4      Completeness

This chapter is a systematic examination of the completeness by age of the vital registration data in 2001 in Cape Town and its health districts of adults.

### 4.1 Completeness of vital registration in adults

In South Africa, it is required by law that every death be registered and the Department of Home Affairs is responsible for the registration of deaths. Under-registration of deaths is common in vital registration systems in many developing countries (Bennett and Horiuchi 1984). The 2001 household census deaths<sup>18</sup> were first adjusted for incompleteness by age, sex and population group using national correction factors derived by Dorrington, Moultrie et al. (2004) in their estimation of mortality using the 2001 South African census. They calculated the national correction factors as a ratio of the expected number of deaths based on national estimates of mortality data obtained from the Department of Home Affairs population register (corrected for under reporting in the vital registration) to the number of deaths reported by households in the 2001 census by age group, sex and population group. The resulting ratios were then used to adjust for the 2001 census household deaths in Cape Town and its eight health districts by age group, sex and population group to get the expected number of deaths. The deaths were then aggregated by population group to obtain the expected deaths in Cape Town

---

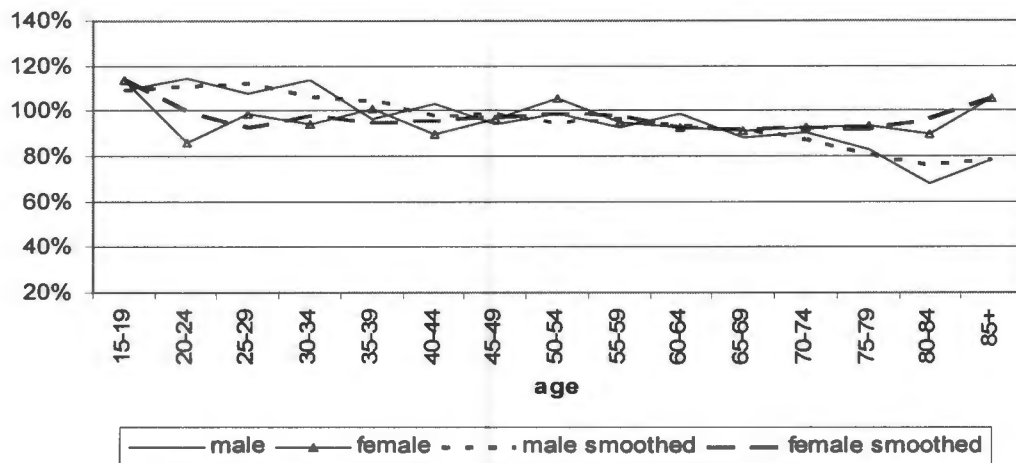
<sup>18</sup> A post-enumeration survey (PES) was undertaken by Statistics South Africa to determine the degree of undercount or over-count in the 2001 census, and numbers and percentages relating to households in the 2001 census are adjusted according to the PES findings through the application of these weights for households (Statistics South Africa 2003).

as well as in each of the eight health districts by age and sex since the vital registration deaths are not available by population group. The household deaths, thus adjusted, can be assumed to be more completely reported, were then compared with the deaths from the vital registration for Cape Town and its eight health districts in 2001 to estimate the completeness of the vital registration data. The ratios obtained indicate the extent of under- or over-registration of deaths in the vital registration system in Cape Town and its health districts.

Deaths in most cases are under-reported, and the under-reporting usually differs between children and adults. Thus the completeness of the vital registration of deaths in 2001 were estimated for adults above age 15 as it is not reasonable to assume that the deaths of children reported by households would be correctly adjusted for incompleteness by Dorrington, Moultrie et al. (2004) adjustment factors. The ratios were then smoothed with a 3-point moving average as there seemed to be random fluctuations with seemingly implausible peaks and troughs by age being observed. The ratios were smoothed on the assumption that it was unlikely that the percentage of deaths reported in one age group should differ markedly from those in neighbouring ages.

#### **4.1.1 Completeness in Cape Town**

The completeness of reporting of male deaths in Cape Town declines with age (Figure 4.1), whilst completeness for females is fairly level with respect to age, with overall completeness similar for both sexes (Table 4.1).



**Figure 4.1 Completeness of vital registration, Cape Town**

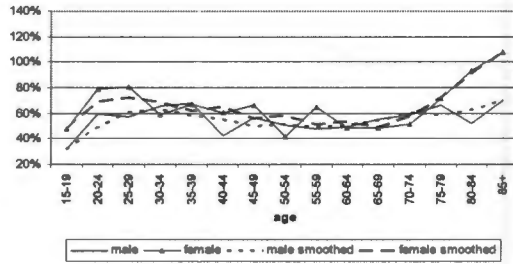
The total average completeness for 15+ exceeds that of either males or females due to the artifice of the age composition of male and female populations.

**Table 4.1 Completeness of vital registration, Cape Town**

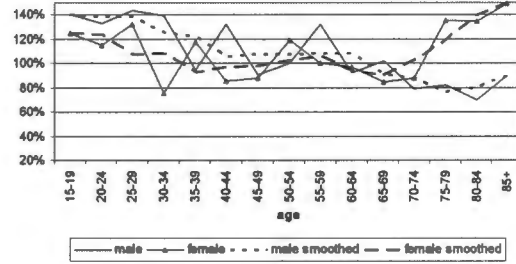
Age	Male	Female	Total
Median (15+)	96.8	94.5	96.2
Average (15+)	95.8	96.5	96.8

### 4.1.2 Completeness by age in the health districts

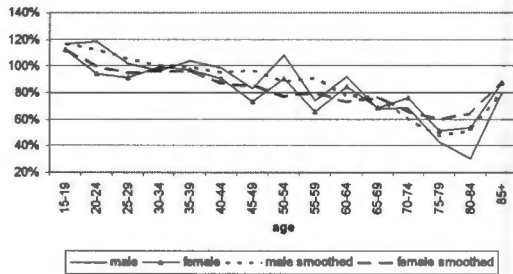
a) Central



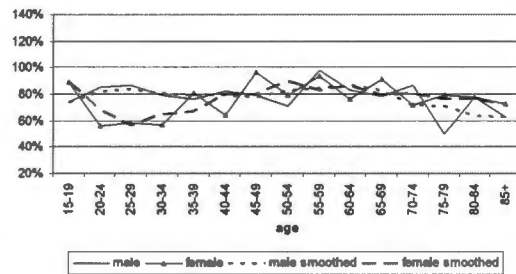
b) Eastern



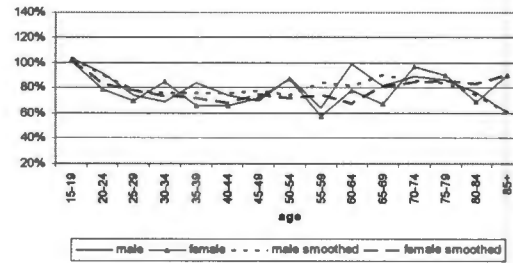
a) Khayelitsha



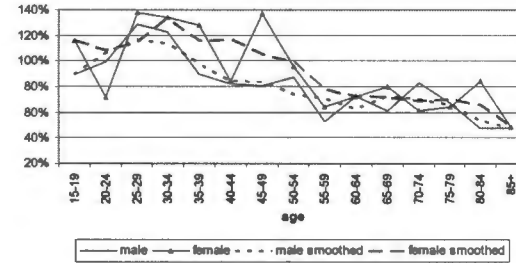
b) Klipfontein



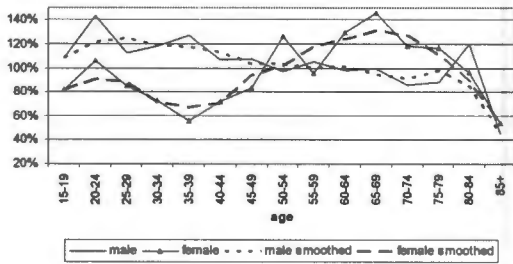
c) Mitchell's Plain



d) Northern Panorama



e) Southern



f) Tygerberg

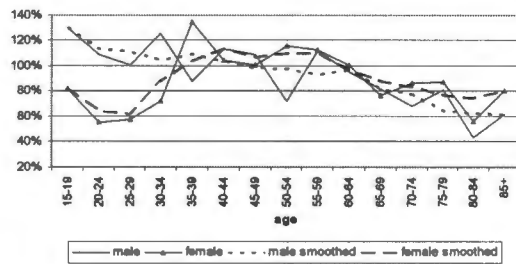


Figure 4.2 Completeness by age in the health districts, 2001

The completeness of vital registration of deaths varies by health districts, with the lowest overall completeness being observed in the Central health district (around 60 per cent in both sexes combined) and the highest completeness being observed in the Eastern and Southern health districts (slightly over 100 per cent) (

Table 4.2). The patterns of completeness with respect to age in males and females are close to one another in all the health districts (Figure 4.2) and Cape Town as a whole (Figure 4.1) except in the Southern health district where the female trend is distinctly different, whilst in the Tygerberg health district female completeness looks odd below the age of 35.

Completeness by age in both sexes is lower than that of Cape Town in the Central, Khayelitsha, Klipfontein, Mitchell's Plain and Northern (above age 40) health districts and is higher in the Eastern and the Southern health districts and similar in the Tygerberg health district (Figure 4.2). Overall female completeness is lower than male completeness in the Khayelitsha, Klipfontein, Mitchell's Plain, Southern and Tygerberg health districts ( Table 4.2), whilst it is higher in the Central, Eastern and Northern Panorama health districts.

Male completeness by age declines with age in a similar fashion to Cape Town as a whole in all the health districts except in the Central, Klipfontein and Mitchell's Plain health districts, where it is approximately level with age. These declines by age in the males, especially declines of over 50 per cent by age 60 in most of the health districts, could be genuine (as a result of under-reporting of deaths as age increases). The female completeness pattern by age seems to be fairly level in all the health districts except in the Khayelitsha and Southern (and Tygerberg below age 40) health districts depicting the female stable pattern for Cape Town as a whole. The most erratic pattern with age in

both sexes seems to be occurring in the Eastern health district (with increases of as much as 50 per cent between adjacent age groups) compared to the other health districts and Cape Town as a whole and this might be due to fewer numbers of deaths (being one of the health districts with the least number of deaths compared to the other health districts (about 9 per cent of the total Cape Town deaths)).

Completeness of deaths in the younger and older ages in most of the health districts is high which might be due to fewer deaths being reported at the younger ages and age exaggerations at the older ages in the deaths reported by households in the census. There are also random fluctuations as evidenced by peaks and dips in some of the age groups in the health districts. The high ratios in Southern may be compensated for by the low ratios in Central as they have similar population numbers but differ in the number of deaths.

The problem of a death of someone living in one health district being recorded in another health districts might also add to the inaccuracy of the completeness of the vital registration in the health districts. There is also the issue of suburbs of different socio-economic conditions being in the same health districts, as completeness of the vital registration of deaths might differ by these socio-economic conditions and this might explain the different levels by health district and the changing patterns by age, with suburbs of poor socio-economic conditions more likely to under-register deaths to avoid extra expenses.

**Table 4.2 Overall completeness of death registration, Health districts**

	Female		Male	
	Median	Average	Median	Average
<b>Central</b>	65.3	65.9	56.9	55.5
<b>Eastern</b>	114.5	109.7	100.4	107.9
<b>Khayelitsha</b>	87.5	82.5	92.1	85.6
<b>Klipfontein</b>	77.5	76.1	79.0	78.1
<b>Mitchell's Plain</b>	77.7	78.4	81.6	80.9
<b>Northern Panorama</b>	84.7	92.1	82.4	80.9
<b>Southern</b>	95.7	96.1	106.5	104.3
<b>Tygerberg</b>	86.1	88.1	95.8	92.9

## Chapter 5 Trends in Completeness

This chapter considers the trends in completeness in Cape Town and its health districts by looking at the mortality rates of particular causes which are not expected to change that much over time. This chapter also looks at the death registration completeness of children over time.

### **5.1 Indicators of completeness trends in adults: Mortality rates of non-lung and non-oesophageal cancers, the 10-14 age group and the 60+ age group**

So far completeness has only been estimated for the year 2001 and thus we need to determine completeness for the other years in the period 1996 to 2004. In a population there are some causes of mortality the rates for which are not expected to change much over time. Such a group of causes are the non-lung and non-oesophageal cancers (Debbie Bradshaw and David Bourne; MRC, personal communication). There are also age specific mortality rates that are not expected to change much over time in a population and these include the mortality rates of children between the ages of 10 and 14, which are usually low and are not expected to change that much over time, as this age group is not affected to any great extent by most of the causes of death that affect other age groups, like HIV/AIDS (Feeney 2001). Mortality rates for those over 60 not expected to change much over time, as appears to be the case from a comparison of national mortality rates over time from around 1985 to around 1998 as noted by Dorrington, Moultrie et al. (2004), these rates are also not expected to be affected to a great extent by HIV/AIDS in future.

The three mortality rates over time were inspected by sex to observe whether there was any trend apparent in the health districts. Thus any

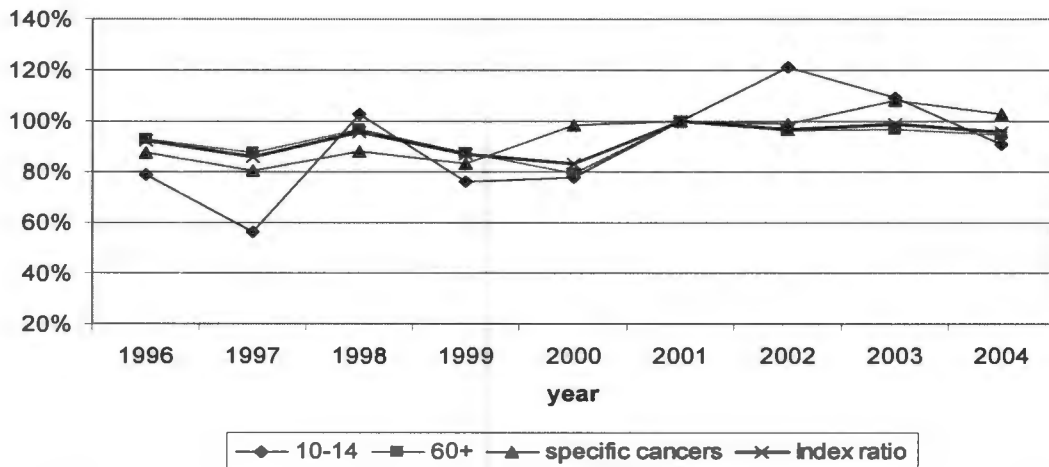
changing trend in completeness of deaths in Cape Town and the health districts will be reflected as a changing trend in these mortality rates. In order to standardise the comparison, ratios of the rates in the various years to those in 2001 were calculated for each sex. An index ratio for males and females in each year was calculated as a weighted average of the three ratios (the number of deaths in the respective categories defined as the weights), which if there is a distinct pattern provides a more robust indicator for adjustment removing any random fluctuations that might be apparent in the three different series of rates<sup>19</sup>. The index was calculated by weighting the ratios by the number of deaths in their respective categories in each of the health districts.

### **5.1.1 Trends in completeness: Cape Town**

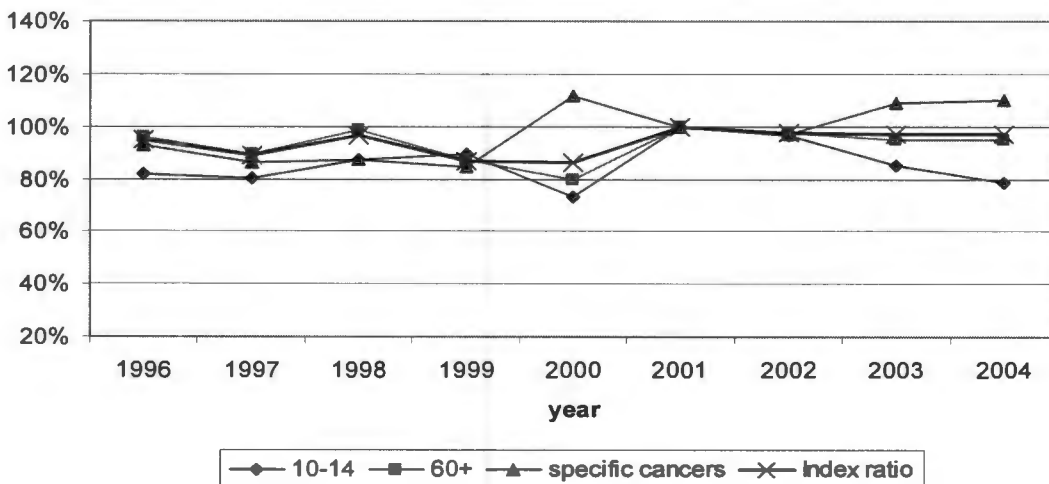
From Figure 5.1, it can be seen that, with the exception of deviations that are probably due to random fluctuation in mortality rates at individual ages, the completeness appears to have drifted from around 90 per cent in 1996 to 80 per cent in 2000 of the completeness in 2001, after which it appears to have remained level at close to 100 per cent.

---

<sup>19</sup> This also allows one to include the 10-14 age group mortality rates in the health districts, which involved fewer deaths, each health district averages around 5 deaths per year for populations of around 17 000 in the larger health districts, with even fewer deaths in the smaller health districts.

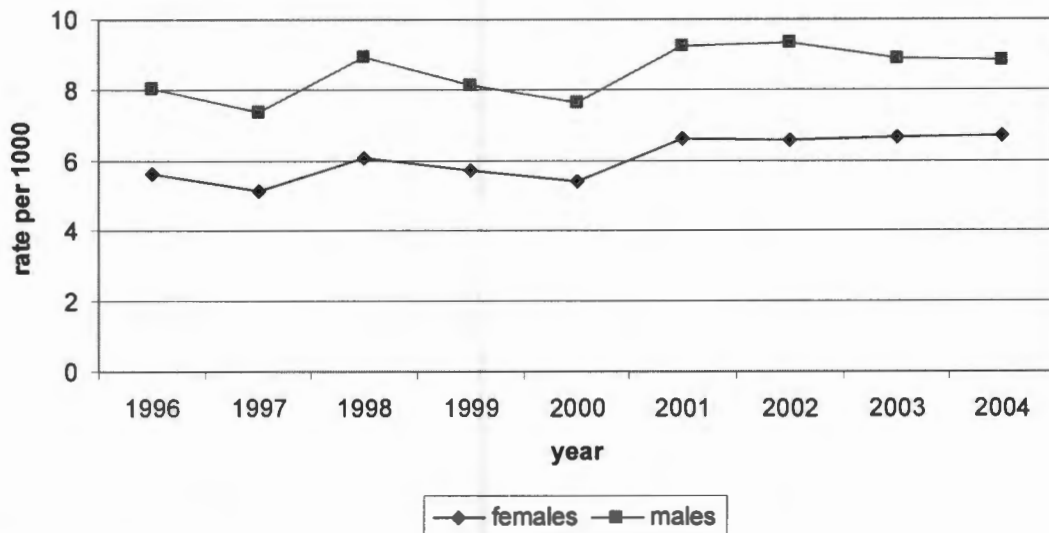


**Figure 5.1 Mortality ratios for non-lung and non-oesophageal cancers, the 10-14 age group, the 60+ age group and the weighted index 1996-2004: Cape Town, Females**



**Figure 5.2 Mortality ratios for non-lung and non-oesophageal cancers, the 10-14 age group, the 60+ age group and the weighted index, 1996-2004: Cape Town, Males**

For males (Figure 5.2), the pattern is very similar although completeness may have been slightly higher in the early years.



**Figure 5.3 All cause crude death rates unadjusted for incompleteness**

Inspection of the all-cause crude death rates over time (Figure 5.3) shows a similar pattern with two periods of completeness, 1996 to 1999 and 2001 to 2004 as noted earlier with a dip in 1997 and a peak in 1998.

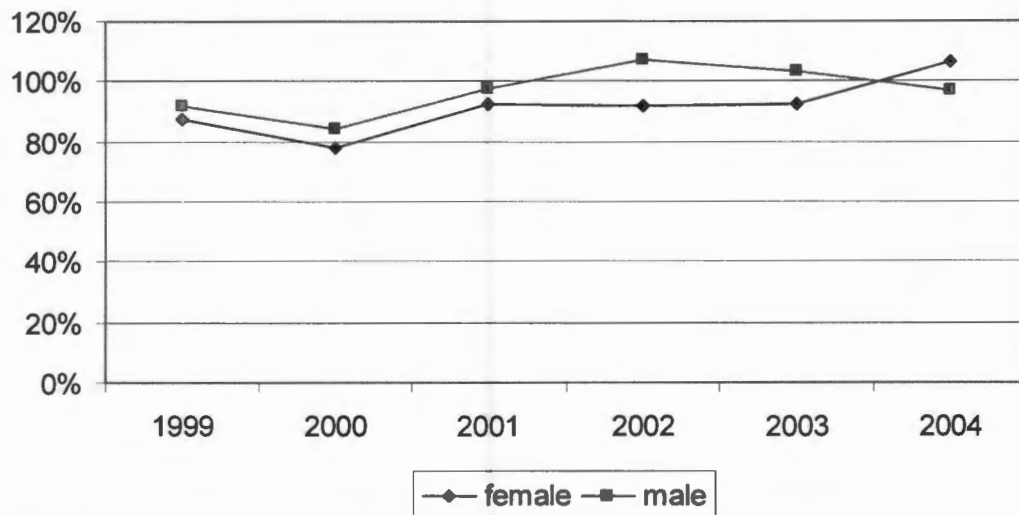
### 5.1.2 Comparison of vital registration (injury) with NIMSS deaths

The National Injury Mortality Surveillance System (NIMSS) has provided information about the extent and scope of deaths due to non-natural<sup>20</sup> causes in South Africa since 1999 covering the country's metropolitan areas and several other major towns and cities (Matzopoulos 2005; Prinsloo, Donson et al. 2005). Data are collected at state mortuaries<sup>21</sup> by the police and forensic pathology departments where the deaths are categorised according to the International Classification of Disease (ICD-10) to enable international

<sup>20</sup> Non-natural deaths are due to violence, suicide, transport collisions, and other unintentional injuries (Prinsloo 2004).

<sup>21</sup> In Cape Town deaths due to non-natural causes are collected at Salt River and Tygerberg state mortuaries.

comparisons. The completeness of the injury deaths from the vital registration system relative to those captured by the NIMMS is measured as the ratio of the one to the other shown in Figure 5.4.



**Figure 5.4 Injury deaths versus NIMMS injury deaths, completeness**

This comparison shows completeness to have improved to a somewhat stable level after 2000, with two levels of completeness being observed in both sexes, that for the period 1999 to 2000 and that for the period 2001 to 2004, with completeness in the first period being lower than in the second, where completeness is a little over 100 per cent for males and a little under for females.

Thus, provided one can assume that the NIMMS data are complete, all these trends suggests that completeness of adult death registration in Cape Town was at two different levels, below 100 per cent, up to 2000 and then around 100 percent after 2000.

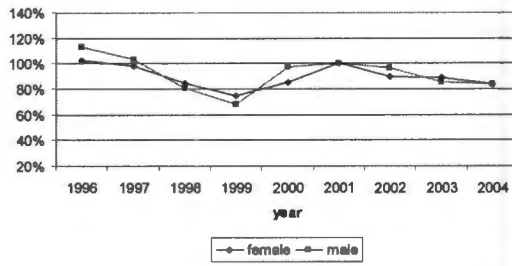
### 5.1.3 Trends in completeness: Health districts

Similar to Cape Town as a whole, all the health districts (Figure 5.5) show two levels of completeness in the registration of deaths, 1996-1999 and 2001-2004

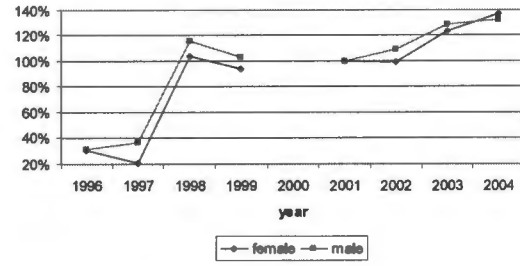
with 2000 sometimes at the level of the first and sometimes the second period or sometimes different from the level for either period in some of the health districts, with the exception in Tygerberg which has level completeness throughout and Khayelitsha which has a consistent upward trend (almost doubling over time). The two levels in completeness in the health districts may have been brought about by the rearrangement in the local government in 2000, with a consistent once off rise after 2000 in all the rates that have been examined in Cape Town.

Completeness over time seems to be changing to varying degrees in the health districts with increases in the Eastern, Khayelitsha and Northern Panorama health districts, decreases in the Central and Southern health districts and more or less no change in Klipfontein, Mitchell's Plain and Tygerberg health districts. Completeness appears to be increasing fairly linearly in the Eastern health district after 2000; prior to 1998 the estimates are improbably low. The Southern health district is the only one in which we observe a decline in completeness between the two periods, mirroring change in levels in the other health districts.

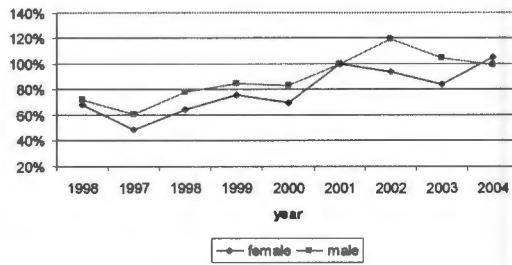
a) Central



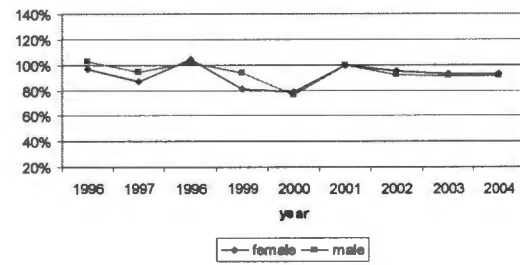
b) Eastern



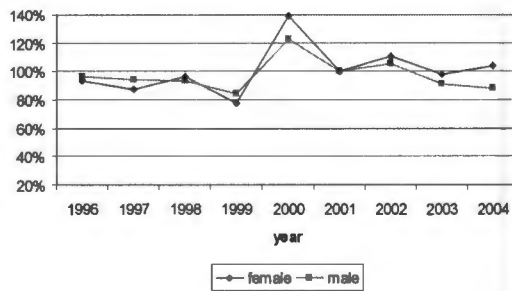
c) Khayelitsha



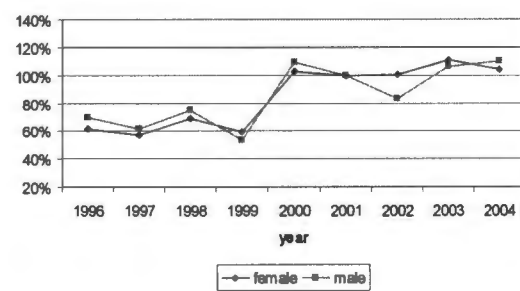
d) Klipfontein



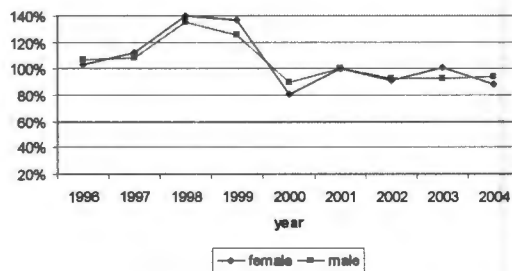
e) Mitchell's Plain



f) Northern Panorama



g) Southern



h) Tygerberg

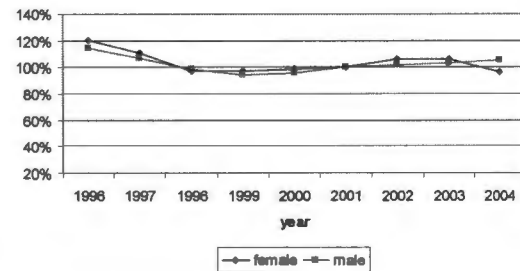


Figure 5.5 Weighted index ratios, 1996- 2004: Health districts

Given the stability of completeness for the city as a whole over the whole period, the peaks and dips that are evident in most of the health districts must be due to registration of deaths in the wrong health districts as evidenced by corresponding dips and peaks in the same years in different health districts and this seems to have been rectified after 2000 in all the health districts where we observe completeness to be stable thereafter.

The consistency of the completeness of death registration for the city as whole against the extreme fluctuation in the completeness trends over time (and completeness with respect to age as well) in most of the health districts is strongly suggestive of a lack of consistency as to the health districts in which deaths of the population living in that health districts are registered.

## 5.2 Estimation of completeness over time

The weighted index ratios were used to determine the completeness by age and sex in years other than 2001 in Cape Town as a whole and its health districts except in the Khayelitsha health district where the fitted trend lines<sup>22</sup> (both sexes) were used instead, as they were seen to produce the best adjustment factors of completeness in the other years with the variation between the two sexes attributed to random fluctuation around the index. The completeness in the other years was calculated by multiplying the completeness by age and sex in 2001 (smoothed) by the weighted index ratio in each year on the assumption that completeness by age in both sexes has remained stable in the period. The weighted index ratios were considered to be a good indicator of adjustments over time because of the consistency between

---

<sup>22</sup> The trend line was found to be a good fit to the data with an  $R^2$  value of 0.69 in females and 0.71 in males, and the slope was significantly different from zero.

the male and female weighted index ratios in each of the years, with deviations in some years between the two sexes being attributed to random fluctuations around the index. The estimated adjustment factors by age and sex were then used to adjust the vital registration deaths in each of the individual health districts and Cape Town as a whole in each year by dividing the number of deaths in each age group by the corresponding adjustment factor.

There were some inconsistencies found in the weighted index ratios and the completeness ratios by age in 2001 between the two sexes and these were smoothed in estimating the age and sex completeness in the other years in Cape Town and its health districts. In Cape Town, and the Central and Tygerberg health districts the weighted index ratios and the completeness ratios by age in 2001 for both males and females were consistent with each other and were found to be reasonable enough to determine the adjustment factors by age and sex in years other than 2001. Whilst in the Eastern health districts the weighted index ratios were reasonable except for 1996 and 1997 in which the very low factors led to implausibly high rates as well as in 2000 where there were no deaths registered.

In the Klipfontein health district in 1999 a weighted average of the male and female index ratios was used as the female ratio, which seemed inconsistent. The same was done for the Northern Panorama and Mitchell's Plain health districts in 2002 and 2004 respectively to replace the male ratio as they seemed inconsistent. In the Southern health district completeness ratios by age for males and females combined in 2001 were used instead of the female completeness ratios by age, which were considered to be less reliable than the weighted index ratios.

### **5.3 Completeness of vital registration in children (0-4)**

This section examines completeness of infant (0) and child (0-4) deaths in Cape Town and its health districts. Vital registration of deaths provides an important source of demographic data that is independent of the census. Early childhood deaths are less completely registered than those at older ages, for when births escape registration subsequent deaths are likely to do so as well (Courbage and Fargues 1979). Comparison of deaths in the vital registration with other sources is very useful when determining the extent of its completeness but this is limited by the availability of these data, which in most cases are few and unreliable in developing countries. In the case of South Africa, given the paucity of reliable data on child mortality since the 1998 DHS, we have to resort to estimates provided by models, specifically those provided by the ASSA model.

The ratio of the number of deaths of children aged 0-4 to the number of women aged 15-49 were obtained from the ASSA model of the city in each year between 1996 and 2004 for Africans, Whites and Coloureds (the model includes the Indians with Coloureds due to their small numbers in the city). Women aged 15-49 are the population giving birth to children at risk of dying. This ratio was used in preference to a mortality rate since there is significant under registration of births, and under-count of children in the census, making it impossible to use these data as a basis for estimating the expected number of deaths for the city and its health districts. Proportions of the four population groups of females aged 15-49 in Cape Town from the 1996 and 2001 census were used to project the population group proportions between 1996 and 2004 for the city and its health districts by interpolating between 1996 and 2001 and extrapolating between 2001 and 2004 assuming an exponential rate of change between the censuses. Using the female aged 15 to 49 population

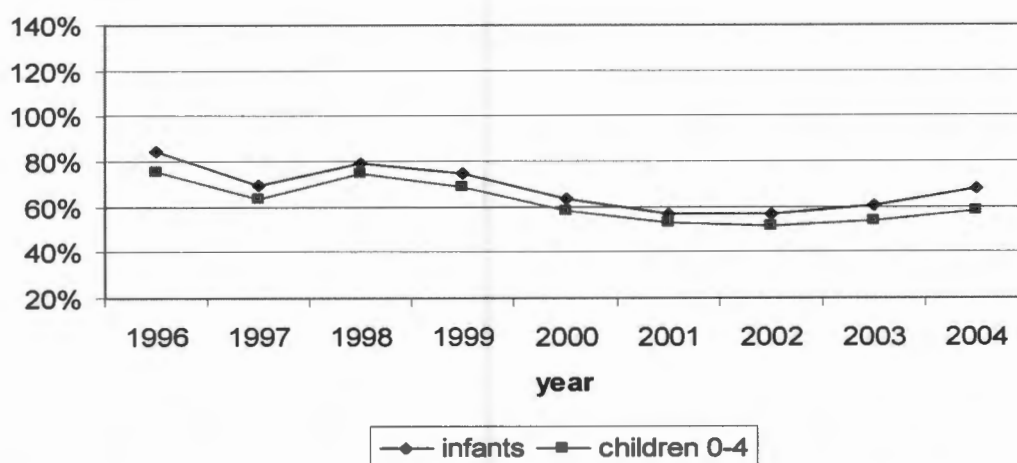
group proportions (with Coloured and Indian combined) as weights, a weighted average of this ratio of the mortality of children to number of women of childbearing age from the model was calculated in each year. A weighted average takes into account the proportional relevance of each population group in Cape Town, rather than treating each health district population as being average.

The expected deaths in each year were then estimated by multiplying the weighted average ratios of the children (0-4) with the total female population aged between 15 and 49. The expected deaths are calculated for both sexes combined as there is no reason to suppose that the completeness between the male and female children is different. Assuming the deaths from the model to be complete, the completeness each year of the registered deaths is estimated as the ratio of the vital registration deaths to the expected deaths. The same procedure was followed for the infant deaths.

The same method of using the ratio of children and infants to the women aged 15 to 49 from the ASSA model to estimate completeness was applied in the eight health districts. The mortality ratios from the model of Cape Town were used to estimate the expected number of child deaths in the health districts, and this was done on the assumption that mortality of each of the population groups in each of the health districts is the same as that for the city as a whole. The weighted average mortality ratios of the children were evaluated in the same manner but using the population group distributions in each of the health districts between 1996 and 2004 as weights that were evaluated.

### 5.3.1 Completeness in Cape Town

Completeness of deaths is consistently higher in infants (0) than in children aged 0 to 4 (Figure 5.6), although it displays the same pattern over time maintaining the same small difference over time.



**Figure 5.6 Completeness of vital registration, infants (0) and children (0-4): Cape Town**

Hence, one can conclude that the deaths of children aged between 1 and 4 are less completely registered than those of infants, possibly due some older children living away from their mothers. Another possibility is that the infants that are dying are mostly dying from hospitals and are more likely to be registered than children who might mostly be dying from home. Registration of deaths in infants and children appears to have declined significantly between 1998 and 2001, but appears to have slightly improved thereafter. The smooth pattern between 1999 and 2004 might reflect assumptions in the model<sup>23</sup>, which produce too high a peak in mortality around this period.

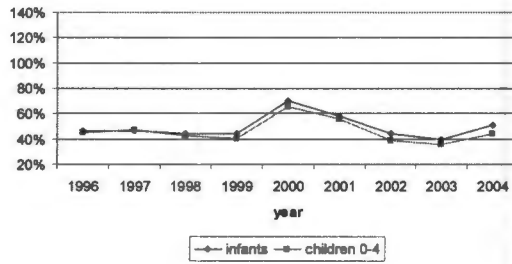
<sup>23</sup> Errors might be due to the ASSA model assumptions, specifically the survival rates might be too low and the prevention of mother to child transmission (PMTCT) of HIV might be too low, causing the estimates of mortality in the model to be too high.

### 5.3.2 Completeness in the health districts

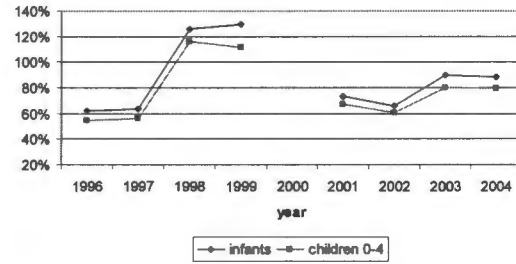
The completeness of vital registration of deaths of children (0-4) varies a great deal between the health districts (Figure 5.7), with no particular health district having either the lowest or highest completeness over the whole period being observed. The completeness of infant and child deaths in all the health districts followed the same pattern over time with completeness of children (0-4) only differing in the levels from the infants, having slightly higher completeness ratios, though with varying magnitude of difference between the two. Thus, this means that infant deaths were slightly more completely registered than child (1-4) deaths, though the differences are small with very little variation in each year in each of the health districts which might be attributable to random fluctuations.

The sudden drop in completeness after 2000 in all the health districts except in the Klipfontein and Mitchell's Plain health districts the only health districts dominated by the African and Coloured population, might be an artefact of the changes in the local government triggering a decrease in registration of child deaths, or it may well be that deaths from other health districts are no longer being wrongly registered.

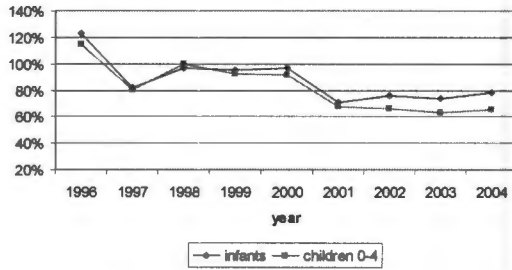
a) Central



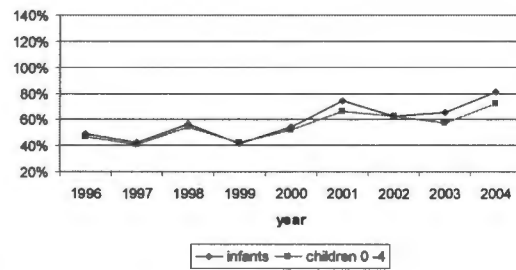
b) Eastern



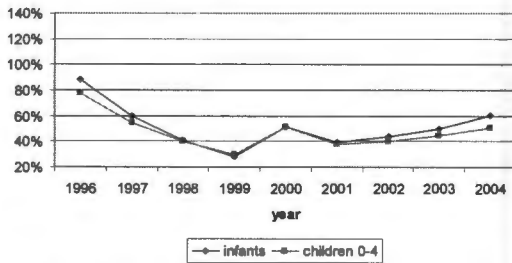
c) Khayelitsha



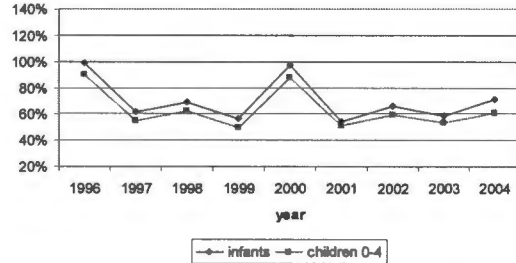
d) Klipfontein



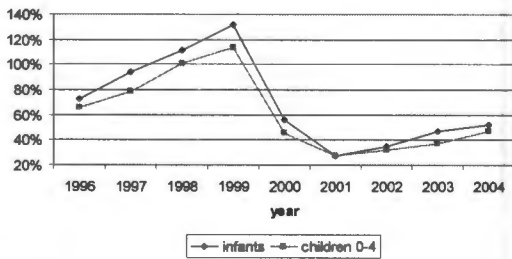
e) Mitchell's Plain



f) Northern Panorama



g) Southern



h) Tygerberg

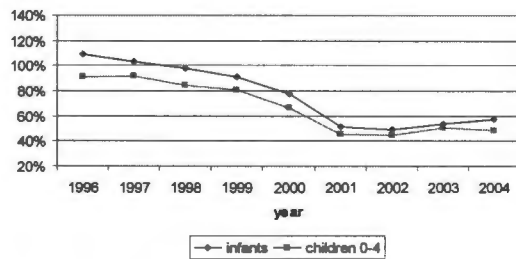


Figure 5.7 Infant and child completeness by health district

Completeness of child deaths in the Eastern, Klipfontein, Khayelitsha, Southern and Tygerberg health districts again has two levels, 1996 to 2000 and 2001 to 2004, (Figure 5.7), depicting a similar pattern as adults (see Section 5.1.3), but differing in the magnitudes of increases and declines between the two levels. Significant declines in vital death registration occurred in the Mitchell's Plain (1996-1999), Southern (1999-2001) and Tygerberg (1996-2001) health districts. Completeness seems to have been level in the Central and Northern health district apart from the peaks in 2000. The problem of a death of someone living in one health district being recorded in another health districts seems to be the major contributor to the inaccuracy of the completeness of the vital registration in the children in all the health districts, since the pattern for Cape Town as a whole is quite smooth.

#### **5.4 Comparison of adult and child completeness over time**

Completeness of death registration of children (0-4) averaged around 60 per cent, about 35 per cent lower than the completeness of adult deaths in Cape Town. Child deaths are less completely registered than adult deaths in all the health districts. The patterns of adult and child completeness, Figure 5.5 and Figure 5.7 respectively, in all the health districts differ in the levels of completeness, except to some extent in the Eastern, Klipfontein (between 1996 and 2000), Southern (between 1996 and 2000) and the Tygerberg health districts. The peaks and troughs (deviations) in children and adult completeness though seem to be occurring in the same years in all the health districts except in the Tygerberg health district where completeness falls for child deaths whilst it is stable in the adults.

Completeness of child deaths in the Eastern, Klipfontein, Khayelitsha, Southern and Tygerberg health district (Figure 5.7) has two levels, 1996 to

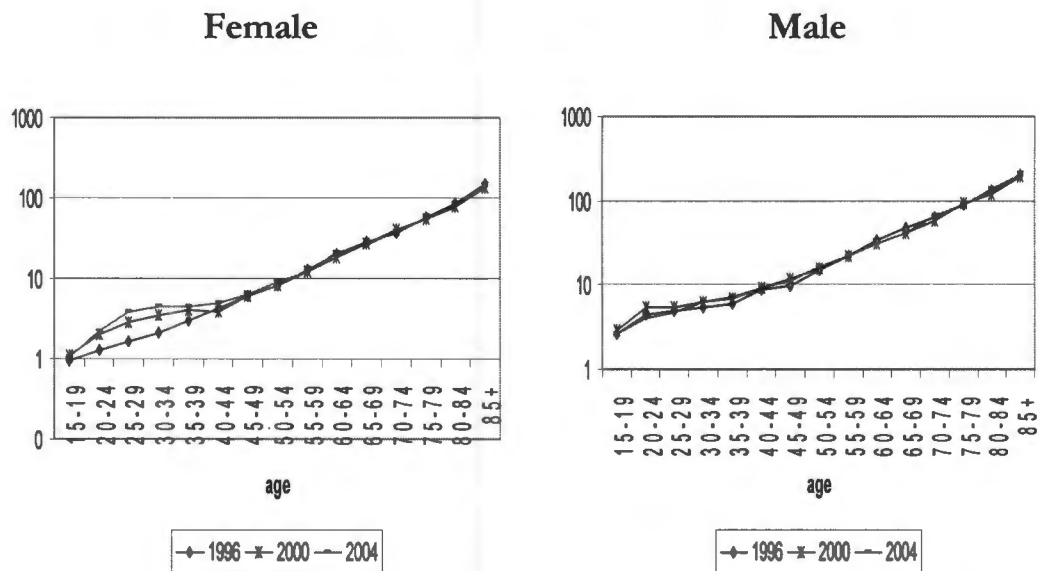
2000 and 2001 to 2004, depicting a similar pattern as in the adults in some of these health districts, but differing in the magnitudes of increases and declines between the two levels. The differences between adult and child registration might be linked to inheritance of the deceased benefits. For the deceased's family to claim the inheritance they will need the death certificate, thus children have nothing to pass on, thus getting a death certificate might just be an unnecessary expense. This of course is all speculation, and it does not explain why child deaths are less completely registered than adult deaths by about 35 per cent.

## Chapter 6 Mortality rates

This chapter combines the results of completeness by age and sex in 2001 in Chapter 4 and the trend estimates (weighted index ratios) in Chapter 5 to estimate the completeness ratios (adjustment factors) by age and sex in each year of adults. These are then used to adjust the vital registration of deaths in each year, before the calculation of mortality estimates.

### 6.1 Cape Town mortality rates

The female age specific mortality rates in Cape Town (Figure 6.1) have remained unchanged over time at all ages except in the 20 to 39 age groups, with the age specific mortality rates more than trebling (from 1.4 to 4.6 deaths per thousand) in the 25 to 29 age group.



**Figure 6.1** Age specific mortality rates per 1000, 1996, 2000 and 2004: Cape Town

The most significant increase occurred between 1996 and 1999, and this is probably due to the onset of the HIV/AIDS epidemic in Cape Town and South Africa as a whole. However, the male age specific mortality rates (Figure

6.1) have not changed as much with an increase of only 18 per cent in the 30 to 40 year age group (from 6.2 to 7.3 deaths per thousand males) between 1996 and 2004 peaking in 2002 at 7.8 deaths per thousand.

Male mortality rates are significantly higher than female mortality rates at all ages; with the male mortality rates more than double the female rates below the age of 50 with the gap between the two narrowing with age. The narrowing between the two sexes is also apparent in the mortality rates between the age of 15 and 60 (Table 6.1), with female mortality rates increasing by about 40 per cent between 1996 and 2004, whilst the male mortality rates have hardly changed between 1998 and 2004 after the most significant increase between 1997 and 1998. The step change in mortality between 1997 and 1998 might be a real increase or might be an increase caused by an increase in death reporting.

**Table 6.1 Comparison of the mortality rates ( ${}_{45}m_{15}$ ) per 1000**

	Female Cape Town	Male Cape Town	Female Western Cape (1)	Male Western Cape (1)
1996	3.3	6.8	5.5	9.4
1997	3.1	6.6	5.5	9.4
1998	3.5	7.6	5.8	9.8
1999	3.8	7.7	6.1	9.8
2000	3.9	7.5	6.3	10.1
2001	4.1	7.7	6.6	10.1
2002	4.3	8.1	6.9	10.4
2003	4.2	7.6	7.5	10.8
2004	4.5	7.4	7.8	11.1

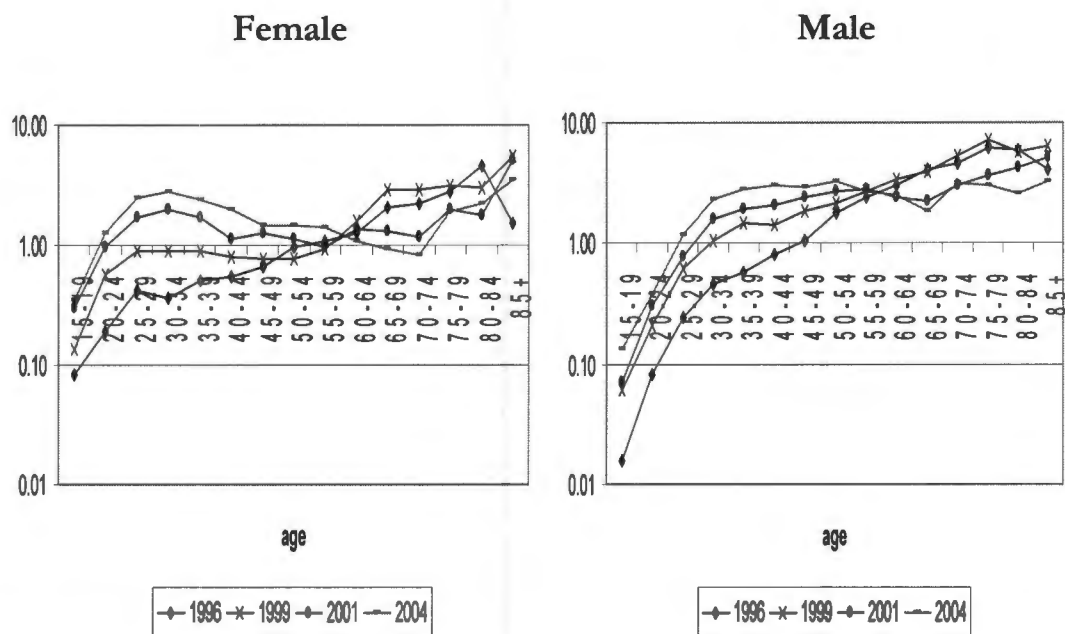
Source: (1)  ${}_{45}m_{15}$  derived from the projected  ${}_{45}q_{15}$  by (Dorrington, Johnson et al. 2006).

The pattern of mortality in Cape Town is similar to the pattern in the Western Cape (Table 6.1), only differing in the levels of mortality of both sexes with Western Cape having higher mortality rates in both sexes. The magnitude of increase in each year is similar for both Cape Town and the Western Cape as well; this suggests that the adjustment factors that have been used to correct for incompleteness in the registration of deaths in Cape Town are reasonable in both sexes, since the population of Cape Town comprises about 65 per cent of the Western Cape population, thus we would expect similar patterns of mortality but with different levels.

## **6.2 Cause specific mortality rates in Cape Town**

### **6.2.1 Communicable mortality rates**

There has been a substantial increase in the communicable female mortality rates below the age of 60 (Figure 6.2), with mortality rates above this age declining. The most significant increase (of more than six times) in the whole period occurs between the age of 20 and 35, and this is due to HIV/AIDS and its opportunistic diseases as these are the age groups most susceptible to the epidemic. The pattern of communicable male mortality rates (Figure 6.2) is similar to the female pattern, merely differing in the magnitude of the increases and decreases below and above the age of 60 respectively. Otherwise the major increase (about 4 times) in the male mortality rates occurs in the 20 and 44 age range, also probably due to the HIV/AIDS epidemic, with the increases being noted in the 15 to 19 age group possibly being random fluctuation due to the small number of deaths in this age range.



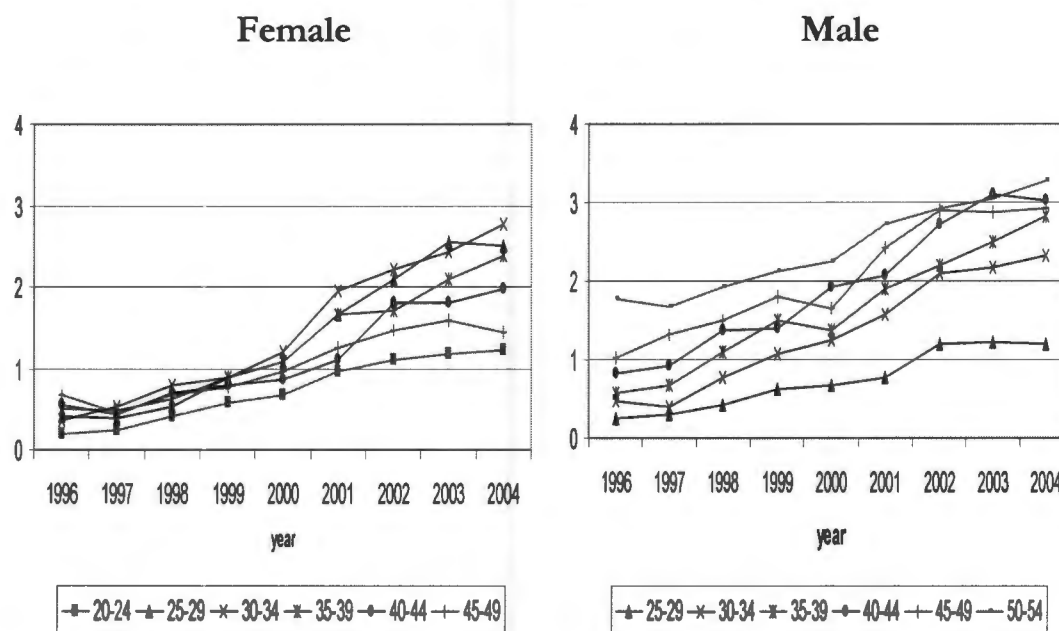
**Figure 6.2 Age specific communicable mortality rates per 1000, 1996-2004: Cape Town**

These communicable mortality rates in a period of an HIV/AIDS epidemic are consistent with other studies that have been conducted by the MRC Burden of Disease Research unit and Statistics South Africa (2006) showing similar ages being affected by the epidemic in both sexes with the age of the female peak 10 years younger than that of the males.

Looking at the individual five-year age groups between the age of 20 and 55 that are being severely affected by the communicable disease (Figure 6.3), as noted earlier the largest increase in the female rates occurs in the three age groups between 20 and 34<sup>24</sup> (an increase of about 7 times over the period),

<sup>24</sup> Largest increase occurs in the 30 to 34 age group from 0.36 to 2.76 deaths per 1000 females between 1996 and 2004.

whilst the increase in the male mortality rates seems to be similar in all age groups with the exception of the 25-29 age group.

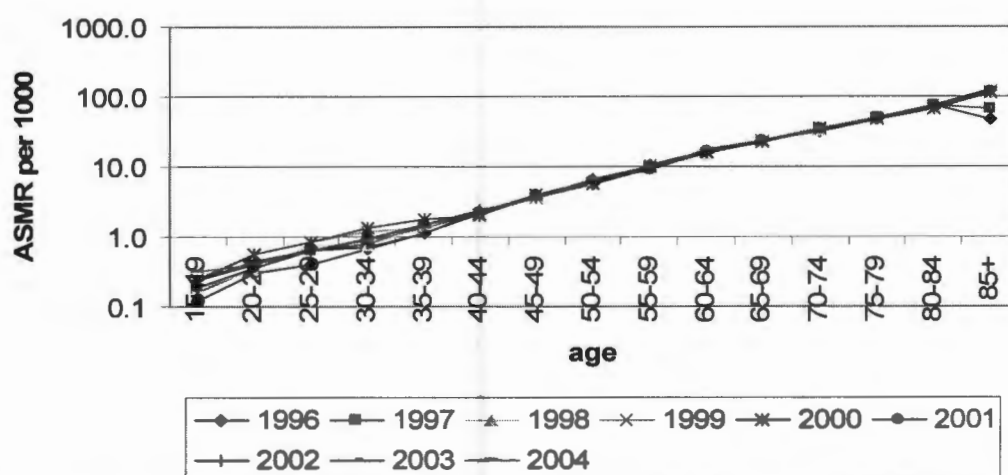


**Figure 6.3 Selected age specific mortality rates ( ${}_5m_x$  per 1000), 1996-2004: Communicable diseases, Cape Town**

The differences between the five-year age group female mortality rates increase after 2000, prior to which the rates of increase were almost similar, whilst the rates of increase in the male rates seem to be similar in all age groups with the exception of the age groups below 30. This increase in the rates is mostly due to HIV/AIDS mortality.

### 6.2.2 Non-communicable mortality rates

There appears to be little change in the female mortality rates due to non-communicable diseases at all ages (Figure 6.4), with a dip in the oldest age groups in 1996 and 1997 which is most probably due to deaths that have been misclassified as ill-defined deaths which has corresponding peaks in those years.

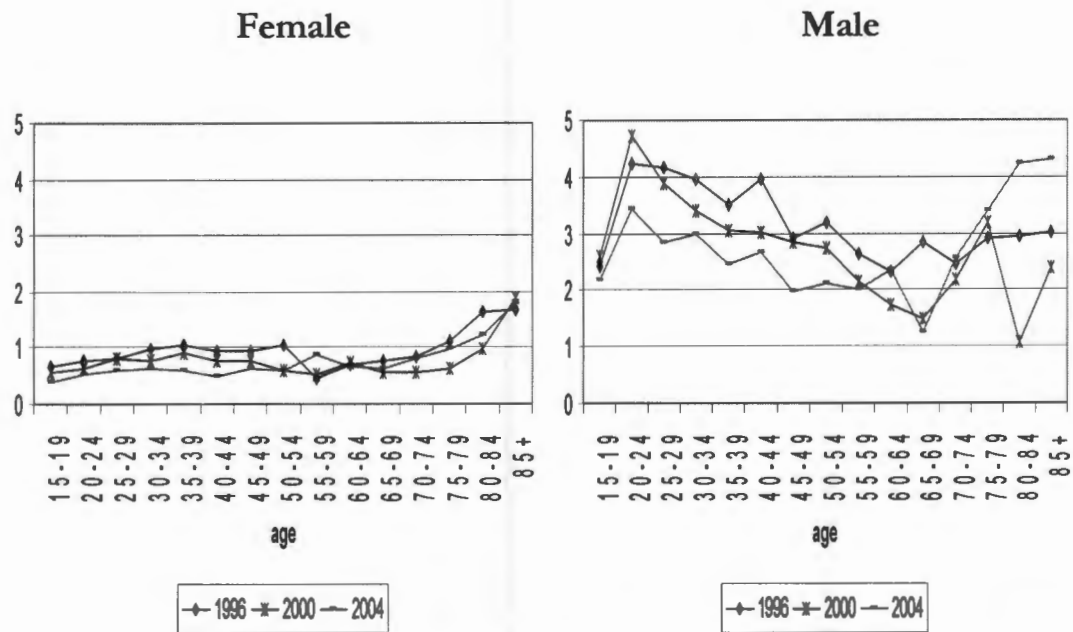


**Figure 6.4 Female non-communicable mortality rates 1996-2004: Cape Town**

The male non-communicable mortality pattern (not shown) is similar to the female pattern. The apparent changes below the age of 40 are probably random fluctuations due to the fewer number of deaths as the non-communicable diseases mostly afflict people in the older ages.

### 6.2.3 Injury mortality rates

The injury mortality rates by age have declined in both sexes (Figure 6.5), with the decline being slightly less noticeable for females since the numbers are so small. The male mortality rates are more than double the female mortality rates at all ages as was also noted by Groenewald, Bradshaw et al. (2001). The male injury mortality rates are significantly higher in the younger age groups in comparison with the other three broad cause groups, which is also expected as the Western Cape is one of the provinces mostly affected by the burden of injury deaths.

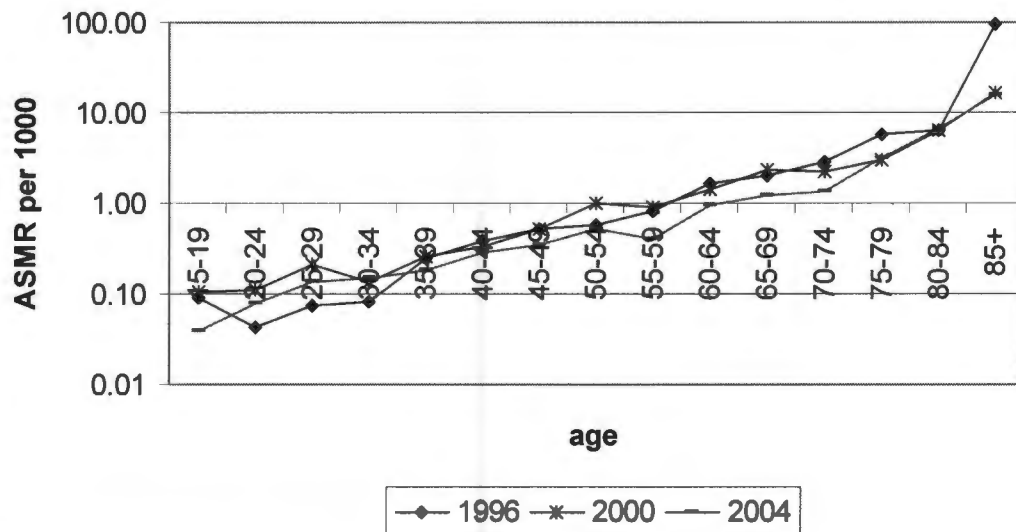


**Figure 6.5 Age specific injury mortality rates per 1000, 1996-2004: Cape Town**

In the overall male mortality rates of Cape Town, the increase in the communicable mortality rates is offset by the decline in the injury mortality rates, thus concealing the increase in mortality from HIV/AIDS (communicable disease), a contrast to the overall female mortality rates where the increase is noticeable as female injury rates have always been less significant.

#### 6.2.4 Ill-defined mortality rates

Ill-defined mortality rates (Figure 6.6) are more significant in the older age groups, which is probably a result of more deaths at these ages in both sexes (males not shown) though there is some evidence of a decline over time, with erratic patterns in the young age groups due to the small number of deaths.



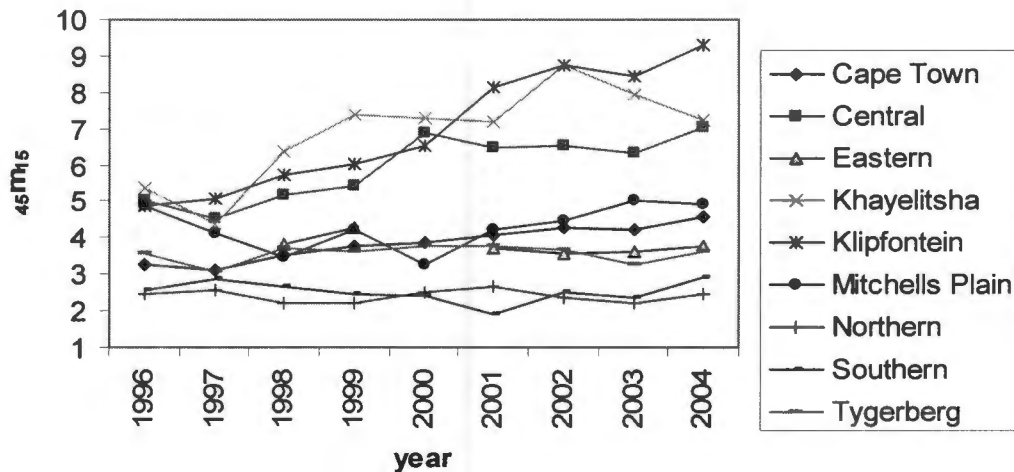
**Figure 6.6 Female ill-defined mortality rates 1996-2004: Cape Town**

The mortality estimates of the four broad groups are consistent with the patterns estimated by the MRC Burden of Disease Research unit, with ill-defined rates declining over time, injury rates high but declining over time, communicable rates increasing over time in the young ages due to the HIV/AIDS epidemic and the non-communicable rates remaining somewhat constant over time in the older age groups due to the older population in Cape Town. The absence of any apparent deviations from the expected patterns in the four broad causal groups estimated mortality rates suggests that the completeness factors that have been used to adjust for the deaths in Cape Town are reasonable.

### 6.3 Mortality rates in the health Districts

Looking at the mortality rate for the age group 15 to 60 for males and females (Figure 6.7 and Figure 6.8), we observe that the most significant increase is in the Klipfontein health district in both sexes and has the highest mortality rates after 2001 with other notable increases occurring in the Central and

Khayelitsha health districts, otherwise the rest of the health districts seem to have stable mortality in both sexes over time, with slight increases after 2002 in some of the health districts.



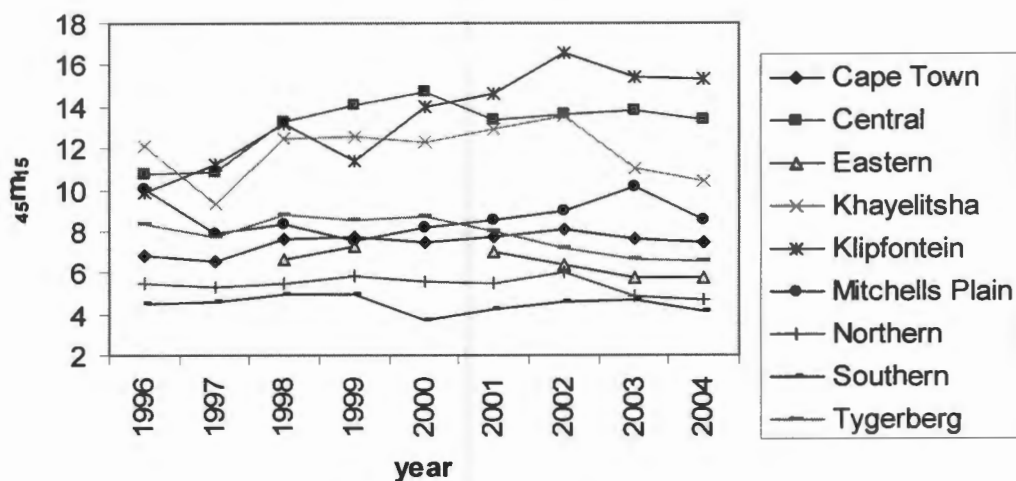
**Figure 6.7 Adult mortality rates ( $_{45}m_{15}$  per 1000): Females**

In 1996 and 1997 there was an over adjustment of deaths in the Eastern health district as observed in the mortality rates (very high mortality rates<sup>25</sup> produced) as a consequence of the low weighted index ratios, brought about by the few number of deaths in the three mortality rates used to derive the weighted index ratios in these particular years thus analysis of mortality rates in these years was omitted.

In the Khayelitsha health district there seems to be an under adjustment of the deaths in 1997 in both sexes which is probably the result of fewer deaths in the 60+ age group used to derive the weighted index ratios whilst the significant decline (with age) after 2002 seems to be real as evidenced by the

<sup>25</sup> Mortality rates more than double in comparison with the other years and use of the average adjustment factors produces mortality estimates that are too low and the year 2000 had no death data, this makes all the death data before 2000 suspect in the Eastern health district.

drop in the 10-14 and the 60+ age group mortality rates, whilst the non-oesophageal and non-lung cancer mortality rates remained constant, a consistent pattern in both sexes.



**Figure 6.8 Adult mortality rates ( $_{45}m_{15}$  per 1000): Males**

The Eastern and the Khayelitsha health districts are the only health districts where the mortality trends are consistent in both sexes, with the rest of the health districts showing slight deviations in the male and female mortality rates ( $_{45}m_{15}$ ), which might reflect real differences in the mortality rates between the sexes. Otherwise the adjustment factors for the health districts seem to be producing reasonably sensible estimates of mortality in the health districts.

The increase in the 15 to 60 mortality rate in both sexes in varying proportions in Cape Town and its health districts over time (Figure 6.7 and Figure 6.8) is mostly due to increases in communicable diseases mortality, specifically HIV/AIDS and its opportunistic diseases which mostly affect the population in this age range, with the increase more noticeable in females than in males. The increase in the male mortality rates is not noticeable because it was offset by the high but declining injury mortality in most of the health districts, with

female mortality rates increasing more rapidly than male mortality rates and the gap between the two narrowing. Even though there is a significant decline in the injury mortality rates in most health districts, they still remain very high for the males.

The ill-defined mortality rates have declined in all the health districts and this most probably due to the change in the classification system which has brought a marked improvement in the classification of causes of deaths in Cape Town. Mortality rates in the older age groups do not seem to have changed at all in all the health districts (more details on this can be found in the Appendix), but looking at the four broad causal groups in Cape Town, a significant decline in the communicable diseases mortality rates is revealed, which is being offset by an increase in the non-communicable deaths which might be the epidemiological transition taking place in Cape Town, but there is apparently no shift of mortality from the younger to the older ages since though the infectious diseases have declined HIV/AIDS seems to be reversing those gains.

The adjustment factors that have been used to adjust the vital registration deaths in the health districts and in Cape Town as a whole seem reasonable, with no acute deviations in the patterns of mortality that are being produced over time, with the patterns becoming more rigorous after 2001, which makes it beneficial for future projections of completeness.

## Chapter 7 Discussion and Conclusions

### 7.1 Adult death registration

Overall completeness of vital registration in Cape Town as a whole in the year 2001 is relatively high for both sexes, whilst it varies between the health districts completeness varies. In part these differences can be attributed to the mix of the population groups within the health districts which varies significantly from one health district to the next (especially the proportion of Africans), but the exact extent of this this can not be established due to the incompleteness of population group information on the death certificates.

This highlights the need to capture population group in the vital registration data as it might reveal who is being registered, as completeness is unlikely to be equal for all population groups in the health districts. Completeness can then be evaluated separately by population group and this might give more accurate levels of completeness in the health districts. The differences might also be due to the different socioeconomic conditions found between and within the health districts as they comprise suburbs with different socioeconomic status, but this requires further investigation.

Completeness with respect to age displays similar patterns for males and females in Cape Town as whole and all its health districts. There are relatively small differences in the overall completeness between men and women in all the health districts with the exception of the Southern health district (unreliable trend in females). This shows that the deaths in Cape Town and its health districts are being equally registered in both sexes with no preference towards a particular sex. The female completeness pattern by age is fairly level in all the health districts, except in the Khayelitsha and Southern health districts, following the female pattern for Cape Town as a whole. This clearly

shows that the registration of female deaths in Cape Town is quite good with respect to age. However, the reason of the decline in male completeness with age in Cape Town as well as in the health districts excluding the Central, Klipfontein and Mitchell's Plain health districts remains unclear.

Age exaggeration, as might be expected, seems to be affecting the completeness ratios at older ages in most of the health districts for both sexes, with sudden rises evident. However, the high completeness ratios of the vital registration in the youngest age groups in some of the health districts, which might be due to underreporting of deaths by the households, are somewhat unexpected. Though adjustments have been made to the census household deaths, they might not be sufficient in these younger and older age groups. It is also possible that ages are overstated in the 2001 census as compared to the vital registration, as age exaggeration is generally found to be greater in deaths (due to the fact that the person is not alive to correct the reported age) than in censuses. Otherwise apart from peaks and troughs in some age groups in most of the health districts, which might be due to random fluctuations, the completeness ratios by age seem to be consistent.

## **7.2 Trends of completeness over time**

This research has outlined the patterns and recent trends of death registration completeness in Cape Town and its eight health districts between 1996 and 2004. The analysis presented on trends over time shows two distinct levels of completeness, for the periods 1996-2000 and 2001-2004 for both sexes. The Khayelitsha and Tygerberg health districts differed from the rest in that they did not show any discontinuity in level over time, and this is probably due to the fact that their suburbs remained relatively unchanged during reallocations. The Southern health district pattern is a mirror image of the other health

district patterns, suggesting mis-allocation of some of the deaths between these health districts and the Southern health district. This leads to the conclusion that completeness is higher after 2000 where the estimates derived are consistent and stable in Cape Town as a whole. One of the most useful features of the trend in completeness is that one is able to use the derived adjustment factors after 2000 to reliably estimate mortality. This is also a clear demonstration of greater reliability of estimates after 2000, with fewer deaths being registered in a health district other than the health district of residence of the deceased, which can be of particular use in future projections of completeness estimates.

The level of completeness over time in Cape Town as a whole is more stable than that in the individual health districts, which suggests certain inconsistencies in the registration of deaths in the health districts which are absent at city level. This could be due to inconsistencies in the boundaries of suburbs in the health districts (some suburbs are covered by different health districts). This is also supported, as mentioned above, by the absence of any peaks and troughs in completeness over time in the Khayelitsha and Tygerberg health districts where suburbs did not shift during the local government reallocations in 2000.

In addition the effect of the change in the local government in 2000 could also be another contributing factor, but to an unknown extent, in the accuracy of the overall completeness levels and their difference in the health districts, with some health districts recording some 2000 deaths in 2001. This has the effect of underestimating the overall level of completeness in one year relative to the following year where the deaths were carried over to.

Since populations in smaller areas are prone to greater changes and instability than larger populations; this might explain the decreases in

completeness trends in the Central and Southern health districts which have the smallest populations. Whilst the increases in the Eastern and Northern health districts with the largest populations are either real increases in completeness or an artifact of an increasing population, the consistent increase in the Khayelitsha health districts is real. The patterns of deviation are similar in the males and females which suggest similar causes to be responsible for these deviations in both sexes, with some of the differences between the sexes reflecting real differences in completeness.

The estimates of completeness of adult death registration for Cape Town are consistently higher than the estimates of completeness nationally derived by Statistics South Africa (2006) and Anderson and Phillips (2006) between 1997 and 2004. This is to be expected since the national estimates comprise rural and urban areas with urban death registration expected to be higher, thus one would expect Cape Town as an urban area to have better coverage. However, this could also be due to the different methods that have been used to estimate completeness. Statistics South Africa have used the Preston and Hill method (Preston and Hill 1980) which assumes a stable population, closed to migration which is inappropriate as the population in South Africa is subject to a degree of migration. Anderson and Phillips have compared vital registration deaths with projected deaths from the Spectrum model, which is also inappropriate as it assumes the UN East Asia model life table which does not reflect the shape and the male/female differential in adult non-AIDS mortality in South Africa.

While it would have been useful to compare these results with those from other sources this was not possible as no estimation of completeness has been produced at city level let alone health district level in South Africa to date. These estimates of completeness are the most reliable that could be

estimated at health district level, given the uncertainty of small area estimates in general, and the uncertainties associated with changes in time.

### **7.3 Completeness of child death registration**

The completeness of vital registration of deaths of children (0-4) differs between the health districts as was the case in the adult death registration, although the patterns over time in the children are more erratic than those of adults. This is most probably a reflection of the erratic number of child deaths in most of the health districts over time, and it is not possible to offer an explanation for the variation being observed in the completeness of child death registration in each of the health districts over time.

Infant deaths are more completely registered than child deaths though both have the same pattern over time. This is evident in all the health districts and in Cape Town as whole, although with varying differences. This might be due to older children living away from their mothers. The completeness of child death registration is lower than adult completeness in Cape Town as a whole and in each of the health districts, which is the norm observed in developing countries. Estimates of completeness of child death registration are lacking in developing countries since there are no equivalent indirect methods such as the ones used for adults. While we have attempted to produce reliable estimates of the level of completeness for child death registration, greater uncertainty remains regarding their accuracy when compared to the adult estimates since they are derived from the number of deaths in the ASSA2003 model, and thus they are dependent on the accuracy of the model. Indications are that to some extent the pattern and even the level of completeness is an artefact of the assumptions in the model.

#### 7.4 Overall conclusion

We were able to verify the reasonableness of the completeness estimates by comparing the trends in the mortality rates over time with the patterns from studies by the Medical Research Council Burden of Disease Research unit (Groenewald, Bradshaw et al. 2001; Bradshaw, Nannan et al. 2006) and Statistics South Africa (Anderson and Phillips 2006; Statistics South Africa 2006). These mortality trends were consistent with each other with respect to epidemiological expectations, patterns and general levels of mortality as well as in the cause specific mortality rates over time. Differences in the levels of mortality might be real as result of different methods being used by different sources where no adjustments for incompleteness are done for most of these mortality estimates.

The approach that has been used provides reasonably consistent estimates of adult death registration in Cape Town with the similar mortality patterns and trends with other sources validating this. This method that was applied is much simple to use does not involve any complex mathematical formulations, and it only involves the vital registration data and household census deaths. A weakness is deficiencies in the household census deaths, but if adjustment factors can be derived or exist, as was the case here, then the deficiencies would be catered for. This of course also depends on the accuracy of the adjustment factors for these household deaths, because if they are erroneous, incorrect completeness estimates would be derived.

As described one has to make a choice regarding how to handle completeness over time. One can assume equal completeness by age at any point in time and use the overall completeness to adjust for deaths. This is inappropriate as mentioned in Chapter 2, because usually death registration is not invariant with age. On the other hand one can assume the completeness

ratios by age derived in 2001 for the other years, with no significant changes expected to have occurred in the death registration by age, given the short time interval from 1996 to 2004.

The method is superior to the indirect techniques in that it does not rely on model life tables, and the effect of HIV/AIDS will be taken into account without any uncertainty, as mortality conditions are inferred directly from the data. Unfortunately the same approach could not be applied to child death registration, as we did not have an accurate estimate of child mortality at the time of the census (if we had had we could have estimated adjustment factors for children) and we can not assume that the completeness between adults and children is equal as it has been found to be different. Thus, a different approach was used for children, one that makes use of estimates of child deaths from a projection model to estimate completeness of death registration of children. For this reason, one cannot usefully estimate the life expectancy at birth, as this will be dependent on the accuracy of the independent estimates of the child deaths.

In the end the fairly high completeness for adult death registration in Cape Town and its health districts, mean that any adjustments made to the death data to allow for incompleteness are fairly small, and thus the effect of any errors in the adjustment factors will be negligible.

These results provide insights into the trends and patterns of completeness in the data in Cape Town that has not been fully analysed yet. Apart from errors that arise from data capturing that can be rectified, the data that are already in existence paint a picture of a sound system of collection of deaths in comparison with other developing countries, or even the country as a whole. However, at health district level, there is still need for improvement in death registration, in particular the Central and Southern health districts

where a decline in completeness was observed. The less developed health districts with population groups in which data have historically been poor also need improvement in death registration. Population group is recorded on the death certificate in about 25 per cent of the cases nationally, this needs improving as this might reveal the differences in mortality between the population groups in Cape Town and the health districts. This will allow one to assess the health status and needs and areas that need intervention more accurately by population group.

Evaluation of completeness of infant and child deaths still remains a challenge and there is a need to develop robust methods of estimation in children under five. An area related to this is the completeness of infant and child deaths in comparison with births in Cape Town, which might help to find more robust estimates of completeness of infant and child death registration. This might require the estimation of birth registration, which will add value to the accuracy of the completeness estimates of infant and child deaths. The reasons for some particular patterns of completeness also need to be investigated further, especially the decline of male completeness with age. The differences in completeness between the health districts might be due to the different socioeconomic conditions found between and within the health districts as comprise suburbs with different socioeconomic status. Further investigation is necessary to determine whether socioeconomic status affects the registration of deaths and to what extent.

The level of completeness of the various causes of deaths especially in this era of the HIV/AIDS epidemic is another important area that needs attention. Exploring further the completeness of some causes of death that are causing a high burden in Cape Town or even South Africa as a whole will help

in coming up with reliable mortality estimates for causes of death This would be beneficial to the government in their intervention programmes. This will also help to monitor the progression of the HIV/AIDS epidemic with reliable mortality estimates.

Completeness estimation by race is a final area that needs to be explored further to see whether the differences in completeness between the population groups are significant. On a broad level there is also a need to investigate the completeness of death registration in the other metropolises and cities of South Africa, and following the example of Cape Town, with the approach adopted in this thesis applied to estimate mortality. This will also enable comparisons to be made of the different systems that are in place in the local governments in trends of the coverage of deaths.

## References

- Abrahams, K., L. Berry and M. Hendricks (2006). Child health: The general context. Cape Town, Child Health Unit, University of Cape Town.
- Anderson, B. A. and H. E. Phillips (2006). Adult mortality (Age 15-64) based on death notification data in South Africa: 1997-2004. Pretoria, Statistics South Africa.
- Arriaga, E. E., P. D. Johnson and E. Jamison (2003). Population Analysis with Microcomputers. Presentation of Techniques. Washington, U.S. Census Bureau.
- Bennett, N. and S. Horiuchi (1984). "Mortality estimation from registered deaths in less developed countries." Demography **21**(2): 217-233.
- Bennett, N. G. and S. Horiuchi (1981). "Estimating the completeness of death registration in a closed population." Population Index **47**(2): 207-221.
- Bhat, P. N. M. (2002). "General Growth Balance Method: A reformulation for populations open to migration." Population Studies **56**(1): 23-34.
- Bradshaw, D., D. Bourne and N. Nannan (2003). What are the leading causes of death among South African children? MRC policy brief. Cape Town, Medical Research Council.
- Bradshaw, D., R. E. Dorrington and F. Sitas (1992). "The level of mortality in South Africa in 1985 - what does it tell us about health?" South African Medical Journal **82**(44): 237-240.
- Bradshaw, D., P. Groenewald, R. Laubscher, N. Nannan, B. Nojilana, R. Norman, D. Pieterse, M. Schneider, R. E. Dorrington, D. Bourne, L. Johnson and I. Timaeus (2001). Initial burden of disease estimates for South Africa, 2000. Cape Town, South African Medical Research Council.

- Bradshaw, D., P. Groenewald, R. Laubscher, N. Nannan, B. Nojilana, R. Norman, D. Pieterse and M. C. Schneider (2003). Initial Burden of Disease Estimates for South Africa, 2000. Cape Town, South African Medical Research Council.
- Bradshaw, D. and N. Nannan (2004). Health Status. South African Health Review 2003/4. Durban, Health Systems Trust.
- Bradshaw, D., N. Nannan, R. Laubscher, P. Groenewald, J. Joubert, B. Nojilana, R. Norman, D. Pieterse and M. Schneider (2006). South African National Burden of Disease Study 2000: Estimates of Provincial Mortality. Cape Town, South African Medical Research Council.
- Bradshaw, D., N. Nannan, R. Laubscher, P. Groenewald, J. Joubert, B. Nojilana, R. Norman, D. Pieterse and M. C. Schneider (2004). South African National Burden of Disease Study 2000: Estimates of Provincial Mortality. Cape Town, South African Medical Research Council.
- Bradshaw, D., M. Schneider, R. Dorrington, D. Bourne and R. Laubscher (2002). "South African cause of death profile 1996: Burden of disease in transition." South African Medical Journal **92**(8): 618-623.
- Bradshaw, D., M. Schneider, R. Norman and D. Bourne (2006). Mortality patterns of chronic diseases of life style in South Africa, 1995-2005. Cape Town, South African Medical Research Council: Chapter 2, pp 9-22.
- Brass, W. (1975). Methods for Estimating Fertility and Mortality from Limited and Defective Data. Chapel Hill, North Carolina, University of North Carolina.
- Brass, W. and K. Hill (1973). Estimating adult mortality from orphanhood. International Union for the Scientific Study of Population, Paper

presented at Proceedings of the International Population Conference. Liege,1973.

- City of Cape Town (2001). Background Report, City of Cape Town: Economic Trends and Analysis 1980-2000. Cape Town, City of Cape Town, Economic Development, Tourism and Property management.
- Courbage, Y. and P. Fargues (1979). "A Method for Deriving Mortality Estimates from Incomplete Vital Statistics." Population Studies 33(1): 165-180.
- Department of Health (2004). South African Demographic and Health Survey 2003: Preliminary Report. Pretoria, Department of Health.
- Dorrington, R. (2005). Projection of the Population of Cape Town, 1985-2021, unpublished interim report.
- Dorrington, R., L. Johnson, D. Bradshaw and T.-J. Daniel (2006). The demographic Impact of HIV/AIDS in South Africa. National and Provincial Indicators for 2006. Cape Town, Centre for Actuarial Research, South African Medical Research Council and Actuarial Society of South Africa.
- Dorrington, R., I. M. Timaeus, T. Moultrie and N. Nannan (2004). "Estimates of provincial fertility and mortality in South Africa, 1985-1996." Southern African Journal of Demography 9(2): 25-57.
- Dorrington, R. E., T. A. Moultrie and I. M. Timaeus (2004). Estimation of mortality using the South African Census 2001 data. CARE Monograph No. 11. Cape Town, Centre for Actuarial Research.
- Feeney, G. (2001). "The Impact of HIV/AIDS on Adult Mortality in Zimbabwe." Population and Development Review 27(4): 771-780.

- Groenewald, P. and D. Bradshaw (2005). Official death statistics under represent AIDS as a cause in South Africa. AIDS Analysis Africa Online. Cape Town.
- Groenewald, P., D. Bradshaw, B. Nojilana, D. Bourne, J. Nixon, H. Mahomed and J. Daniels (2001). Cape Town Mortality, 2001, Part I, Cause of death and premature mortality. Cape Town, City of Cape Town, South African Medical Research Council, University of Cape Town.
- Groenewald, P., N. Nannan, D. Bourne, R. Laubscher and D. Bradshaw (2005). "Identifying deaths from AIDS in South Africa." AIDS 19(2).
- Hill, K. (1987). "Estimating census and death registration completeness." Asian and Pacific Population Forum 1(3): 8-13.
- Hill, K. (2001). Methods for Measuring Adult Mortality in Developing Countries: A Comparative Review, Harvard Burden of Disease Unit, Center for Population and Development Studies; The Global Burden of Disease 2000 in aging Populations.
- Hill, K. and Y. Choi (2004). Death Distribution Methods for Estimating Adult Mortality: Sensitivity Analysis with Simulated Data Errors. Adult Mortality in Developing Countries Workshop, The Marconi Center, Marin County, California.
- Hill, K. and B. Queiroz (2004). Adjusting General growth balance method for migration. Paper prepared to Adult Mortality in Developing Countries meeting, Berkeley, July 2004.
- Himes, L. C. (1994). "Age Patterns of Mortality and Cause of Death Structures in Sweden, Japan and the United States." Demography 31(4): 633-650.
- Horiuchi, S. (1989). Some Methodological Issues in the Assessment of the Deceleration of the Mortality Decline. Differential Mortality:

- Methodological Issues and Biosocial Factors. L. Ruzicka, G. Wunsch and P. Kane. Oxford, Clarendon Press: 64-78.
- Kinsella, K. and M. Ferreira (1997). *Aging Trends: South Africa*, International Programs Center, U.S. Bureau of the Census, HSRC/UCT Centre for Gerontology, University of Cape Town.
- Martin, L. G. (1980). "A modification for use in destabilised populations of Brass's technique for estimating completeness of death registration." Population Studies **34**(2): 381-395.
- Matzopoulos, R. (2005). "Violent deaths in South Africa: The 2003 National Injury and Mortality Surveillance System." SA Crime Quarterly **September 2005**(13): 29-36.
- Municipal Demarcation Board (2005). *Revisiting the demarcation and establishment of metropolitan municipalities in South Africa: An exploratory paper*. M. Oranje and M. Planners. Pretoria.
- Nannan, N., D. Bradshaw, I. Timaeus and R. Dorrington (2000). "The Impact of HIV/AIDS on infant and child mortality in South Africa." XIII<sup>th</sup> International AIDS Conference, Durban, South Africa, 8-13 July 2000.
- Palloni, A. (1981). "A Review of Infant Mortality Trends in Selected Underdeveloped Countries: Some New Estimates." Population Studies **35**(1): 100-119.
- Preston, S., A. Coale, J. Trussel and M. Weinstein (1980). "Estimating the completeness of reporting of adult deaths in populations that are approximately stable." Population Studies **46**(2): 179-202.
- Preston, S. and K. Hill (1980). "Estimating the completeness of death registration." Population Studies **34**(2): 349-366.
- Preston, S. H., P. Heuveline and M. Guillot (2001). Demography: Measuring and Modelling Population Processes. Oxford, Blackwell Publishing.

- Prinsloo, M. (2004). Cape Town. A profile of Fatal Injuries in South Africa: Fifth Annual Report 2003 of the National Injury Mortality Surveillance System. R. Matzopoulos. Cape Town, Crime, Violence and Injury Lead Programme/ Medical Research Council: 37-44.
- Prinsloo, M., H. Donson and M. Maruping (2005). A profile of fatal injuries in South Africa: 6th Annual report of the National Injury Mortality Surveillance System 2004. Cape Town, Medical Research Council/ UNISA Crime, Violence and Injury Lead Programme.
- Scott, V., D. Sanders, G. Reagon, P. Groenewald, D. Bradshaw, B. Nojilana, H. Mahomed and J. Daniels (2001). Cape Town Mortality, 2001, Part II, An equity lens – lessons and challenges. Cape Town, City of Cape Town, South African Medical Research Council, University of Cape Town, University of Western Cape.
- Shryock, H. S. and J. S. Siegel (1976). The Methods and Materials of Demography (Condensed Edition). San Diego, Academic Press.
- Statistics South Africa (2001a). Recorded deaths 1996. Pretoria, Statistics South Africa.
- Statistics South Africa (2003). Census 2001: Census in brief. Pretoria, : Statistics South Africa.
- Statistics South Africa (2003). Census 2001: How the count was done. Pretoria, Statistics South Africa.
- Statistics South Africa (2005). Mortality and causes of death in South Africa, 1997-2003: Findings from death notification. Statistical release P0309.3. Pretoria, Statistics South Africa.
- Statistics South Africa (2006). Mortality and causes of death in South Africa, 2003 and 2004: Findings from death notification. Pretoria, Statistics South Africa.

Timaeus, I., R. Dorrington, B. Bradshaw and N. Nannan (2002). From apartheid to AIDS. Technical report Mortality trends in South Africa 1985-2000. Cape Town, Medical Research Council.

United Nations (1997). Manual X: Indirect Techniques for Demographic Estimation. New York, United Nations.

## Appendix: Adult mortality estimates in the health districts

This section gives results of mortality estimates in some selected years in the eight health districts of Cape Town after adjustment of the adult vital registration deaths.

### A4.1 Central health district

Age specific mortality rates for females in the Central health district (Figure A4.1) have remained more or less the same above age 40; whilst below this age there is a significant increase between 1996 and 2000.

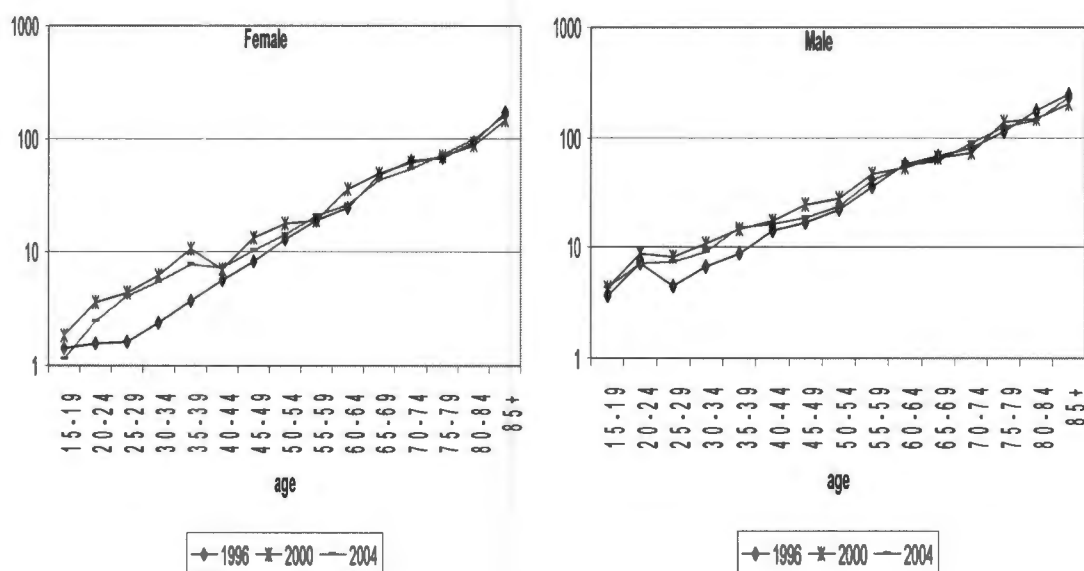


Figure A4.1 Female and male age specific mortality rates per 1000, Central health district

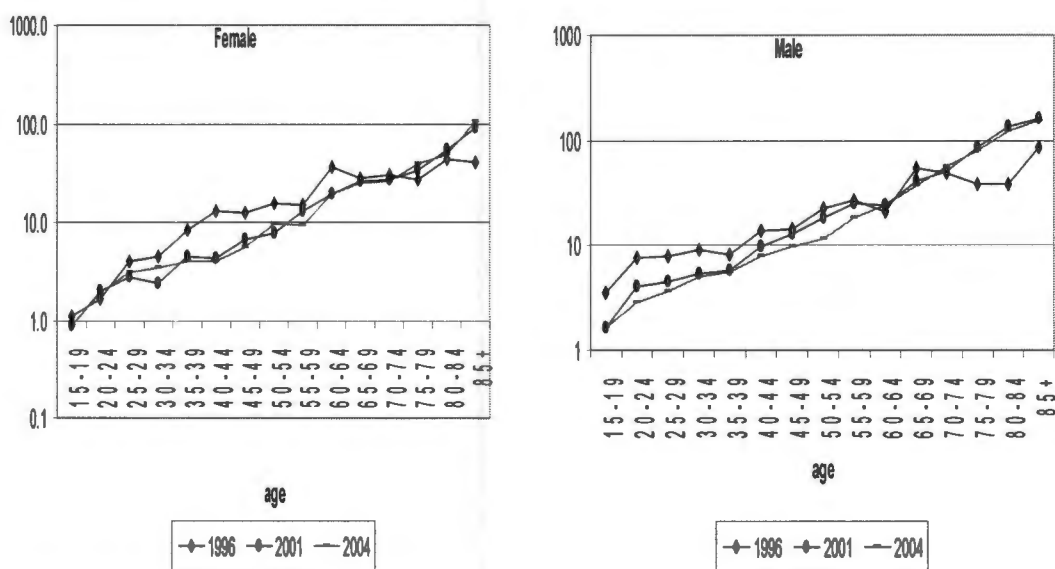
This increase is due to communicable causes specifically HIV/AIDS which increased in that period as compared to the other three broad groups (ill-

defined, non-communicable and injury mortality rates) whose mortality rates remained more or less the same.

The increase in the male mortality rates (Figure A4.1) occurs below the age of 45, though the increase is not as significant as in the females due to the high injury mortality rates which seem to have declined slightly and are being replaced by the HIV/AIDS (communicable) rates.

#### A4.2 Eastern health district

Unlike in the Central health district, mortality rates in the Eastern health district seem to be increasing after 2001 in both sexes (Figure A4.2), especially in the middle ages in females and below age 45 in males.



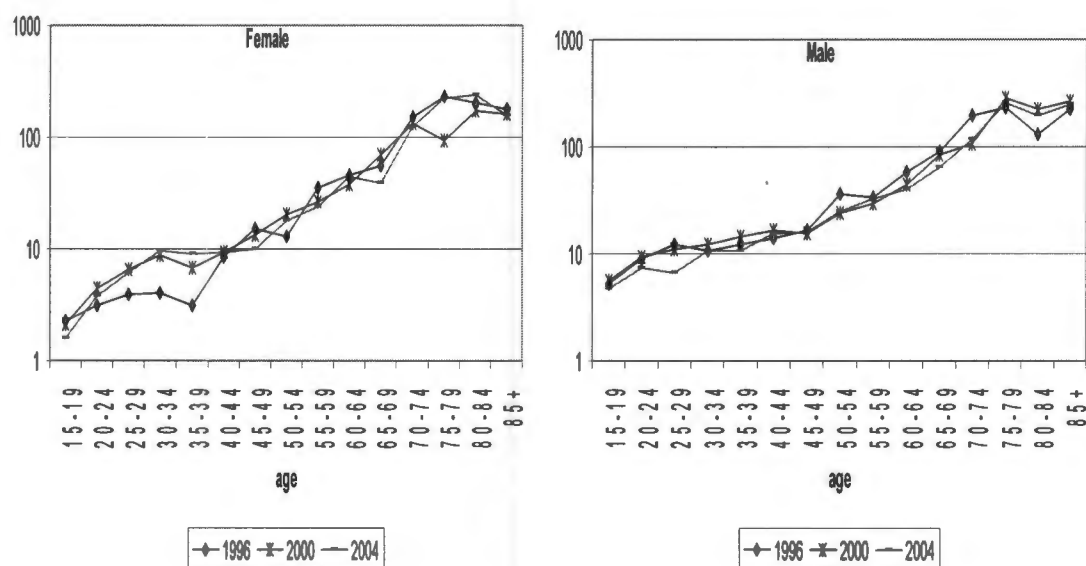
**Figure A4.2 Female and male age specific mortality rates per 1000, Eastern health district**

This increase which is occurring after 2001 brings into question the reliability of the adjustment factors in the Eastern health district which have previously been shown to be fickle in 1996 and 1997 and with missing deaths in 2000,

thus can only rely on the rates after 2001 which seem to have more rigorous patterns.

### A4.3 Khayelitsha health district

Age specific male mortality rates in the Khayelitsha health district (Figure A4.3) have remained somewhat constant in the whole period, whilst the female mortality rates (Figure A4.3) have increased between the age of 20 and 40.

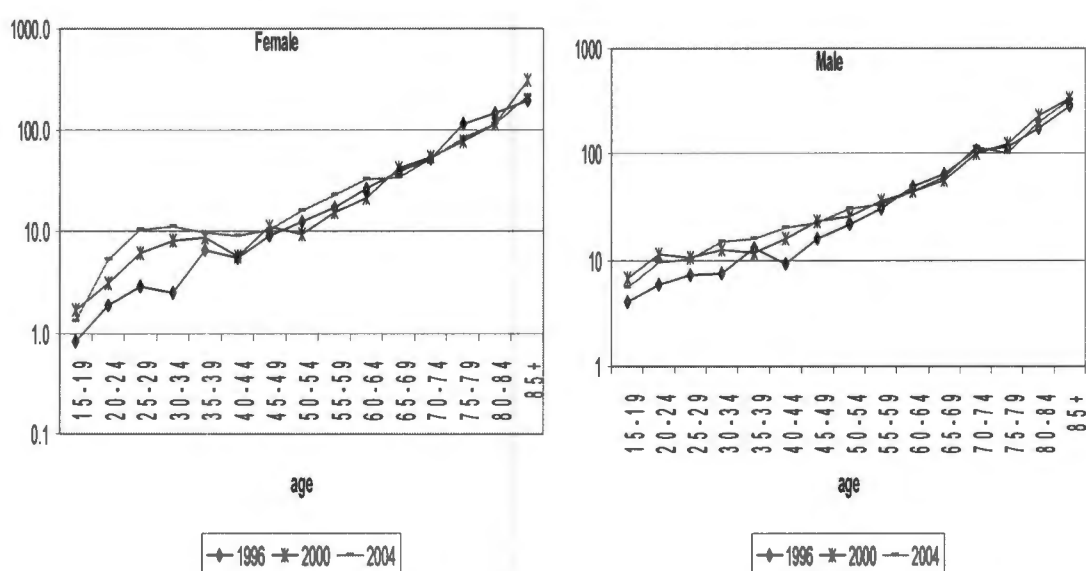


**Figure A4.3 Female and male age specific mortality rates per 1000, Khayelitsha health district**

This mortality increase in the females is due to the increase in communicable mortality rates specifically HIV/AIDS, whilst the increase in male communicable rates is unnoticed in the overall mortality rates because it is being offset by the decline in the injury mortality rates in the ages between 15 and 45. These patterns seem consistent with each other thus making the adjustment factors for the Khayelitsha health district reasonable.

#### A4.4 Klipfontein health district

In the Klipfontein health district we have the same pattern of mortality as in the Khayelitsha health district being observed with female mortality rates (Figure A4.4) increasing between the age of 15 and 40 in the period, with most significant increase in the 30 to 40 age group, except that in the male mortality rates (Figure A4.4) the increase below the age of 50 in the rates is noticeable unlike in Khayelitsha.



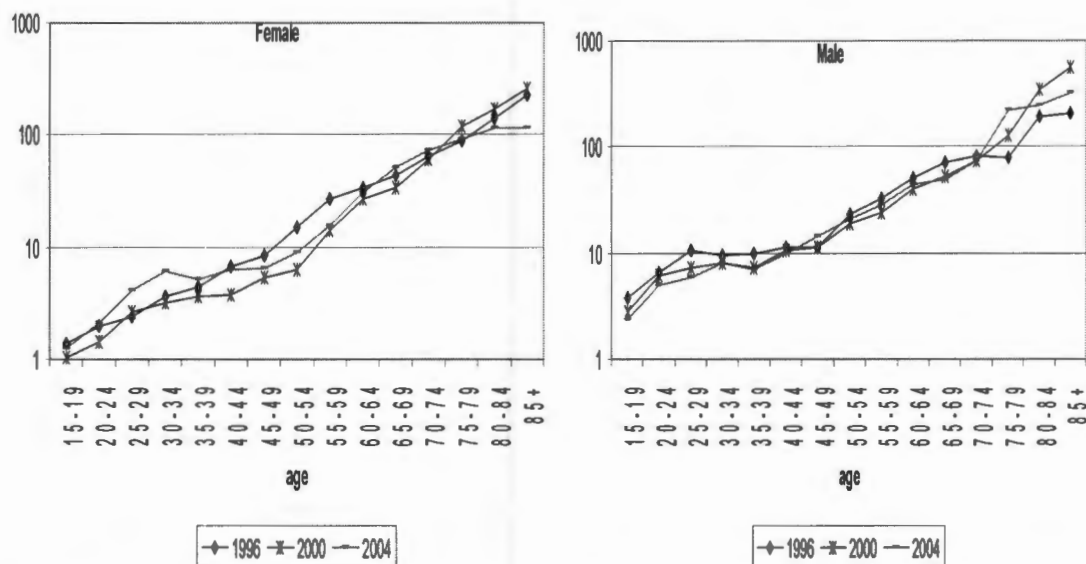
**Figure A4.4 Female and male age specific mortality rates per 1000, Klipfontein health district**

This is because of the decline in the male injury mortality rates which is not as significant as in the Khayelitsha health district in the period below the age of 50.

#### A4.5 Mitchell's Plain health district

We also observe similar mortality patterns in the Mitchell's Plain health district (Figure A4.5) as in the Klipfontein health district in both sexes, except that the increase in female mortality rates seems to be occurring after 2000 below the

age of 40 and does not seem to be as significant as in the four health districts health districts that have been looked at previously (Central, Eastern, Khayelitsha and Klipfontein).



**Figure A4.5 Female and male age specific mortality rates per 1000, Mitchell's Plain health district**

This is because the communicable mortality rates have remained more or less the same over the years with the HIV/AIDS starting to be significant after 2000 in the females, whilst the male injury mortality rates have remained somewhat constant in the Mitchell's Plain health district.

#### **A4.6 Northern Panorama health district**

In the Northern Panorama health district the mortality rates in both sexes (Figure A4.3) have remained more or less the same in the whole period, with

the only noticeable decline in the 20-24 age group in both sexes, which is due to a decline in the injury mortality rates in this age group.

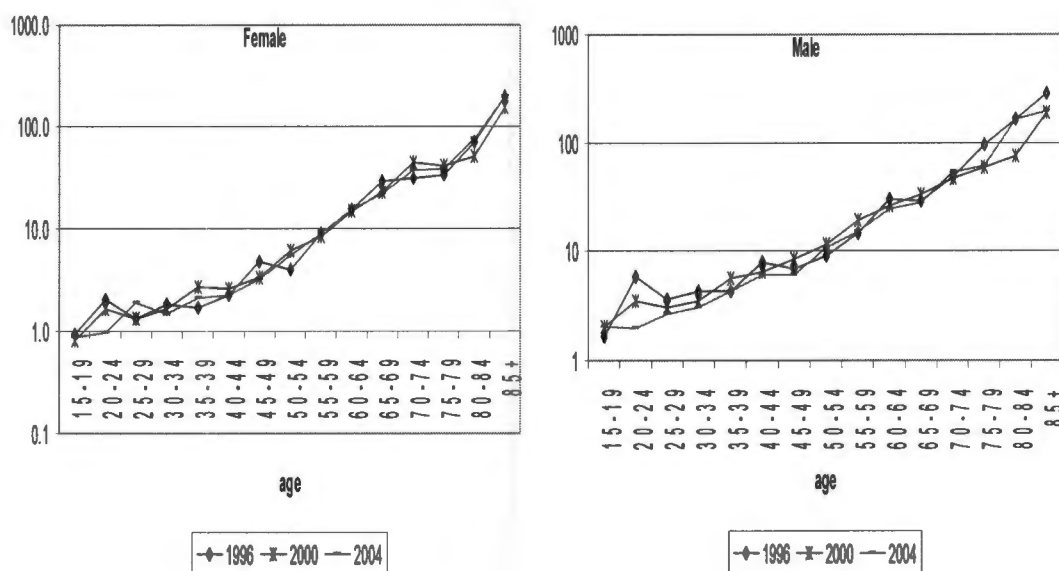


Figure A4.6 Female and male age specific mortality rates per 1000, Northern Panorama health district

#### A4.7 Southern health district

There is an increase in the female mortality rates below the age of 35 between 1996 and 2000, otherwise the mortality rates in the other age groups in the Southern health district (Figure A4.7) have remained more or less the same. The slight increase in the communicable mortality rates is being offset by the slight decline in the injury mortality rates especially in the males.

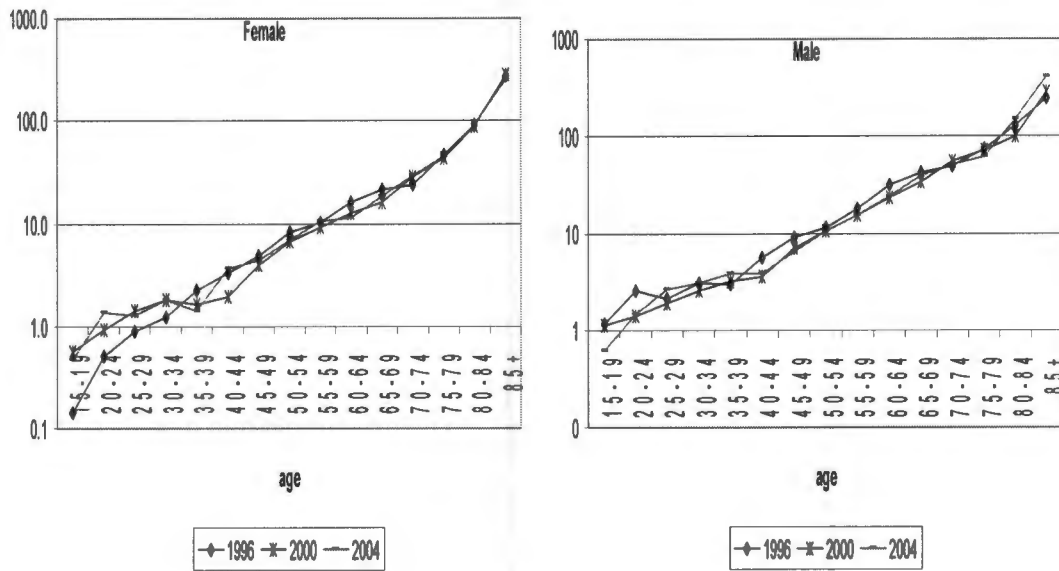


Figure A4.7 Female and male age specific mortality rates per 1000, Southern health district

#### A4.8 Tygerberg health district

Female mortality rates in the Tygerberg health district (Figure A4.8) have remained more or less the same in the period at all the ages, whilst male mortality rates (Figure A4.8) have declined below the age of 50 after 2000 as a result of a significant drop in the male injury mortality rates. The other three broad groups' mortality rates have remained the same except for the female communicable mortality rates which have increased slightly below age 40.

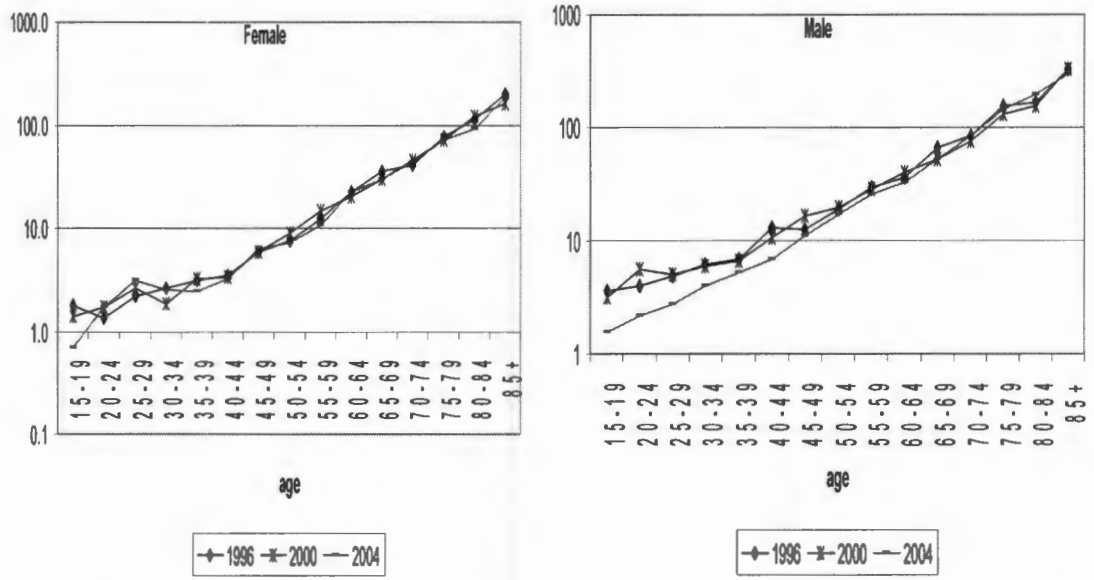


Figure A4.8 Female and male age specific mortality rates per 1000, Tygerberg health district