CENSUS 2011

Estimation of Mortality in South Africa

ISBN:978-0-621-43201-5

Statistics South Africa

The South Africa I know, the home I understand

Census 2011:
Estimation of Mortality in South Africa

Statistics South Africa

Report No. 03-01-62

Pali Lehohla
Statistician-General

Census 2011: Estimation of Mortality in South Africa/Statistics South Africa

Published by Statistics South Africa, Private Bag X44, Pretoria 0001

Stats SA Library Cataloguing-in-Publication (CIP) Data
Census 2011: Estimation of Mortality in South Africa/Statistics South Africa. Pretoria: Statistics South Africa, 2015

60pp
Report No. 03-01-62
ISBN 978-0-621-43201-5

A complete set of Stats SA publications is available at Stats SA Library and the following libraries:

National Library of South Africa, Pretoria Division
National Library of South Africa, Cape Town Division
Library of Parliament, Cape Town
Bloemfontein Public Library
Natal Society Library, Pietermaritzburg
Johannesburg Public Library
Eastern Cape Library Services, King William's Town
Central Regional Library, Polokwane
Central Reference Library, Nelspruit
Central Reference Collection, Kimberley
Central Reference Library, Mmabatho

This report is available on the Stats SA website: www.statssa.gov.za

Copies are obtainable from: Printing and Distribution, Statistics South Africa

Enquiries

Diego Iturralde
Tel:012 310 8922
Fax: 086 670 9723
Email: diegoi@statssa.gov.za

Preface

Evidence-based decision-making has become an indispensable practice universally because of its role in ensuring efficient management of population, economic and social affairs. It is in this regard that Statistics South Africa (Stats SA) is mandated to provide the state and other stakeholders with official statistics on the demographic, economic and social situation of the country to support planning, monitoring and evaluation of the implementation of programmes and other initiatives. In fulfilling its mandate as prescribed in the Statistics Act (Act No. 6 of 1999), Stats SA has conducted three Censuses (1996, 2001 and 2011) and various household-based surveys. Censuses remain one of the key data sources that provide government planners, policy-makers and administrators with information on which to base their social and economic development plans and programmes at all levels of geography. Census information is also used in monitoring of national priorities and their achievement, and the universally adopted Millennium Development Goals. This demand for evidence-based policy-making continues to create new pressures for the organisation to go beyond statistical releases that profile basic information and embark on the production of in-depth analytical reports that reveal unique challenges and opportunities that the citizenry have at all levels of geography. This analytical work also enhances intellectual debates which are critical for policy review and interventions.

The above process is aimed at enabling the organisation to respond to and support evidence-based policy-making adequately, build analytical capacity and identify emerging population, socio-economic and social issues that require attention in terms of policy formulation and research. The monograph series represents the first phase of detailed analytical reports that are theme-based, addressing topics of education, disability, ageing, nuptiality, age structure, migration, fertility, and mortality, among others.

This monograph provides an analysis of child, maternal and adult mortality and health for older adults in South Africa in the period between 2001 and 2011, a period when the country experienced both an upsurge and decline in mortality levels.

Acknowledgments

Statistics South Africa woud like to thank the following contributors for their part in the compilation of this report: Sheila Dlamini, Kadisha Ramaru, Lesego Lefakane, Dr Christine Khoza, Diego Iturralde and Mercy Shoko.

The organisation is also grateful for the comments provided by Drs. Sandile Simelane, Maletela Tuoane-Nkhasi and John Kekovole on the earlier version of the monograph and the team effort of colleagues inlvolved in the collection, processing and packaging of the data used in this monograph.

Special thanks also go to Dr Georges Reiners from The London School of Hygiene and Tropical Medicine for invaluable comments.

Executive summary

Although not entirely because of HIV/AIDS, the first case of HIV/AIDS in 1982 in South Africa was to culminate in the most catastrophic loss of life unprecedented in recent recorded history. Looking with hindsight, Census 2011 could not have occurred at a better time, at least in as far as mortality measurement is concerned. Notwithstanding challenges associated with the collection of mortality data from censuses and sample surveys, as well as those specific to methods used for mortality analyis in South Africa and the majority of the developing countries, the monograph provides an opportuinity to estimate both child and adult mortality and health for older adults for the period between 2001 and 2011, which saw an upsurge and a subsequent decline in mortality levels. The wellbeing of older adults has also become a priority on the global agenda because of the acknowledgement that ageing may be an important demographic characteristic of the 21st century. The monograph also lends itself to the increasing timeliness and completeness of the vital registration data in South Africa for calculation of some indicators.

Direct and indirect demographic techniques were employed in the monograph. Household deaths, orphanhood data and summary birth histories were used in the analysis. The monograph provides a context for mortality data in South Africa, an assessment of the data quality, an assessment of the completeness of the mortality data and estimation of the levels and patterns of mortality in South Africa. The mortality indicators were estimated for the intercensal period and for the period 12 months before the 2011 census.

Life expectancy for South Africa was estimated at 57,9 for 2010. The Infant mortality and Under 5 mortality rates in 2010 were 35 and 48 deaths per 1 000 live births respectively. The life expectancy at ages 50, 60 and 80 was 21, 14 and 5 years respectively and the disability free life expectancy was 17, 11 and 2 years also at ages 50, 60 and 80.

Consistent with mortality literature, mortality differentials were evident by sex, place and population group. The monograph also confirms the established “health-survival paradox” where females have better survival chances than their male counterparts but have worse health outcomes.

Table of contents

Preface ... iii

Acknowledgments ... iv

Executive summary ... v

Abbreviations ... ix

Definition of terms ... x

Chapter 1: Introduction and background ... 1
1.1 Mortality data collation in the case of South Africa ... 1
1.2 Rationale of the monograph ... 1
1.3 Sources of mortality data in South Africa ... 2
1.3.1 Vital registration data ... 2
1.3.2 Enumerated data ... 2
1.4 Objectives of the monograph ... 4
1.5 An overview of the chapters ... 4

Chapter 2: An assessment of 2011 mortality data ... 5
2.1 Introduction ... 5
2.2 Mortality questions asked in the 2011 Census questionnaire ... 5
2.2.1 Household deaths ... 5
2.2.2 Parental survival ... 6
2.2.3 Lifetime fertility and survival of children ... 7
2.3 Data quality assessment ... 8
2.3.1 Comparison between release household deaths and final household deaths ... 8
2.3.2 Imputation rates ... 10
2.3.3 Proportion with unknown response ... 10
2.3.4 Data editing ... 10
2.3.4 Results of data quality assessment ... 11
2.4 Conclusion ... 14

Chapter 3: Numbers of deaths ... 15
3.1 Introduction ... 15
3.2 Census 2011 mortality tables ... 15

Chapter 4: Mortality estimates ... 19
4.1 Introduction ... 19
4.2 Population estimates ... 19
4.3 Assessing completeness of reported household deaths ... 20
4.3.1 Assessing completeness of intercensal deaths ... 20
4.3.2 Assessing completeness of deaths 12 months before the census ... 21
4.4 Mortality indicators ... 21
4.4.1 Childhood mortality ... 21
4.4.2 Adult mortality ... 27

4.4.3 Maternal mortality 29
4.4.4 Life expectancy..30
4.4.5 Life expectancy and disability-free life expectancy at selected older ages 30
4.6 Conclusion 31

Chapter 5: Findings, conclusions and recommended further research agenda........32
5.1 Introduction 32
5.2 A synthesis of the main findings 32
5.3 Conclusion and recommendations..32
5.4 Limitations of the monograph..33

6. References 34

7. Appendices 38

List of tables

Table 2.1: Distribution of household deaths by province: Published tables 9
Table 2.2: A comparison of household deaths between published and final data (unweighted data)..9
Table 2.3: Imputation rates 10
Table 2.4: Fraction of deaths classified as unspecified for selected variables..................10
Table 2.5: Lifetime fertility and survival of children 14
Table 3.1: Number of households reporting death occurrences by province, 2011 15
Table 3.2: Number of deaths by province 16
Table 3.3: Month and year of birth 16
Table 3.4: Distribution of pregnancy-related deaths by age...18
Table 4.1: Estimated completeness of reported household deaths, intercensal deaths..21
Table 4.2: Estimated probabilities of dying between ages 15 and 60 29
Table 4.3 Estimated life and disability-free life expectancy at selected older ages, Census 2011..31

List of figures

Figure 2.1: Census 2011 mortality questions 6

Figure 2.2: Parental survival questions 7

Figure 2.3: Fertility questions 8

Figure 2.4: Trends in the probability of dying between exact ages 15 and 60 estimated for males and females by sex of the respondent, 2011 12

Figure 3.1: Age and sex distribution of deaths, 2011 17

Figure 3.2: Distribution of deaths by population group 17

Figure 3.3: Causes of deaths, 2011 18

Figure 4.1: Distribution of population by age and sex, Censuses 2001 and 2011 20

Figure 4.2: IMR by province 23

Figure 4.3: IMR by district municipality 24

Figure 4.4: IMR by population group 25

Figure 4.5: IMR estimates by source of data and year 26

Figure 4.6: Under-5 estimates by source of data and year 27

Figure 4.7: Trends in the probability of dying between ages 15 and 60 estimated from orphanhood data, Censuses 2001 and 2011 28

List of appendices

Appendix 1: Number of deaths by municipality (unadjusted) 38

Appendix 2: Distribution of deaths by age groups in district municipalities (unadjusted) 40

Appendix 3: Diagnostic plots: open interval of 85+, GGB, RSA Males 41

Appendix 4: Diagnostic plots: open interval of 85+, GGB, RSA Females 42

Appendix 5: Completeness: open interval of 85+, SEG RSA Males 43

Appendix 6: Diagnostic plots: open interval of 85+, SEG RSA Males 44

Appendix 7: Completeness: open interval of 85+, SEG RSA Females 45

Appendix 8: Diagnostic plots: open interval of 85+, SEG RSA Females 46

Appendix 9: Completeness: open interval of 85+, GGB+SEG RSA Males 47

Appendix 10: Diagnostic plots: open interval of 85+, GGB+SEG RSA Males 48

Appendix 11: Completeness: open interval of 85+, GGB+SEG RSA Females 49

Appendix 12: Diagnostic plots: open interval of 85+, GGB+SEG RSA Females 50

Abbreviations

WC	:	Western Cape
EC	:	Eastern Cape
NC	:	Northern Cape
FS	:	Free State
KZN	:	KwaZulu-Natal
NW	:	North West
GP	:	Gauteng
MP	:	Mpumalanga
LP	:	Limpopo
ART	:	Antiretroviral Therapy
CDR	:	Crude Death Rate
GGB	:	Generalised Growth Balance
HSRC	:	Human Science Research Council
IMR	:	Infant Mortality Rate
MMR	:	Maternal Mortality Ratio
PES	:	Post-enumeration Survey
SBH	:	Summary Birth Histories
SEG	:	Synthetic Extinct Generations
Stats SA	:	Statistics South Africa
U5MR	:	Under 5 Mortality Rate
VRS	:	Vital Registration System

Definition of terms

Disability-free life expectancy: Average number of years an individual is expected to live free of disability if current patterns of mortality and disability continue to apply.

IMR: Number of deaths under one year of age occurring in a given geographical area during a given year, per 1 000 live births.

U5MR: Number of deaths under five years of age occurring in a given geographical area during a given year, per 1 000 live births.

MMR: Number of women who die as a result of complications of pregnancy or childbearing in a given year per 100 000 live births in that year.

Household: A household is a group of persons who live together and provide themselves jointly with food or other essentials for living, or a single person who lives alone (Statistics South Africa 2012a).

Chapter 1: Introduction and background

1.1 Mortality data collation in the case of South Africa

Mortality is an important component of demographic change and a critical measure of a population's health and public health systems (McKerrow and Mulaudzi, 2010; Mathers and Boerma, 2010). The population's health, which includes mortality and morbidity, has become largely explained by socio-economic factors (socio-economic determinants of health theory) and as such has become an important indicator of socio-economic inequities in a society. An understanding of the country's mortality levels, patterns and trends is therefore an important part of any demographic inquiry.

In South Africa, vital registration, censuses, sample surveys, health and demographic surveillance systems are all important sources of mortality data. The collection of vital events data and census to enumerate the entire South African population is relatively recent and was enforced by the Births and Deaths Registration Act of 1992 and Births and Deaths Registration Amendment Act 18 of 2010. The Population Registration Act (Act No. 30 of 1950) which classified the population into racial groups had implications regarding the collection of data on the population of the country. The limitations of the sources of demographic data before the advent of democracy are detailed in Khalfani et al. 2005.

1.2 Rationale of the monograph

South Africa is one of the countries in the world that has experienced a drastic reversal in the mortality gains since the 1990s associated with the HIV/AIDS pandemic. South Africa has recorded the highest number of people living with the HIV virus in the world. The recent mid-year estimates show that 5,5 million people are living with HIV/AIDS (Stats SA 2014). HSRC estimated 6,4 million from the 2012 South African National HIV Prevalence, Incidence and Behavioural Survey (Shisana et al. 2014). HIV/AIDS has affected mortality and morbidity for both children and adults. South Africa is the leading country in the provision of ART and this has implications for life expectancy and other mortality indicators. It is important to note that the high levels of adult mortality are not the result of the HIV/AIDS epidemic only. Tollman et al. (2008) reports a heavy burden of chronic infectious illness paralleled by the growing threat of non-communicable diseases using Agincourt HDSS data in South Africa. The monograph is important as it provides estimates on the levels and patterns of mortality in South Africa.

1.3 Sources of mortality data in South Africa

1.3.1 Vital registration data

South Africa has had an inclusive vital registration of mortality data from 1997 and the collection of this information is ongoing. Notice of Death/Stillbirth (DHA-1663) forms, administered by the Departments of Home Affairs and Health and processed by Statistics South Africa are used to capture all registered deaths. Although, still not complete, a feature in most developing countries, South Africa's vital registration data has a relatively high coverage. The completeness of adult deaths in 2011 and 2012 –from the recently available mortality data at the time of writing this monograph – was 93 per cent for each of the years (Dorrington et al. 2014), while Statistics South Africa estimated completeness to be 94 per cent for the 2011 deaths (Statistics South Africa 2014a). It is important to note that the completeness of VRS deaths in South Africa varies by age with completeness at age one estimated to be just over 50 per cent (Dorrington et al. 2014). South Africa's vital registration data are detailed and in addition to the causes of death data are socio-demographic variables. Unlike censuses and surveys which collect mortality data from the household population (excluding institutionalised population), the VRS system collects data from all the sections of the population. The time to release data has been shortened over time, with the processing time of the data including the publication of the reports expected to be 12 months.

1.3.2 Enumerated data

The 1996 Census was the first attempt to enumerate the entire South African population since the 1970 Census. Statistics South Africa, the statistical agency mandated by the government with the production of official statistics in the country, has conducted a number of Censuses and surveys: 1996, 2001 and 2011 Censuses; October Household Surveys (1993–1999); the 2007 Community Survey; General Household Survey from 2002, etc. The aforementioned data sources collect retrospective data regarding a defined reference period on different mortality indicators, which may vary from one survey to the next and are collected on either the whole or a fraction of the population. Some questions have evolved over time e.g. pregnancy and cause of death questions from Census 2001 to Census 2011. In the October Household Survey (OHS), the reference period also changed, for example, the deaths that occurred in the last 12 months before the survey were included in 1993 and 1994 and from 1995 to 1998, and the rest of the years was the deaths that occurred 22 months prior to the survey. The sibling and spousal survival questions were only included in 1997 and 1998 and the parental survivorship questions from 1995 to 1998 to measure adult mortality.

Censuses and surveys are also limited in coverage and are affected by recall bias as household deaths may not be reported at all, or they may be misclassified as being in/out of the census/survey reference period (Timaeus, 1991). There is also possible selection bias where deaths in single member or single adult member households are under-represented due to the possible dissolution of these households after death (Blacker 2004). Surveys are worst affected with regard to household deaths because the uncertainty bounds around estimates are associated with sample size.

In addition to the above-mentioned mortality data sources, there are other inquiries either done in collaboration with Stats SA or independently by other organisations. The Demographic and Health Surveys (DHS) are nationally representative surveys and provide data on mortality-related indicators. South Africa has conducted two DHS surveys, one in 1998 and the last one in 2003. However, the 1998 DHS survey is the only one with robust estimates and in the public domain (Bradshaw, 2007). The South African DHS included modules on parental survivorship, sibling histories and birth histories from which adult, maternal and child mortality estimates were derived respectively. The Human Science Research Council (HSRC) has also included sibling histories and parental survivorship questions in its cross-sectional South African National HIV, Behaviour and Health Surveys. The National Income Dynamics Study (NIDS), which is also a panel study, collects information on household deaths in the last 24 months. A number of other surveys in the country have included mortality questions in one form or the other. The limitation regarding the limited coverage and exclusion of other sections of society highlighted earlier also apply to these surveys.

In South Africa, there are also three health and demographic surveillance systems (HDSS) sites: Africa Centre HDSS in KwaZulu-Natal, Agincourt HDSS in Mpumalanga and Dikgale HDSS in Limpopo. These HDSS sites are part of the INDEPTH global network that conduct regular censuses and collect information on vital events of individuals within the confines of the demographic surveillance sites. Notwithstanding that the HDSSs are longitudinal; they are limited geographically and therefore in generalisability to the mortality experiences of the whole country. Mortality data can also be obtained from other admin records: hospital records, confidential enquiry into maternal deaths etc.

1.4 Objectives of the monograph

Using the 2011 Census mortality data the monograph seeks to:

1.4.1 Assess the quality of mortality data.

1.4.2 Estimate childhood and adult mortality rates.

1.4.3 Estimate maternal mortality ratio.

1.4.4 Estimate the levels, patterns and trends of mortality in South Africa.

1.4.5 Estimate the life expectancy and disability-free life expectancy for older adults in South Africa.

1.5 An overview of the chapters

The monograph consists of five chapters: Chapter 1 provides the rationale for mortality research followed by a discussion of sources of mortality data in South Africa as well as objectives, and provides an overview of the monograph. Chapter 2 is an assessment of Census 2011 household deaths, parental survival and lifetime fertility data. Chapter 3 shows the Census 2011 mortality tables. Chapter 4 looks at completeness of Census 2011 mortality data including childhood and adult mortality, and older adults' life and disability-free life expectancy. Lastly, Chapter 5 provides findings, conclusions and recommendations.

Chapter 2: An assessment of 2011 mortality data

2.1 Introduction

Collection of mortality information through household questionnaires is problematic in developing countries and South Africa is no exception (UN, 2008). Chapter 2 provides an assessment of the mortality information collected from household deaths, data on parental survival as well as summary birth histories. This monograph is part of a series of monographs written by Statistics South Africa using the Census 2011 data and there is an overlap on some of the monographs. To avoid duplication, the data quality assessment in this section provides details on data unique to this monograph.

2.2 Mortality questions asked in the 2011 Census questionnaire

The collection of Census 2011 data was done using three questionnaire types: Questionnaire A, administered to members of households; Questionnaire B, administered to individuals in transit during census night[1]; and Questionnaire C, administered to individuals residing in collective living quarters. The mortality module was only included in Questionnaire A. However, the exclusion of the mortality module to non-household population, which is estimated at approximately 1,6 per cent of the population in Census 2011, is expected not to have a significant effect on the mortality estimates. The persons, households and mortality datasets have separate weight variables to correct for coverage errors. The information on the weighting of the data is detailed in the PES report (Statistics South Africa, 2012).

2.2.1 Household deaths

Figure 2.1 below shows the 2011 Census mortality schedule and the recall period, which was 12 months before census night. The question on the number of deaths, besides indicating the number of deaths that occurred in a household, it was also meant to be for quality check purposes in order to aid the enumerator in obtaining consistent responses from the respondents and also during the editing process to confirm the number of deaths recorded in subsequent responses. Pregnancy-related questions were included in order to measure maternal mortality. The age of the deceased was used to calculate age-specific deaths in general and to allow estimation of mortality for specific indicators: IMR, Under 5

[1] South Africa conducts a *de facto* census i.e. individuals are counted at the place where they spent the census night which was midnight of the 9th–10th of October (Statistics South Africa, 2012a).

mortality rate, life expectancies at birth and at age 60, probabilities of dying in adulthood etc. The name of the deceased was only used as a reference during the data collection process.

Figure 2.1: Census 2011 mortality questions

SECTION I: MORTALITY IN THE LAST 12 MONTHS

M-00 DEATH OCCURRED

Has any member of this household passed away in the last 12 months (between 10 October 2010 and 9 October 2011)?

1 Yes
2 No
3 Do not know

Mark the appropriate circle with an X.

If 2 or 3, Questionnaire completed

M-00a NUMBER OF DEATHS

How many members of the household passed away in the last 12 months (between 10 October 2010 and 9 October 2011)?

ASK ONLY ABOUT DECEASED WOMEN THAT WERE AGED 12 - 50 AT THE TIME OF DEATH

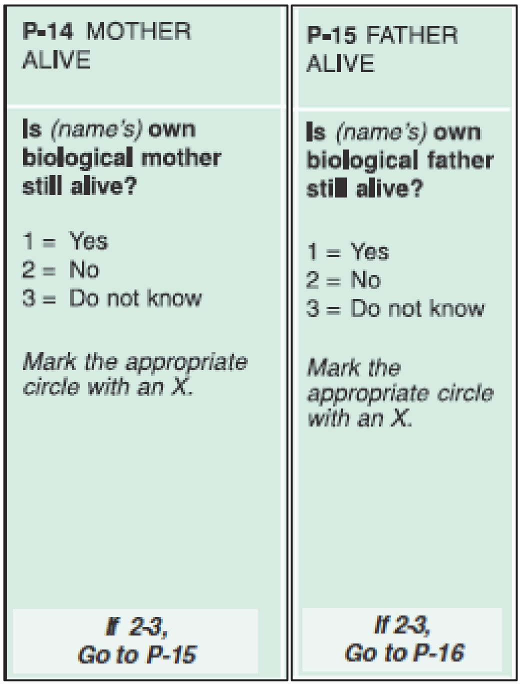
M-01 NAME OF DECEASED	**M-02** MONTH AND YEAR OF DEATH	**M-03** SEX OF THE DECEASED	**M-04** AGE OF THE DECEASED	**M-05** NATURAL OR UNNATURAL DEATH	**M-06** PREGNANT AT TIME OF DEATH	**M-07** DEATH DURING BIRTH	**M-08** POSTNATAL DEATH
What was the first name of *(the deceased)***?** *Use CAPITAL LETTERS only*	**What was the MONTH and the YEAR of** *(the deceased's)* **death?** *Write the month and year in the appropriate boxes.*	**Was** *(the deceased)* **male or female?** 1 = Male 2 = Female *Mark the appropriate circle with an X.*	**What was** *(the deceased's)* **age in completed years at the time of death?** *Write the age in the boxes. If age is less than 1 year, write 000.*	**Was the death due to a natural or an unnatural cause?** 1 = Natural (e.g. illness) 2 = Unnatural (e.g. accident, assault) 3 = Do not know *Mark the appropriate circle with an X.*	**Did** *(the deceased)* **die while pregnant?** 1 = Yes 2 = No 3 = Do not know *Mark the appropriate circle with an X.*	**Did** *(the deceased)* **die while giving birth?** 1 = Yes 2 = No 3 = Do not know *Mark the appropriate circle with an X.*	**Did** *(the deceased)* **die within 6 weeks after delivery?** 1 = Yes 2 = No 3 = Do not know *Mark the appropriate circle with an X.*

If 1 to M-06 or M-07, Questionnaire completed

2.2.2 Parental survival

The parental survival questions are used for indirect estimation of adult mortality. The technique for estimating adult mortality by asking the parental survivorship from surviving children was first developed by Brass, 1975. The original methodology has undergone numerous revisions but hinges on the fact that the proportion of respondents who reported their parents alive at the time of census can be used to estimate adult mortality, as long as exposure time can be assessed through the age of the respondent at the time of the census. For example, the proportion with mothers and fathers who are alive at the time of the census is closely related to the life table probability of surviving for a number of years equal to the age of the respondent and starting from the mean age at childbearing at the time of the respondent's birth, also adjusting for the age difference between males and females. The adult mortality estimated from the orphanhood technique like other kinship techniques, pertain to a mortality regime of the past, and the time location of estimates thereof are also estimated (e.g. Brass and Bamgboye 1981; Palloni and Heligman 1985; Zlotnik and Hill 1981). The 1996, 2001 and 2011 censuses included questions on the survival status of parents for all members of the household. Below is the extract from the 2011 Census questionnaire showing parental survival questions and valid responses thereof. The "do not know" response was in anticipation that some individuals would not know their parents' survival status and that proxy responses on behalf of other household members were allowed during data collection. These questions are well established for indirectly measuring adult mortality (Timaeus 1991).

Figure 2.2: Parental survival questions



P-14 MOTHER ALIVE	P-15 FATHER ALIVE
Is *(name's)* **own biological mother still alive?**	**Is** *(name's)* **own biological father still alive?**
1 = Yes 2 = No 3 = Do not know	1 = Yes 2 = No 3 = Do not know
Mark the appropriate circle with an X.	*Mark the appropriate circle with an X.*
If 2-3, Go to P-15	***If 2-3, Go to P-16***

2.2.3 Lifetime fertility and survival of children

Population censuses and surveys have also proven to be a more useful source of infant and under-5 mortality estimates based on the Brass questions of children ever born alive and surviving (Reniers et al. 2010). The section on fertility in questionnaire A of the 2011 Census is primarily used for estimating fertility, but questions on children ever born, children surviving and children no longer alive are important for mortality estimation using the Brass technique, particularly for countries whose vital registration systems are non-existent or incomplete. However, the technique is rendered obsolete in the advent of the HIV/AIDS epidemic because the deaths of the mothers (supposedly the respondent) are highly correlated with that of the children. Although there have been some developments in correcting for this bias (Blacker and Brass 2005; Ward and Zaba 2008; Hallett et al. 2010; Mutemaringa 2011; Walker et al. 2012), they are far from complete (Moultrie et al. 2013). Secondly, the rollout of ART to prevent mother-to-child transmission prolongs survival and reduce the bias for the most recent time period, but the bias is expected to persist for past time periods (ibid). Poor quality data are also a challenge for any reliable estimates. Figure 2.3 show the extract of the fertility questions from the census questionnaire. The date of death of the last child born in P-41 was used to estimate the deaths in the last 12 months which served as a numerator for computation of direct estimates of IMR. The date of birth of the last child born in P-38 was used to estimate the births in the last 12 months which served as a denominator (after adjustments) for computation of direct estimates of IMR and MMR.

Figure 2.1: Fertility questions

SECTION G: FERTILITY - ASK OF WOMEN AGED 12-50 YEARS LISTED ON THE FLAP

P-32 CHILDREN EVER BORN	**P-33** AGE AT FIRST BIRTH	**P-34** TOTAL CHILDREN EVER BORN	**P-35** TOTAL SURVIVING AND LIVING IN THE HOUSEHOLD	**P-36** TOTAL SURVIVING AND LIVING ELSEWHERE	**P-37** TOTAL CHILDREN NO LONGER ALIVE	**P-38** LAST CHILD BORN	**P-39** SEX OF LAST CHILD BORN	**P-40** LAST CHILD BORN ALIVE	**P-41** DATE OF DEATH OF LAST CHILD BORN
Has *(name)* **ever given birth to a live child, even if the child died soon after birth?** 1 = Yes 2 = No 3 = Do not know	**At what age did** *(name)* **have her first child born?**	**How many children has** *(name)* **ever had that were born alive?**	**How many of** *(name's)* **children are still alive and living with her in this household, including grown-ups?**	**How many of** *(name's)* **children are still alive and living elsewhere, including grown-ups?**	**How many of** *(name's)* **children are no longer alive?**	**When was** *(name's)* **last child born, even if the child died soon after birth?**	**Is** *(name's)* **last child born male or female?** 1 = Male 2 = Female 3 = Do not know	**Is** *(name's)* **last child born still alive?** 1 = Yes 2 = No 3 = Do not know	**When did** *(name's)* **last child born die?**
Mark the appropriate circle with an X.	**Example** 2 5	**Example** Boys 0 2 Girls 0 2 Total 0 4	**Example** Boys 0 2 Girls 0 1 Total 0 3	**Example** Boys 0 0 Girls 0 0 Total 0 0	**Example** Boys 0 0 Girls 0 1 Total 0 1	**Example** 1 9 0 4 2 0 0 5	*Mark the appropriate circle with an X.*	*Mark the appropriate circle with an X.*	**Example** 1 0 0 3 2 0 0 7
If 2 or 3, Go to H-01		*Write the correct number in the boxes below*	*Write the correct number in the boxes below*	*Write the correct number in the boxes below*	*Write the correct number in the boxes below*			***If 1 or 3, Go to H-01***	

2.3 Data quality assessment

2.3.1 Comparison between release household deaths and final household deaths

The mortality data published in the release version of the Census 2011 (Statistics South Africa, 2012b) in 2012 are different from the final version of the Census 2011 mortality data used in the analysis of this monograph. The release data included 604 544 deaths including nearly 20 per cent, or 115 221, deaths with an unspecified age and unspecified age and sex; these were flagged for further investigation. First, a sample of scanned questionnaire images of the aforementioned death records was assessed by comparing the captured images of the questionnaire and the recorded data. These constituted 653 randomly selected death records. The results of the screening showed that during processing, about 21 per cent of the 653 selected records were erroneously read by the scanners as valid records, whereas the response to whether a death had occurred in the household during the reference period was "No". Marks on the questionnaire can be expected since mortality questions were on the last page on the questionnaire, and were therefore misread as entries. This prompted the manual recapturing of all the 115 221 death records and resulted in 468 067 deaths (weighted data). Further details regarding the revisions of the data is provided in the discussion document published with the 10 per cent sample of Census 2011 (Statistics South Africa, 2014b).

Table 2.1 below shows the total deaths and the distribution of the data flagged for further investigation. Mpumalanga and Limpopo had the highest proportion of mortality data that was unspecified and Eastern Cape and Northern Cape the lowest. Cases that had a combination of unspecified sex and age were the highest, almost 20 per cent.

Table 2.1: Distribution of household deaths by province: Published tables

Province	Total number of deaths	Unspecified age	Unspecified sex	Unspecified age and sex	Unspecified age	Unspecified sex	Unspecified age and sex
	Number				Per cent		
WC	45 453	849	160	10 494	1,9	0,4	23,1
EC	92 185	2 354	355	12 359	2,6	0,4	13,4
NC	14 369	386	53	2 130	2,7	0,4	14,8
FS	44 318	881	153	8 315	2,0	0,3	18,8
KZN	136 636	7 948	843	21 292	5,8	0,6	15,6
NW	45 903	1 202	153	7 832	2,6	0,3	17,1
GP	118 066	9 983	650	27 427	8,5	0,6	23,2
MP	51 828	1 046	161	13 656	2,0	0,3	26,3
LP	55 786	885	172	14 715	1,6	0,3	26,4
RSA	**604 544**	**25 534**	**2 700**	**118 220**	**4,2**	**0,4**	**19,6**

Table 2.2 shows the comparison between the data published in the release report and final data used in this monograph. The number of deaths in the final data was reduced by approximately 22 per cent, which approximated the fraction unspecified.

Table 2.2: A comparison of household deaths between published and final data (unweighted data)

Province	Number of deaths at the time of the release	Month and year of death not stated	Out-of-scope and invalid cases	Not meeting the minimum processability rule	Total records deleted	Final data*
WC	37 115	4 629	3 836	856	9 321	27 794
EC	81 678	2 742	7 045	1 553	11 340	70 338
NC	12 401	766	934	276	1 976	10 425
FS	38 842	4 113	2 741	814	7 668	31 174
KZN	115 976	6 780	12 267	3 377	22 424	93 552
NW	38 064	2 753	2 980	853	6 568	31 478
GP	99 545	16 657	11 595	2 821	31 073	68 472
MP	44 345	7 159	3 512	838	11 509	32 836
LP	50 036	8735	3 432	905	13 072	36 964
RSA	**518 002**	**54 334**	**48 342**	**12 293**	**114 969**	**403 033**

*The data shown here are unweighted.

2.3.2 Imputation rates

Imputation rates (Table 2.3) show the extent of editing done on the variables as a result of the application of the editing rules to the data. Imputation rates ranged from approximately 3 per cent to 10 per cent. The mother alive and pregnancy-related questions had the least and highest imputation rates (2,0 and 10,1 per cent respectively).

Table 2.2: Imputation rates

Variables	Fraction imputed (per cent)
Month	3,1
Year	2,8
Sex	3,4
Age	5,7
Cause of death	4,5
Pregnancy-related*	10,1
Mother alive	2,0
Father alive	3,0

*Pregnancy-related death imputation is the average of the three pregnancy-related questions.

2.3.3 Proportion with unknown response

Table 2.4 shows the fraction of deaths classified as unspecified for selected variables. Results show that pregnancy-related deaths had the most unspecified while sex and population group of the deceased had the least. It is important to note that the population group of the deceased was not recorded in the census, therefore, the population group of the deceased was derived by using the population group of household members and details of derivation are in Statistics South Africa, 2012a.

Table 2.4: Fraction of deaths classified as unspecified for selected variables

Variables	Unspecified (per cent)
Age	2,6
Sex	0,4
Cause of death	4, 0
Population group	0,1
Pregnancy-related	13,8

2.3.4 Data editing

Data editing in censuses and surveys is inevitable, even in developed countries where the majority of the population is educated and literate (Dorrington et al. 2004). Although there are content and coverage errors, the focus of this section is on content errors which result from incorrect information being captured in the census questionnaire, or not captured at all. Editing rules were developed to correct the errors with Census 2011 data and were based on logical and other reasonable techniques.

Editing of households deaths

Consistency between variables was checked and edited where necessary. Valid deaths had to be within the reference period of 12 months before the census, otherwise the death was deleted. Response to the sex of the deceased (male/female) was only changed if the deceased was within the reproductive age and answered “Yes” to one of the three pregnancy-related questions. Otherwise, sex with an invalid response was imputed to unspecified. The only time the variable “age of the deceased” was imputed was if the age was out of range (i.e. not 0–120 years) and was imputed to unspecified. Response to the “cause of death” variable was also imputed to unspecified only if it was out of range. Pregnancy-related deaths were only applicable to women aged 12–50 years and if the deceased had information on pregnancy-related deaths and they were out of the specified age range, or the response for sex was male, then the response was imputed to not applicable.

Editing of parental survival data

Parental survival questions were edited in conjunction with the parent person number. The valid responses for mother/father alive were only changed when inconsistent with the mother/father person number. If mother/father alive was invalid, and the mother/father person number pointed to a valid person (with acceptable age and sex in relation to the index person), then the response for mother or father alive was imputed to “yes”. The fertility module was also used to impute for invalid mother alive responses.

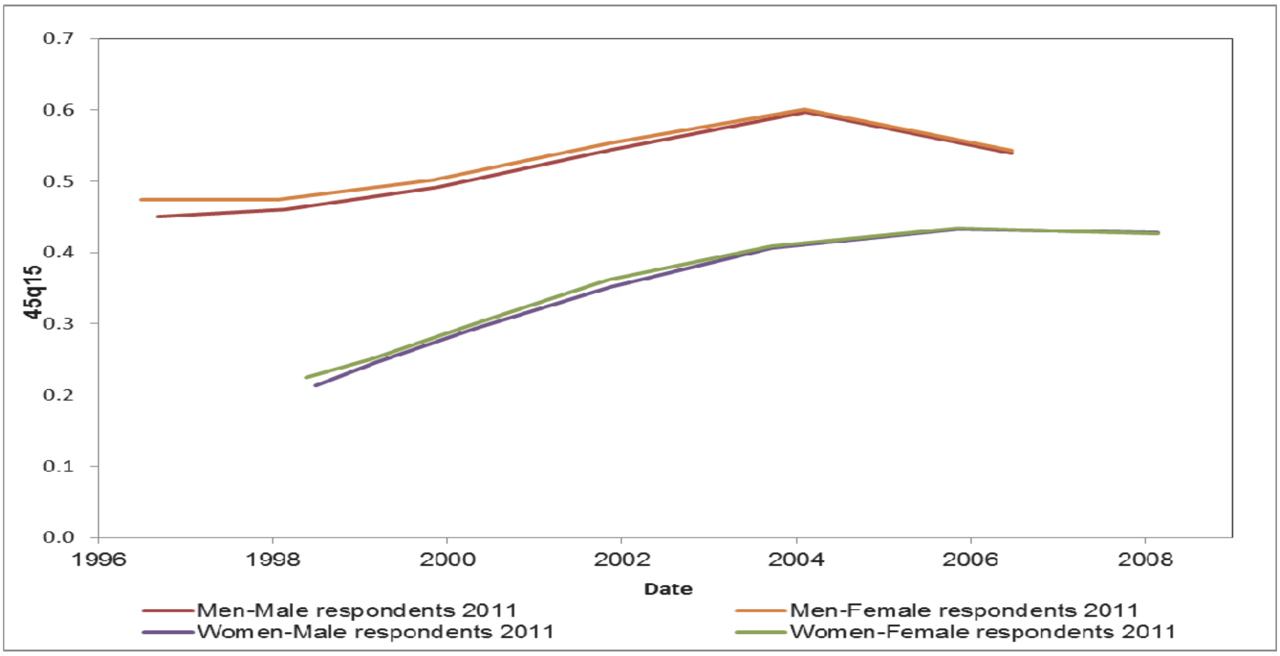
2.3.4 Results of data quality assessment

Parental survival status by sex and age

Although the orphanhood questions included in censuses and surveys are relatively simple and do not necessarily require big samples, they also have their challenges. Udjo (2005) highlights that male mortality is exaggerated by an absenteeism effect, wherein fathers who are absent in their children’s lives are reported as dead and therefore overstating male mortality. The adoption effect whereby fostered children report their foster parents (particularly mothers) as their biological parents is likely to result in understatement of female mortality and likely to exaggerate the difference in survival between males and females (Hill and Trussell 1977; Udjo 2005; Robertson et al. 2008; Masquelier 2011). The other weakness of the orphanhood method is that the survival status of parent/s can only be obtained from offspring who themselves are alive at the time of the census (Hill and Trussell 1977). The relative dependency between parent and child's mortality in the context of HIV/AIDS is therefore problematic. The method can only provide broad estimates of the overall level of adult mortality, not detailed schedules of age specific death rates and estimates at sub-national level may be biased due to interprovincial migration e.g. the parent whose survivorship is reported may not necessarily be residing in the same province as the respondent (Dorrington, Timæus et al. 2004).

In this monograph, the analysis of orphanhood status is done in order to check the plausibility of the data by comparing with established patterns. The proportion of respondents whose mother or father's survival status was unspecified was 1,4% and 3,6% respectively, and this is regarded as small enough to cause insignificant effects on the estimates. Figure 2.4 below shows that reporting of father and mother survival only slightly differ by sex of the respondent suggesting good quality of age and mortality data in 2011. Estimates of the patterns of mortality for the intercensal period in the subsequent chapters would further provide a sense of the quality of the data. Regarding the difference in survival by sex; men have a significantly lower survival prognosis than women and this is consistent across ages as expected.

Figure 2.4: Trends in the probability of dying between exact ages 15 and 60 estimated for males and females by sex of the respondent, 2011



Lifetime fertility and survival of children

The Brass technique has undergone further developments to improve the technique. The method is premised on the fact that the probability of death is a product of the proportion of deaths amongst children ever born to women in each age group (reproductive ages) with multipliers which adjust for non-mortality factors (from a Life table) represented by the equation from UN (1983):

$$q_x = D_i k_i \qquad (1)$$

Where:

q_x = is the probability of dying between birth and exact age x

D_i = is the proportion of deaths among children ever born to women in age group *i*

k_i = is a multiplier that adjusts for non-mortality factors determining the value of D_i

The main source of error with regards to input data for application of this method include the underreporting of total number of children ever born and children dead by the women, as well as the over-reporting of children surviving. According to Brass the probability of dying should increase with the mother's age as a result of increasing exposure to the risk of dying for the children. Table 2.5 shows results for children (both sexes) reported by women of reproductive ages. The disaggregation by sex, however, showed implausible patterns and are not shown here. Column 2 in the table shows the number of women who did not specify their parity while the third column shows women with parity inconsistent with the mother's age. Columns 9 and 10 should be consistent depending on the quality of data. Column 11 is the ratio between the aforementioned columns showing the inconsistency between the reported children dead and those derived from children ever born and surviving. As evident in Table 2.5, there is discordancy in the reported number of children dead by age of the mother and that derived from the children ever born and surviving, shown by a ratio which is not unity (Column 11). Although there is an increase in the probability of dying, the increase is not in a strictly monotonic way. This may reveal some shortcomings with the data i.e. underreporting of dead children or overstatement of surviving children.

Table 2.5: Lifetime fertility and survival of children

Age group	Women	Parity unstated*	Children inconsistent with mother's age	Consistent	Total Children Ever Born (TCEB)	Total Children Living in the Household	Total Children Living Elsewhere	Total Children Surviving (TCS) (6+7)	Total Children Dead	TCEB-TCS (5-8)	Ratio (8/9)	Probability of death
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
15-19	2 450 558	582 689	6 553	1 861 316	383 871	329 072	40 342	369 414	12 593	14 457	0,9	0,04
20-24	2 612 782	311 077	8 798	2 292 907	1 760 735	1 384 629	288 368	1 672 997	58 926	87 738	0,7	0,05
25-29	2 482 425	166 272	6 725	2 309 428	3 070 652	2 301 109	601 398	2 902 507	107 139	168 145	0,6	0,05
30-34	1 972 270	91 585	3 407	1 877 278	3 505 566	2 640 888	658 269	3 299 157	125 658	206 409	0,6	0,06
35-39	1 742 722	63 123	2 061	1 677 538	3 981 636	2 997 915	740 550	3 738 465	148 028	243 171	0,6	0,06
40-44	1 532 074	49 734	1 073	1 481 267	4 121 782	2 916 435	921 877	3 838 312	178 356	283 470	0,6	0,07
45-49	1 411 631	49 657	686	1 361 288	4 171 242	2 587 659	1 234 318	3 821 977	241 165	349 265	0,7	0,08
Total	**14 204 462**	**1 314 137**	**29 303**	**12 861 022**	**20 995 484**	**15 157 707**	**4 485 122**	**19 642 829**	**871 865**	**1 352 655**	**0,6**	

*Before applying the el-Badry correction

2.4 Conclusion

This chapter provided an assessment of mortality information collected from household deaths in the 12 months preceding the census, data on parental survival as well as summary birth histories. Part of the assessment formed the revision of the household deaths. The fraction of data missing and the imputation rates are relatively low. The data also showed expected patterns except that on summary birth histories by sex. While not free from reporting errors, the data on parental survival, household deaths and summary birth histories for both sexes may be usable.

Chapter 3: Numbers of deaths

3.1 Introduction

This section provides analysis of the unadjusted Census 2011 mortality data.

3.2 Census 2011 mortality tables

Tables 3.1 and 3.2 show the mortality data at household level, indicating which households reported a death in the 12 months before the census. The two tables are not consistent with the subsequent tables because households may report more than one death. Table 31 shows that 432 650 households reported a death in the last 12 months preceding the census. Interestingly, 28 571 households did not know whether there was a death in the household. The absolute number of deaths cannot be compared across provinces because mortality levels are affected by the population size and the age distribution of the population. Readers are cautioned that numbers may slightly differ between tables because of rounding.

KwaZulu-Natal reported the highest number of deaths (109 767), which is consistent with previous mortality patterns in the country. The majority of households reported between a single and four deaths.

Table 3.1: Number of households reporting death occurrences by province, 2011

Province	Yes	No	Do not know	Total
Western Cape	32 166	1 598 605	3 154	**1 633 925**
Eastern Cape	72 199	1 612 447	2 697	**1 687 344**
Northern Cape	11 240	289 613	547	**301 400**
Free State	33 211	788 523	1 551	**823 285**
KwaZulu-Natal	99 641	2 435 052	4 644	**2 539 336**
North West	34 971	1 024 772	2 256	**1 061 998**
Gauteng	74 779	3 824 209	9 839	**3 908 826**
Mpumalanga	35 483	1 038 153	1 830	**1 075 466**
Limpopo	38 961	1 377 070	2 054	**1 418 085**
South Africa	**432 650**	**13 988 444**	**28 571**	**14 449 665**

Table 3.2: Number of deaths by province

Number of deaths reported by households	WC	EC	NC	FS	KZN	NW	GP	MP	LP	RSA
1	31 744	69 946	10 685	31 589	93 939	33 282	73 681	33 746	37 505	**416 118**
2	1 969	8 178	1 154	3 356	13 075	3 782	6 016	3 637	3 046	**44 213**
3	246	862	117	418	1 704	452	840	340	228	**5 206**
4	56	238	59	113	813	160	207	168	82	**1 897**
5	0	61	5	22	96	17	37	18	17	**271**
6	0	45	6	19	118	13	41	27	8	**277**
7	11	0	0	10	0	0	16	0	0	**37**
8	0	0	8	8	23	0	0	8	0	**47**
Total	**34 025**	**79 330**	**12 033**	**35 535**	**109 767**	**37 705**	**80 838**	**37 944**	**40 887**	**468 065**

Table 3.3 below shows the number of deaths by month and year. Most deaths (63 290) were recorded in October, the month of enumeration compared to the next highest number of deaths, 45 668 in September; this trend has also been observed with other censuses elsewhere.

Table 3.3: Month and year of birth

	Year		
Month	**2010**	**2011**	**Total**
January		29 464	**29 464**
February		30 629	**30 629**
March		33 096	**33 096**
April		33 718	**33 718**
May		33 238	**33 238**
June		44 237	**44 237**
July		39 277	**39 277**
August		38 347	**38 347**
September		45 668	**45 668**
October	36 052	27 238	**63 290**
November	37 601		**37 601**
December	39 503		**39 503**
Total	**113 156**	**354 912**	**468 068**

Figure 3.1 show the distribution of deaths by age and sex. The unspecified age and sex are distributed proportionally across age groups. As expected, mortality for male infants is higher than that of their female counterparts. Mortality for youth is higher for females compared to males while the inverse is seen in the older adulthood ages.

Figure 3.1: Age and sex distribution of deaths, 2011

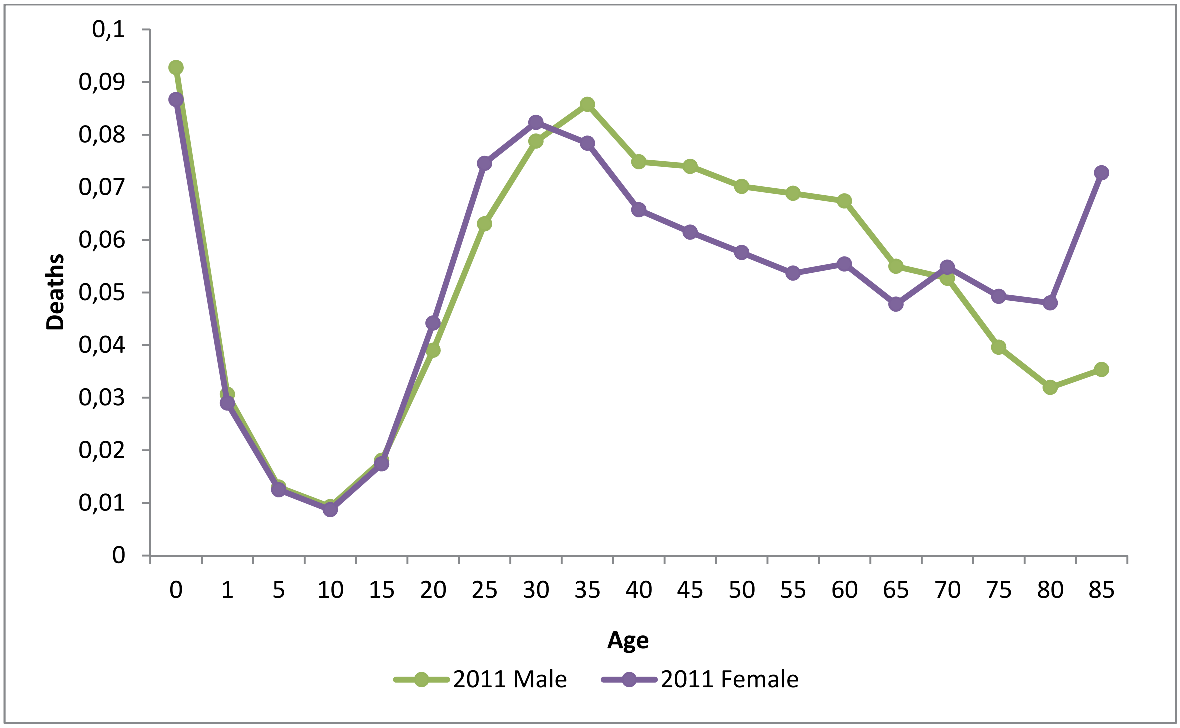


Figure 3.2 below shows the distribution of observed deaths by population group. The black African population shows the highest level of mortality of all the population groups and across all the ages (except after age 65). The mortality distribution of the whites and the Indian/Asian population groups is the lowest. “Other”, a valid population group category in Census 2011, is not included.

Figure 3.2: Distribution of deaths by population group

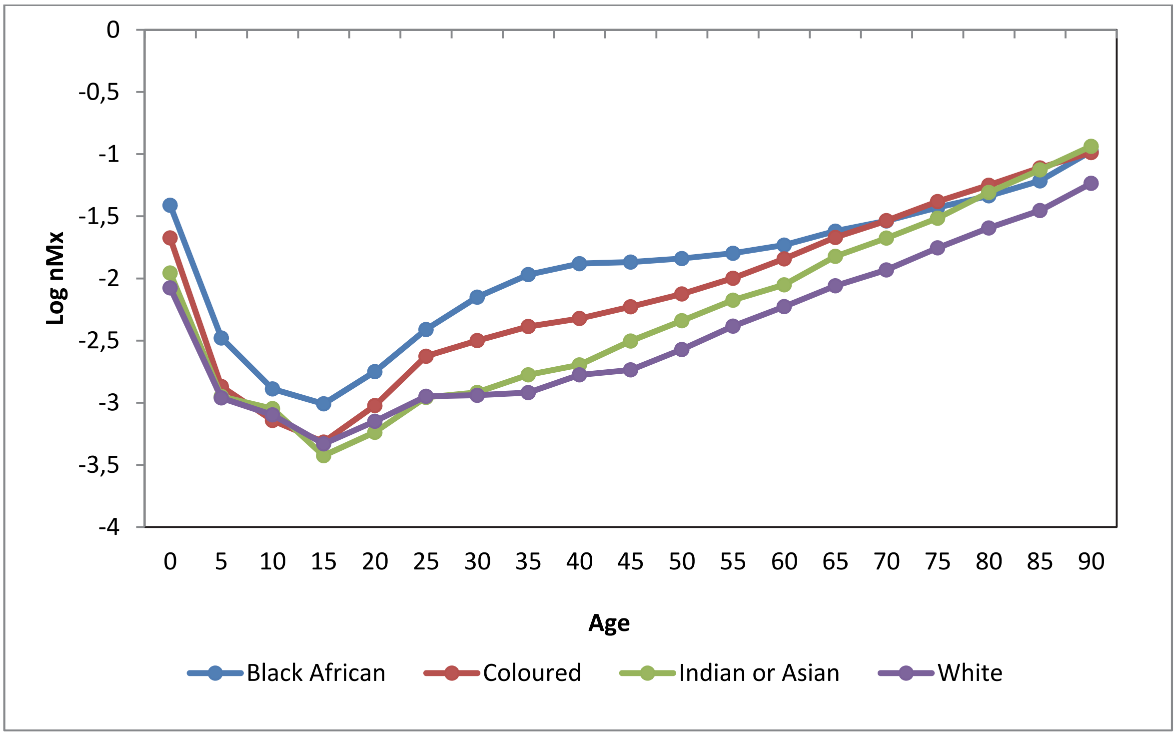


Figure 3.3 shows that the majority of deaths were due to natural causes of death, with the males having more than double the number of female deaths due to unnatural causes.

Figure 3.3: Causes of deaths, 2011

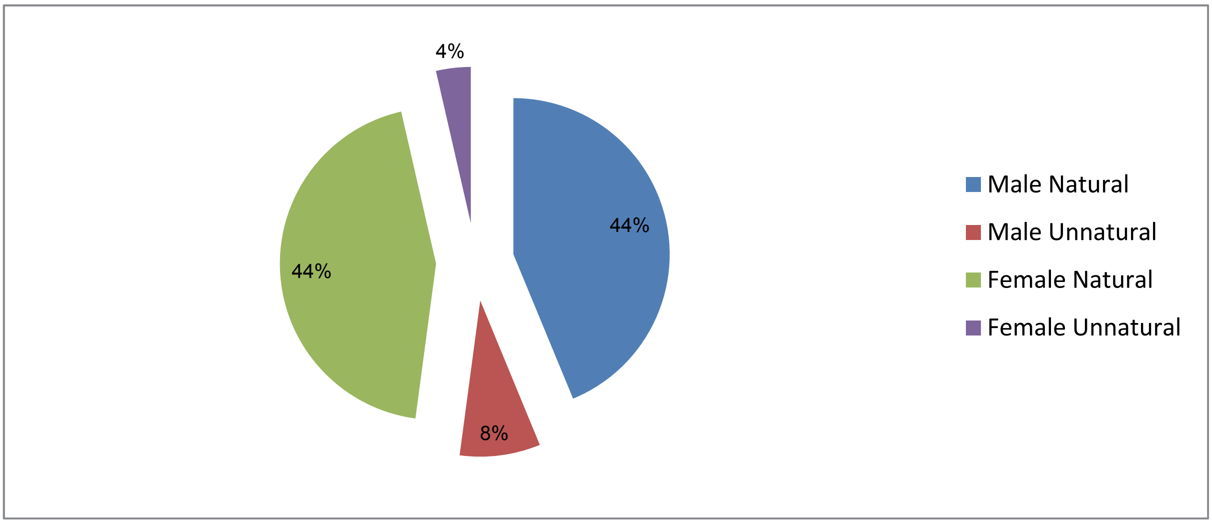


Table 3.4 below shows the distribution of pregnancy-related deaths by age of the woman. Female deaths with unspecified response on the pregnancy-related questions are high (approximately 17 per cent of the total reported deaths for females of reproductive age).

Table 3.4: Distribution of pregnancy-related deaths by age

Age	Yes	No	Do not know	Unspecified	Total
10-14	46	652	1	226	**925**
15-19	379	2 155	12	560	**3 106**
20-24	916	5 600	17	1 299	**7 832**
25-29	1 319	9 751	40	2 111	**13 221**
30-34	1 197	10 885	47	2 435	**14 565**
35-39	865	10 489	41	2 293	**13 689**
40-44	514	8 856	23	1 998	**11 390**
45-49	360	8 335	24	1 880	**10 599**
50-54	71	1 646	3	473	**2 194**
Total	**5 667**	**58 370**	**208**	**13 275**	**77 520**

Chapter 4: Mortality estimates

4.1 Introduction

The chapter starts with a discussion on population estimates and the rest of the section provides a discussion of both child and adult mortality estimates and life expectancy, and disability-free life expectancy for older adults.

4.2 Population estimates

The population estimates provide the denominator for estimation of mortality. In the monograph the population for both 2001 and 2011 are used. The change in the size of the population between 2001 and 2011 should be explained by the following demographic equation:

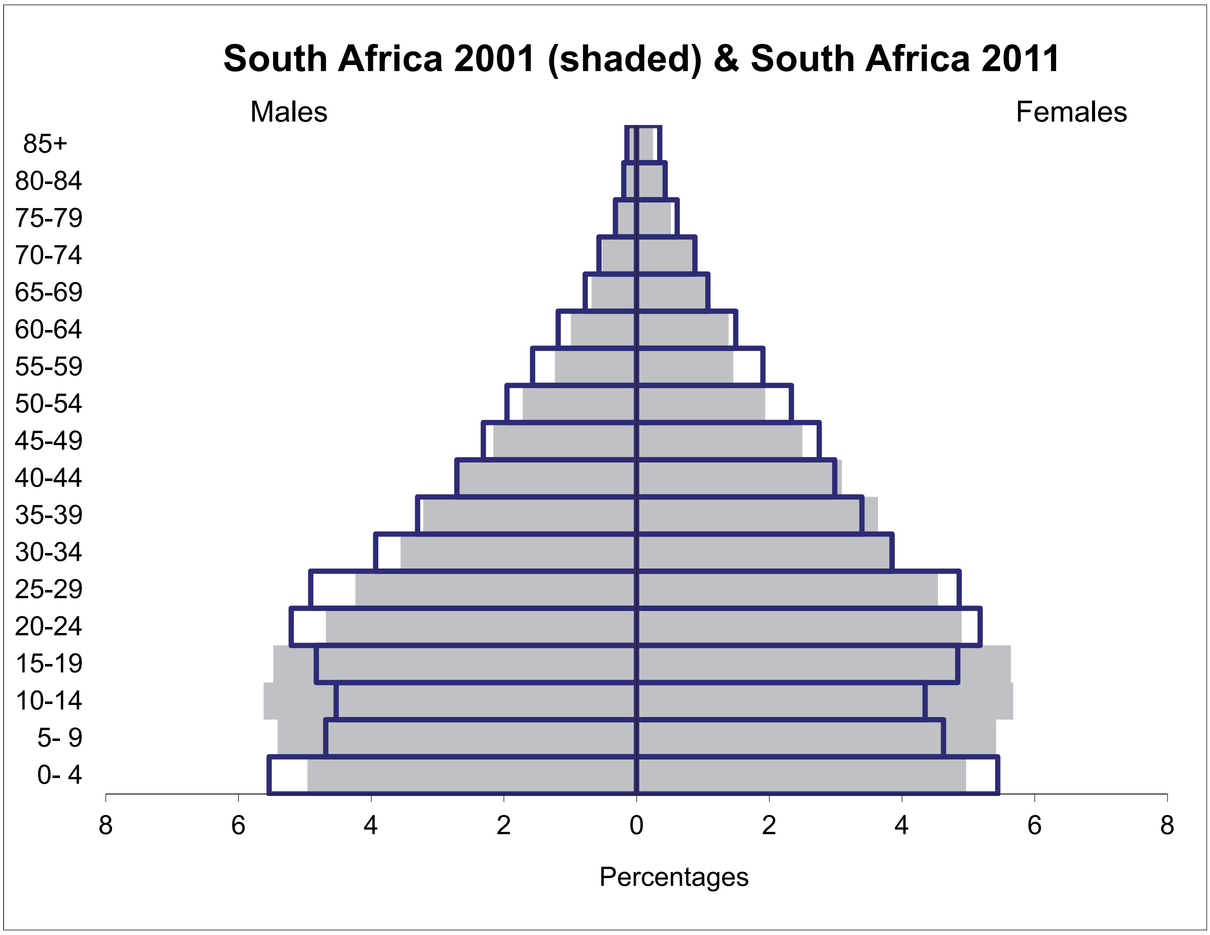
$$P(T) = P(0) + B[0,T] + D[0,T] + I[0,T] - O[0,T] \qquad (2)$$

Where

$P(T)$	= number of persons alive at time T (2011)
$P(0)$	= number of persons alive at time 0 (2001)
$B[0,T]$	= number of births between time 0 and T (2001 and 2011)
$D[0,T]$	= number of deaths between time 0 and T (2001 and 2011)
$I[0,T]$	= number of in-migrants between time 0 and T (2001 and 2011)
$O[0,T]$	= number of out-migrants between time 0 and T (2001 and 2011)

In the monograph, the population is not adjusted, except for the births in the last 12 months which are used as the denominator for direct estimation of IMR and MMR. The births were adjusted first by using the el-Badry correction to apportion women with missing number of children between the estimated true missing and those who were actually childless (El-Badry 1961), and then the relational Gompertz model was also used to adjust and correct for fertility distributions derived from reports on births in the 12 months preceding the census. For provincial estimates the relational Gomperzt model was used for all the provinces except for Western Cape, where the Feeney variant of the Brass P/F ratio was used, although the two methods did not yield significantly different estimates. For population group estimates, the relational Gompertz model was used for the black African and the coloured populations while the Feeney variant was used for the white and Indian/Asian population groups. Figure 4.1 provides for the age structure of the 2001 and 2011 population.

Figure 4.1: Distribution of population by age and sex, Censuses 2001 and 2011



4.3 Assessing completeness of reported household deaths

4.3.1 Assessing completeness of intercensal deaths

In the monograph the intercensal survival methods, the Generalised Growth Balance (GGB) method (Hill 1987) and the Synthetic Extinct Generation (SEG) method, Bennett-Horiuchi (1981) are used to estimate the completeness of deaths, which eliminates the assumption of a stable population from the previous death distribution methods. The programs available on International Union for the Scientific Study of Population (IUSSP) (Moultrie 2013) were used. Deaths and population from Censuses 2001 and 2011 disaggregated into five-year age groups were used to provide an intercensal completeness estimate. Table 4.1 below shows the completeness of intercensal household deaths by method used. Interestingly, there is not much difference for male deaths completeness by method used but for females. The estimated completeness for females using the SEG+GGB is striking for females (89 per cent from 65 and 57 per cent for GGB and SEG respectively). Also notable are the differences between the completeness for males and females across the methods.

Table 4.1: Estimated completeness of reported household deaths, intercensal deaths

	GGB	SEG	SEG+GGB
Male	74	69	72
Female	65	57	89
Total	**70**	**63**	**81**

4.3.2 Assessing completeness of deaths 12 months before the census

Deaths at age zero are assumed to be complete and possible exaggeration due to possible reporting of stillbirths assumed to be insignificant. The assumption for completeness at age zero is consistent with the research that a survey can validate the vital registration deaths by enabling calculation of a fraction for adjusting the incomplete registered deaths (Becker et al. 1996). The reported 42 055 is also comparable to the 41 164 from the UN IGME's estimate (United Nations Children's Fund 2014). The published vital registration deaths completeness (South Africa Department of Health 2011, Stats SA 2014a) is used to provide an adjustment factor for the Census 2011 adult deaths and also provide an estimate for adulthood mortality, which are used together with child deaths to derive the mortality of the entire population using COMBIN, a program from MORTPAK.

4.4 Mortality indicators

4.4.1 Childhood mortality

Success in reducing mortality is associated with improvement in the well-being of a population and in particular, childhood mortality is often regarded as a sensitive indicator of socio-economic development. The MDG 4 focuses on reducing mortality of under-fives, (by two-thirds, between 1990 and 2015). With the deadline of the MDG approaching, estimates of childhood mortality are critical for monitoring the country's progress.

Estimating childhood mortality: direct methods

The births are derived from question P-38 (Figure 2.3) which asks the date of birth of the last child born. All the dates were provided for whose child was the last and only births that occurred between 10 October 2010 and 9 October 2011 were extracted for calculation of IMR q(1). The same applied for deaths, asked in question P-41. The births were then adjusted, first by applying the el-Badry correction for the misreporting of childless women as parity not stated (El-Badry 1961) and then using the relational Gomperzt model to adjust and correct the distribution of births.

The formula used for calculating IMR is as follows:

$$IMR = \frac{D}{B}k \qquad (3)$$

Where

B = the number of live births (adjusted)

D = the number of deaths before age one

k = constant usually 1 000

The result was an IMR of 35 deaths per 1 000 live births, comparable to the estimate from the indirect estimation from children born and surviving and other sources (section 4.4.3 below).

IMR at sub-national level

The reported household deaths and adjusted births, both for age zero and disaggregated by province, were used to estimate the IMR by province (Figure 4.2) and district (Figure 4.3) for 2010. Figure 4.2 shows that Free State has the highest IMR and this is consistent with vital registration data. The Western Cape and Gauteng provinces have the lowest IMR per 1 000 live births compared to other provinces. All metropolitan municipalities reported lower IMR relative to other districts within their respective provinces. Zululand and Thabo Mofutsanyane districts have the highest IMR in the country.

Figure 4.2: IMR by province

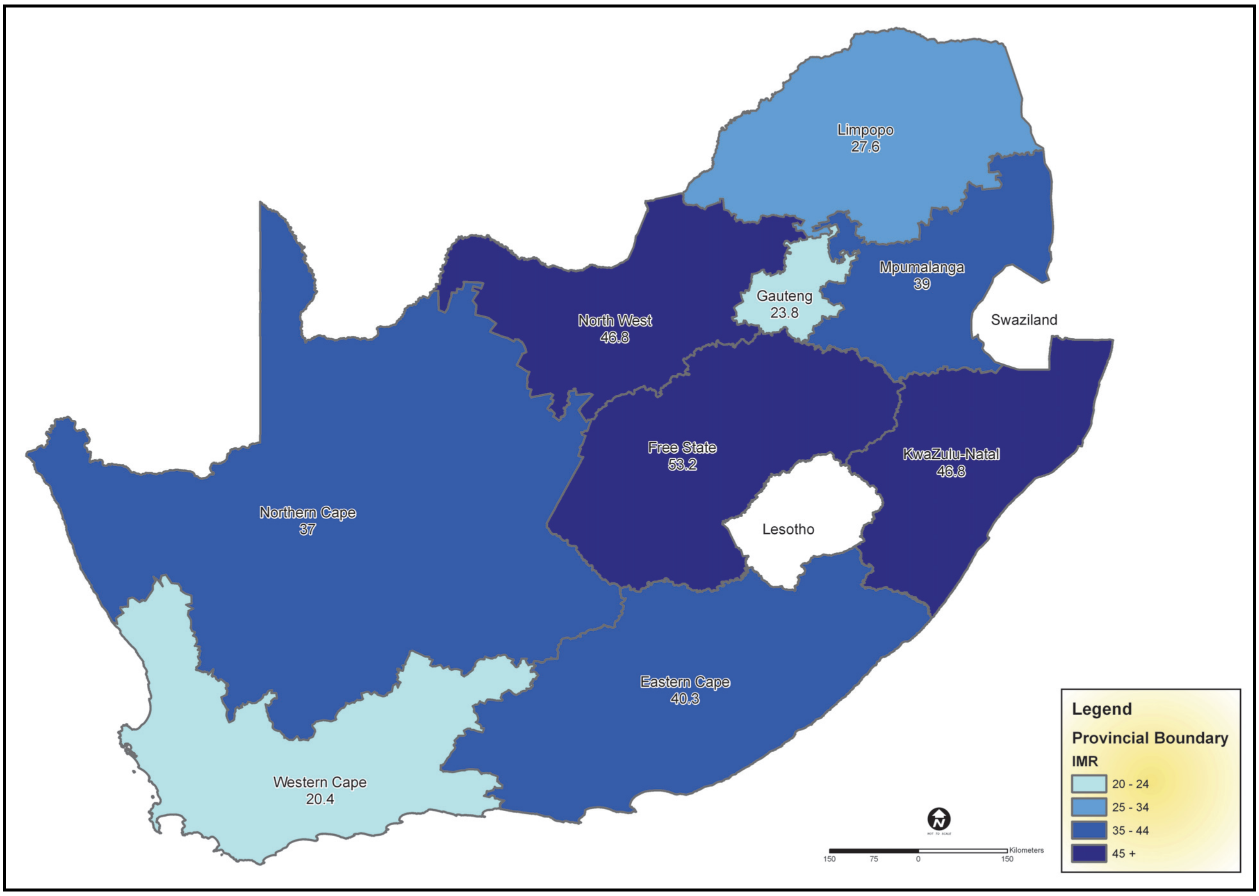
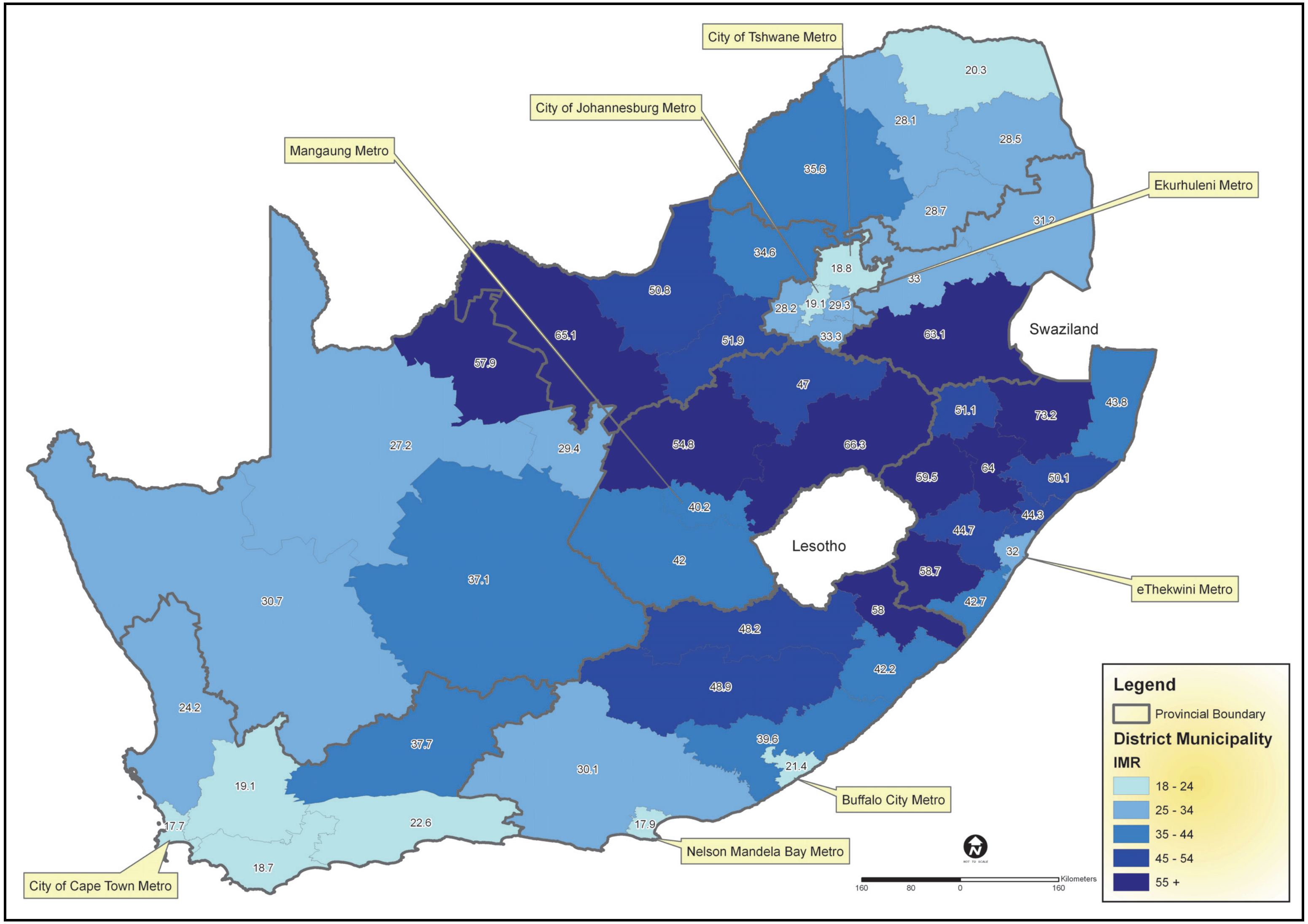


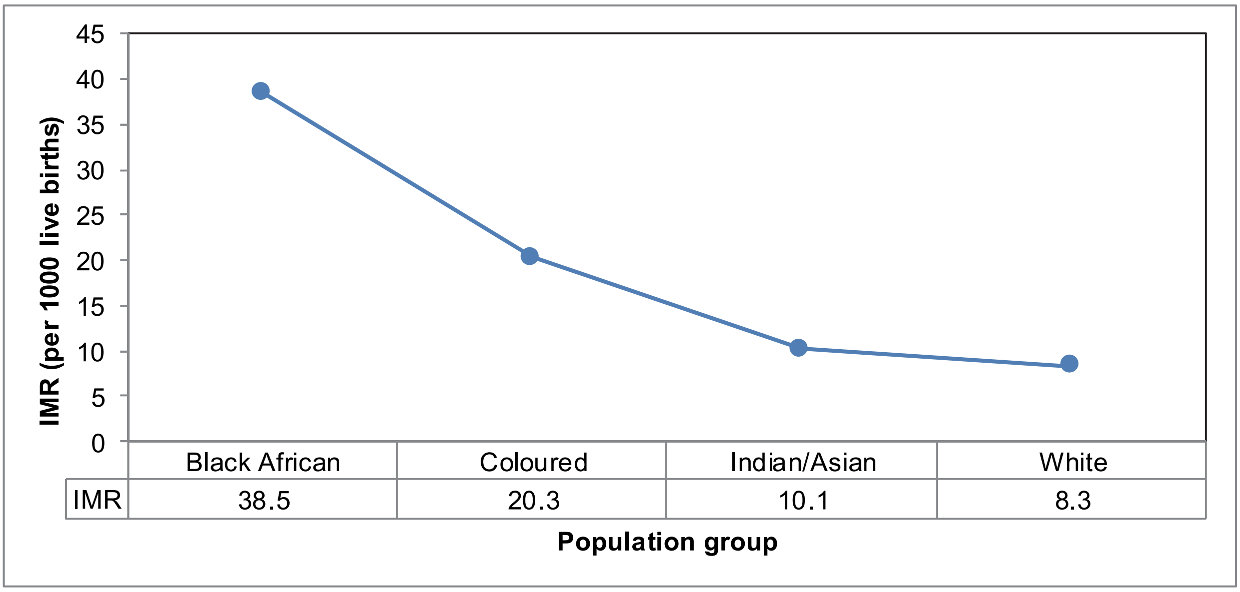
Figure 4.3: IMR by district municipality



IMR by population group

The reported household deaths and adjusted births, both for age zero and disaggregated by population group, were used to estimate the IMR by population group (Figure 4.4). Results show that the IMR for black Africans is the highest, followed by that of the coloured population group while the white population group has the lowest IMR, which is consistent with literature regarding the dynamics of the different population groups in the country.

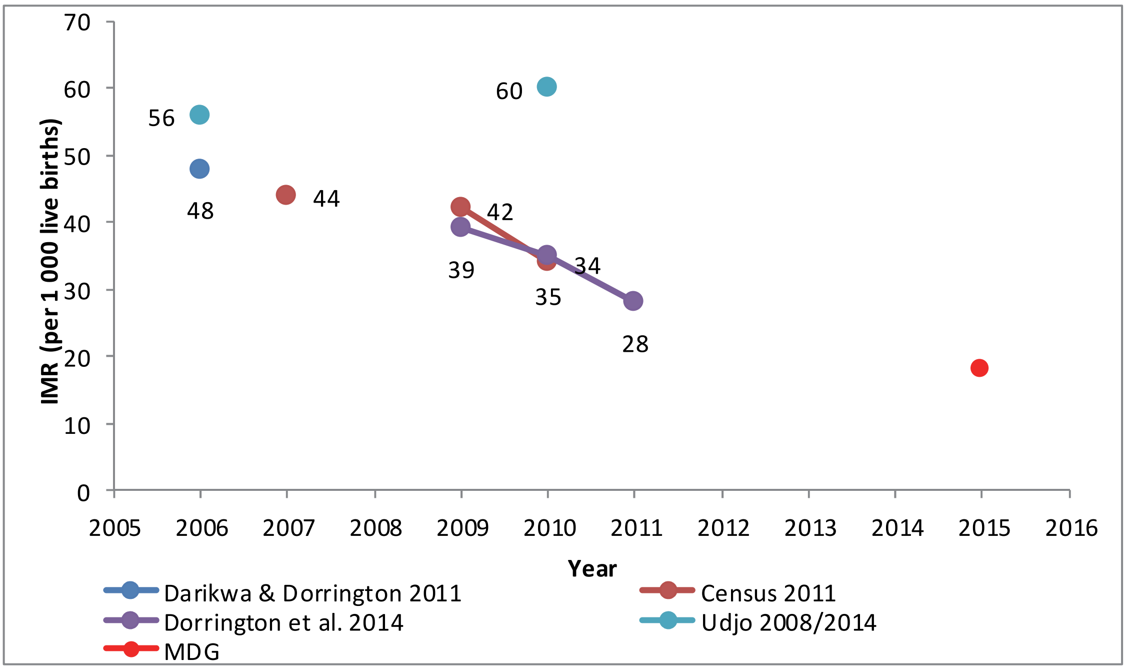
Figure 4.4: IMR by population group



Estimating childhood mortality: Indirect methods

Using the Brass technique of children ever born and children surviving, in 2010 the IMR was estimated to be 34 per 1 000 live births (Figure 4.5). The results also show declining IMR.

Figure 4.5: IMR estimates by source of data and year



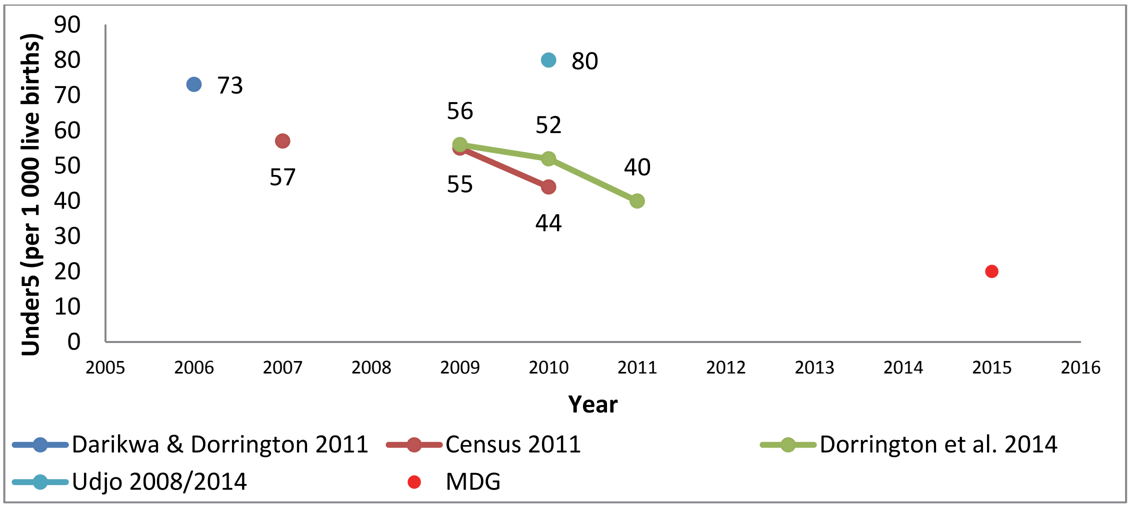
Indirect methods and direct methods on IMR

The indirect techniques for demographic estimation were mainly developed to aid demographers to evaluate and compute demographic estimates, particularly from data that are incomplete or deficient. The comparable IMR estimates from the direct and indirect methods in the monograph is worth further research to check if violations of the assumptions in the indirect estimation of child mortality is yielding implausible estimates, or whether the results are encouraging that the mortality data was complete at age 0 especially considering that the estimates are comparable to other sources.

Estimating childhood mortality: Indirect methods

Figure 4.6 shows the Under-5 mortality (q5) from the Brass technique, estimated to be 44 per 1 000 live births in 2010 which is relatively low compared with estimates from other sources. From a computed life table using Census 2011 data, the Under-5 mortality rate was 47, 48 and 48 per 1 000 live births for males, females and both sexes respectively.

Figure 4.6: Under-5 estimates by source of data and year



4.4.2 Adult mortality

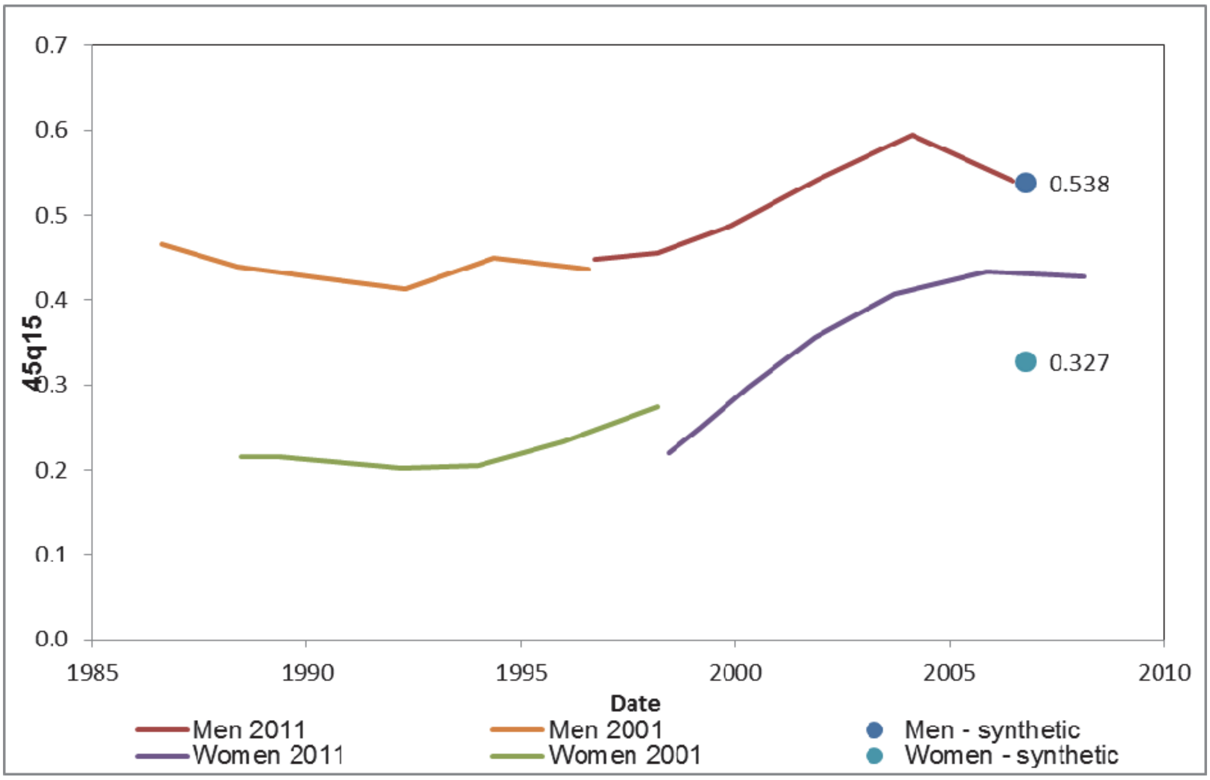
There have been renewed interest in research on adult mortality in Southern Africa in particular, a region which has been disproportionately affected by the HIV/AIDS scourge. Reniers et al. (2010) however, argue: "… the relatively high adult mortality levels in Southern Africa are the result of the triple burden of resurgent or persistent infections, the diseases of 'modernity,' and high death rates from external injuries".

Indirect estimation of adult mortality from parental survival data

The orphanhood data from Censuses 2001 and 2011 are used for analysis in this section. The input data is parental survival by sex and age and mean age at child bearing obtained from the fraction of the population married and number of children born in the last 12 months. The parental survival information was obtained from questions P−14 and P−15 (Figure 2.2).

The pattern of mortality is consistent with vital registration data and other sources (Figure 4.7) notwithstanding the inconsistencies for the two periods, i.e. the inconsistencies for women's mortality between the youngest and the oldest respondents and the implausibly low estimate for women. The results show the gains in mortality towards the late 1980s for both males and females over time until around the mid-1990s, where there are signs of reversals in mortality gains, with the increase in mortality sharper for males than it is for females. There are differences in survival for females and males, with the latter consistently higher although the differences get narrower with time. The sharp increase in both male and female mortality is consistent with vital registration data although the stalling of female mortality from 2004 appears to be earlier than suggested in the vital registration data. The orphanhood data for the two censuses provide an estimate of the average probability of dying in adulthood for the intervening period (estimated to be around 2007 expected to be the peak of mortality in the country) for respondents older than 15 years shown by the synthetic points on the graph. The average probability of dying in adulthood (45q15) in the intervening period is approximately 54 per cent and 33 per cent for males and females respectively, and mortality differential by sex is striking.

Figure 4.7: Trends in the probability of dying between ages 15 and 60 estimated from orphanhood data, Censuses 2001 and 2011



Adult mortality from different sources

In the intercensal period, the adult mortality was approximately 50 per cent for males and ranged between 42 and 45 per cent for females (Table 4.2). In 2010 the probability of dying declined to 44 and 31 per cent for males and females respectively; the decline is expected because mortality has gone down and the intercensal periods include peak periods for mortality. The female adult mortality in 2007 is implausibly low compared with the observed trends in adult mortality.

Table 4.2: Estimated probabilities of dying between ages 15 and 60

Method/source	Year	Male	Female	Both sexes
Orphanhood method	2007	0,538	0,327	0,433
GGB	2001-2011	0,492	0,418	0,455
SEG	2001-2011	0,504	0,449	0,477
GGB+SEG	2001-2011	0,499	0,445	0,472
Life table	2010	0,436	0,312	0,374

4.4.3 Maternal mortality

MMR was calculated using direct methods with the numerator adjusted for incompleteness and denominator also adjusted. The deaths used as the enumerator were obtained from pregnancy-related deaths from questions M−06 to M−08 (Figure 2.1) and the denominator is births in the last 12 months (see 4.2 for source of births). The unspecified deaths for pregnancy related questions were not included in the analysis on the assumption that the responses for "No" were sometimes left as blank during data collection. The unspecified deaths constituted a substantial proportion; they were more than the reported pregnancy-related deaths. The fraction to adjust for maternal deaths was derived from the average completeness of adult deaths on the assumption that the completeness of the household deaths is the same as that of the causes of death. The formula is represented here:

$$MMR = \frac{D}{B}k \qquad (4)$$

Where

D = the number of deaths to females aged 15–49 years

B = the number of live births

k = a constant usually 100 000

Levels of maternal mortality ratios in South Africa remain contested (Udjo and Lalthapersad-Pillay 2014). The issues with measuring maternal mortality include methodological and definitional differences, particularly in the two major sources of data for maternal mortality i.e. vital registration and census or sample surveys. Vital registration data provides the maternal deaths from the causes of deaths whereas the censuses and surveys provide deaths from pregnancy-related questions which may be linked rather to the timing of the deaths. The resultant 580 maternal deaths per 100 000 live births compares with the 613 estimate by Udjo (2014) and seems consistent with the 2007 estimate of 642 from Udjo and Lalthapersad-Pillay (2014). The estimated MMR is very different from the 269 estimated using vital registration data for South Africa by Dorrington et al. 2014.

4.4.4 Life expectancy

Life expectancy is a reflection of the overall mortality of a population. In general, life expectancy has been improving (Dorrington et al. 2012) and this may be attributed to the scale-up of ART. UNAIDS reports that by 2012, about 2,2 million people were accessing HIV treatment while about 87% of HIV+ pregnant women receive ART to reduce the risk of mother to child transmission (PMTCT is offered at 98% of health facilities) in South Africa (UNAIDS 2014).

The life table was constructed from the estimated adult mortality rate and the nMx directly calculated from the reported deaths and adjusted births at age 0. The life expectancy at birth was 55,2 and 60,6 years for males and females respectively, and 57,9 years for both sexes; this is for the 12 months before the census (2010).

4.4.5 Life expectancy and disability-free life expectancy at selected older ages

The disability-free life expectancy is included in the monograph in light of the global acknowledgement of the universality of ageing across the world, and the relationship between chronological age and health. This section of the monograph attempted to estimate the disability-free life expectancy for synthetic cohorts aged 50, 60 and 80 years in 2011 to show the quality of life at older ages. The different ages are informed by the fact that WHO (2014) suggests that while 60 years is internationally recognised as the lowest cut off age for older persons, 50 years is appropriate for sub-Saharan Africa. Eighty years on the other hand is regarded as the oldest of the old. The disability-free life expectancy also known as the Sullivan Index was popularised in his work (Sullivan 1971) and has become widely used for calculating population health because of its robustness, feasibility for cross-sectional data, and that it requires relatively simple input data and is easy to interpret. The method has two components: the mortality and the health components and is an extension of a life table to include the fraction of the population with disability. The health and functionality questions in Census 2011 that asked the degree of difficulty with seeing, hearing, communication, walking, memory and self-care are used for the health component. Some difficulty in at least two of the functional areas or cannot do at all in at least one of the functional areas at the time of the census were used to calculate the proportion of disability among respondents. The following is the formula for disability-free life expectancy:

$$e'_x = \sum (1 - nDP_x) *_n L_x \qquad (5)$$

Where

e'_x = is disability-free life expectancy at time t

D_x = the prevalence of disability in the age interval

P_x = the number of survivors in the age interval at exact age x

${}_nL_x$ = Person Years lived in the age group $x, x+n$

Results show that older females consistently have better survival chances than their male counterparts (Table 4.3). Although there is a notable difference in life expectancy between males and females across ages, the disability-free life expectancy – which is the number of years that the individual expects to live free of disability at a given age – does not differ much between the two. The results suggest that older females have worse health outcomes compared to males.

Table 4.3 Estimated life and disability-free life expectancy at selected older ages, Census 2011

	Life expectancy			Disability-free life expectancy		
Sex	**50 years**	**60 years**	**80 years**	**50 years**	**60 years**	**80 years**
Male	19,4	13,3	4,7	16,1	10,3	2,4
Female	22,6	15,5	5,3	17,2	10,8	2,1
Both sexes	21,0	14,4	5,0	16,7	10,6	2,3

4.6 Conclusion

This section used either direct or indirect estimation techniques (or both) to estimate indicators for child, adult and maternal mortality. The estimation of both child and adult mortality in the country is contested but the bulk of the estimates in this section are largely congruent to estimates published elsewhere.

Chapter 5: Findings, conclusions and recommended further research agenda

5.1 Introduction

This section shows a summary of the main findings. Apart from the mortality indicators, the report also shows the quality of the mortality data collected during the 2011 Census. In the monograph, the mortality data for 2001 and 2010 are used to estimate patterns and trends of mortality in South Africa.

5.2 A synthesis of the main findings

The report shows the completeness of the Census 2011 mortality data relative to the 2001 Census. Male deaths had higher completeness than female deaths. Results show mortality differentials by age, sex, population group and province.

During the period 2001 and 2011, the country experienced an increase and a decline in both child and adult mortality and is consistent using summary birth histories, the orphanhood method and household deaths. Decline in both child (IMR and Under 5) and adult mortality rates has contributed to the increasing life expectancy at birth. The IMR estimates are consistent using direct and indirect methods. The maternal mortality rate remains extremely high at 580 per 100 000 live births which, although consistent with estimates using Census and sample survey data, is starkly different from vital registration estimates. This is partly because of the differences in definition between the two sources of data. The decline in mortality could partly be explained by the increased ART provision in the country. The findings suggest that the country has made significant progress towards achievement of the MDG targets.

The disability-free life expectancy shown for older age groups in the monograph concurs with established knowledge that suggest that females have a higher prognosis of survival but worse health outcomes than their male counterparts.

5.3 Conclusion and recommendations

The monograph has implications for health and the social economic determinants of health. As completeness of data is a barometer for the quality of the data and the reliability of the estimates thereof, efforts at provincial level which is the level at which data collection is co-ordinated – in terms of fieldworker training, logistical and provision of monitoring during data collection – should be proritised for quality data.

5.4 Limitations of the monograph

The estimates provided in this monograph are as accurate as the input data used and the assumptions made in the analysis. No sub-national estimates were done except for IMR where direct estimates were used because of the difficulty in establishing completeness of household deaths at the different levels. The orphanhood method could not be used at sub-national level because of circular migration, which would mean that the parent reported by the child may not necessarily be in the same geographical location as the child.

6. References

Becker, S. &Waheeb, Y. & el-Deeb, B. &Khallaf, N. & Black, R. 1996."Estimating the completeness of under-5 death registration in Egypt." Demography 33(3): 329-339.

Blacker, J. 2004. "The impact of AIDS on adult mortality: evidence from national and regional statistics." AIDS 18(2): S19-26.

Blacker, J. & Brass, W. 2005. "The estimation of infant mortality from proportions dying among births in the past 24 months." Southern African Journal of Demography 10(1/2): 25-42.

Brass, W. 1975. Methods for Estimating Fertility & Mortality from Limited & Defective Data: Based on Seminars Held 16–24 September 1971 at the Centro Latinoamericano de Demograf'ia (CELADE) San Jose`, Costa Rica, Laboratories for Population Statistics: An Occasional Publication.

Darikwa, T. & Dorrington, R. 2011."The Level and Trends of Child Mortality in South Africa, 1996–2006." African Population Studies 25 (1 [Supplement]).

Dorrington, R. & Moultrie, T. &Timæus, I.M. 2004.Estimation of Mortality using the South African Census 2001 Data. Care Monograph No.11. Cape Town University of Cape Town Centre for Actuarial Research.

Dorrington, R. & Bradshaw, D. &Laubscher, R. 2014.Rapid Mortality Surveillance Report 2012. Cape Town: South African Medical Research Council.

El-Badry, M.A. 1961. "Failure of Enumerators to Make Entries of Zero: Errors in Recording Childless Cases in Population Censuses." Journal of the American Statistical Association 56(296): 909-924.

Hallett, T. &Gregson, S. &Kurwa, F. & Garnett, G. &Dube, S. &Chawira, G. & Mason, P &Nyamukapa, C. 2010. "Measuring and correcting biased Child Mortality Statistics in Countries with Generalized Epidemics of HIV infection" Bulletin of the World Health Organization 88(10): 761-768.

Hill, K. &Trussell, J. 1977."Further Developments in Indirect Mortality Estimation." Population Studies 31(2): 313-334.

Hill, K. & You, D. & Choi, Y. 2009. "Death distribution methods for estimating adult mortality: Sensitivity analysis with simulated data errors." Demographic Research 21(9): 235-254.

Khalfani, A. &Zuberi, T. & Bah, S. &Lehohla, P. 2005. Population Statistics.The Demography of South Africa. T. Zuberi, A. Sibanda and E. Udjo. New York, M.E. Sharpe.

Madans, J. & Loeb, M. & Altman, B. 2011. "Measuring disability and monitoring the UN Convention on the Rights of Persons with Disabilities: the work of the Washington Group on Disability Statistics." BMC Public Health 11(4): 1-8.

Masquelier, B. 2011. Model-based Estimates of Adult Mortality in sub-Saharan Africa: Comparisons with Data on Parental and Sibling Survival. Paper for the 6th African Population Conference.

Mathers, C. &Boerma, T. 2010. "Mortality Measurement Matters: Improving Data Collection and Estimation Methods for Child and Adult Mortality." PLoS Med 7(4).

McKerrow, N. &Mulaudzi, M. 2010. Child Mortality in South Africa: Using Exising Data. South African Health Review 2010. S. Fonn and A. Padarath. Durban, Health Systems Trust.

Moultrie, T. & Dorrington, R. & Hill, A. & Hill, K. &Timæus, I. &Zaba, B. 2013. Tools for Demographic Estimation, Paris: International Union for the Scientific Study of Population.

Mutemaringa, T. 2011. Impact of HIV on Estimates of Child Mortality derived using the Summary Birth History (CEB/CS) Method. MPhil University of Cape Town.

Reniers, G. &Masquelier, B. &Gerland, P. 2010. Adult Mortality Trends in Africa: International Handbook of Adult Mortality. R.G. Rogers and E.M. Crimmins, Springer.

Robertson, L. &Gregson, S. &Madanhire, C. & Walker, N. &Mushati, P. & Garnett, G. &Nyamukapa, C. 2008. "Discrepancies between UN models and DHS Survey Estimates of Maternal Orphan Prevalence: Insights from Analyses of Survey Data from Zimbabwe." Sex Transm Infect 84(Suppl 1): i57-i62.

Statistics South Africa (Unpublished). Census 2011 Monitoring and Evaluation.

--- (2012a).Census 2011 Metadata. Pretoria: South Africa.

--- (2012b). Statistical release (Revised): Census 2011. Pretoria, Statistics South Africa.

--- (2012c). Census 2011 Post-enumeration Survey: Results and Methodology. Pretoria. South Africa.

--- (2014a). Mortality and Causes of Death in South Africa, 2011: Findings from Death Notification. Pretoria.

--- (2014b). An Assessment of Household Deaths Collected during Census 2011: A Discussion Document. Pretoria.

--- (2014). Mid-year Population Estimates 2014. Pretoria.

Sullivan, D.F. 1971. "A Single Index of Mortality and Morbidity."Health Services and Mental Health Administration Reports 86(4): 347-354.

Timaeus, I. 1991. "Estimation of Adult Mortality from Orphanhood Before and Since Marriage." Population Studies 45(3): 455-472.

Udjo, E.O. 2005. An Examination of Recent Census and Survey data on Mortality within the Context of HIV/AIDS.The Demography of South Africa. T. Zuberi, A. Sibanda and E. Udjo. London, M.E. Sharpe.

--- (2008)."A Re-Look at Recent Statistics on Mortality in the Context of HIV/AIDS with Particular Reference to South Africa." Current HIV Research 6: 143-151.

--- (2014). "Estimating the Demographic Parameters from the 2011 South African Population Census " Supplement on Population Issues in South Africa 28(1).

UNAIDS. 2014. Global AIDS Response Progress Report 2012 – Republic of South Africa.

Walker, P. & Hill, K. & Zhao, F. 2012. "Child Mortality Estimation:Methods used to Adjust for Bias due to AIDS in Estimating Trends in Under-five Mortality" PLoS Medicine 9(8).

Ward, P. &Zaba, B. 2008."The Effect of HIV on the Estimation of Child Mortality Using the Children Surviving/Children Ever Born Technique." Southern African Journal of Demography 11(1): 39-73.

Shisana, O. &Rehle, T. &Simbayi, L. &Zuma, K. &Jooste, S. &Zungu, N. &Labadarios, D. &Onoya, D. 2014. South African National HIV Prevalence, Incidence and Behaviour Survey, 2012 Cape Town, HSRC Press.

Tollman, S.M. & Kahn, K. & Sartorius, B. &Collinson, M.A. & Clark, S.J. &Garenne, M.L. 2008. "Implications of mortality transition for primary health care in rural South Africa: a population-based surveillance study." Lancet 372(9642): 893-901.

United Nations Childrens' Fund. 2014. Levels & Trends in Child Mortality 2014 Report: Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation. New York.

United Nations. 2013. MORTPAK for WINDOWS (Version 4.3).

7. Appendices

Appendix 1: Number of deaths by municipality (unadjusted)

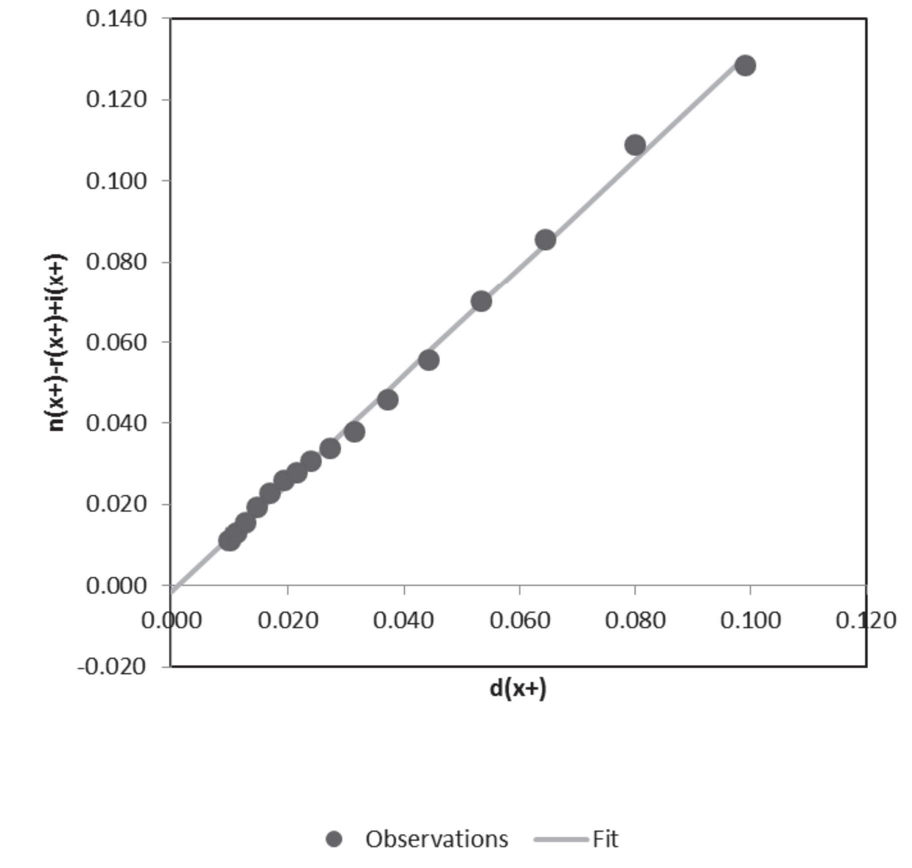
Municipality	Deaths	Municipality	Deaths	Municipality	Deaths	Municipality	Deaths	Municipality	Deaths
Matzikama	518	Emalahleni-EC	2 085	Naledi-FS	363	Uphongolo	1 801	Ekurhuleni	22 492
Cederberg	245	Engcobo	2 205	Masilonyana	880	Nongoma	2 374	City of Johannesburg	26 969
Bergrivier	361	Sakhisizwe	983	Tokologo	334	Ulundi	2 259	City of Tshwane	16 635
Saldanha Bay	569	Elundini	1 963	Tswelopele	679	Umhlabuyalingana	951	Albert Luthuli	2 712
Swartland	656	Senqu	2 069	Matjhabeng	4 990	Jozini	1 237	Msukaligwa	1 675
Witzenberg	621	Maletswai	473	Nala	1 395	The Big 5 False Bay	253	Mkhondo	1 815
Drakenstein	1 339	Gariep	529	Setsoto	1 775	Hlabisa	847	PixleyKaSeme	1 324
Stellenbosch	832	Ngquza Hill	3 351	Dihlabeng	1 498	Mtubatuba	1 827	Lekwa	1 156
Breede Valley	994	Port St Johns	1 522	Nketoana	953	Mfolozi	1 163	Dipaleseng	434
Langeberg	570	Nyandeni	2 956	Maluti a Phofung	5 496	Ntambanana	939	Govan Mbeki	2 537
Swellendam	208	Mhlontlo	2 383	Phumelela	768	uMlalazi	2 624	Victor Khanye	756
Theewaterskloof	491	King SabataDalindyebo	4 551	Mantsopa	710	Mthonjaneni	760	Emalahleni-MP	2 933
Overstrand	549	Matatiele	3 226	Moqhaka	2 043	Mandeni	1 372	Steve Tshwete	1 599
Cape Agulhas	205	Umzimvubu	2 708	Ngwathe	1 585	KwaDukuza	2 144	Emakhazeni	484
Kannaland	200	Mbizana	4 107	Metsimaholo	1 270	Ndwedwe	1 701	Thembisile	3 530
Hessequa	372	Ntabankulu	1 675	Mafube	628	Ingwe	1 373	Dr JS Moroka	2 801
Mossel Bay	504	Nelson Mandela Bay	10 377	Mangaung	8 563	KwaSani	208	ThabaChweu	586
George	1 158	Joe Morolong	1 283	Umzumbe	2 300	Greater Kokstad	434	Mbombela	4 994
Oudtshoorn	708	Ga-Segonyane	1 030	Umuziwabantu	1 354	Ubuhlebezwe	1 378	Umjindi	524
Bitou	355	Gamagara	248	Ezingoleni	745	Umzimkhulu	2 617	Nkomazi	3 382
Knysna	375	Richtersveld	108	Hibiscus Coast	2 743	eThekwini	30 314	Bushbuckridge	4 701
Laingsburg	95	NamaKhoi	430	Emnambithi/Ladysmith	3 012	Moretele	2 306	Greater Giyani	1 709
Prince Albert	105	Kamiesberg	115	Newcastle	4 706	Madibeng	3 868	Greater Letaba	1 997
Beaufort West	449	Hantam	180	Emadlangeni	447	Rustenburg	4 071	Greater Tzaneen	2 907
City of Cape Town	21 548	Karoo Hoogland	99	Dannhauser	1 629	Kgetlengrivier	537	Ba-Phalaborwa	956
Buffalo City	7 507	Khâi-Ma	115	Abaqulusi	2 942	Moses Kotane	2 987	Maruleng	688
Camdeboo	448	Ubuntu	206	uMhlathuze	2 793	Ratlou	1 810	Mutale	485
Blue Crane Route	383	Umsobomvu	367	Nkandla	1 427	Tswaing	1 727	Thulamela	3 578

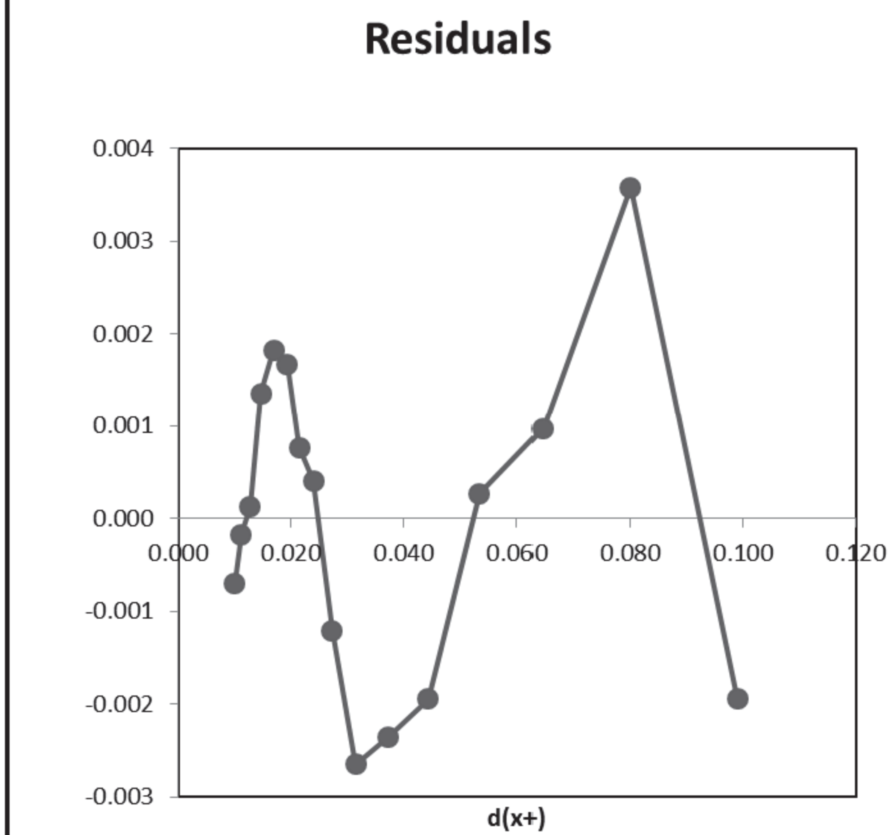
Municipality	Deaths	Municipality	Deaths	Municipality	Deaths	Municipality	Deaths	Municipality	Deaths
Ikwezi	130	Emthanjeni	538	Maphumulo	1 204	Mafikeng	2 878	Musina	230
Makana	831	Kareeberg	147	Vulamehlo	971	Ditsobotla	2 118	Makhado	3 739
Ndlambe	708	Renosterberg	84	Umdoni	747	RamotshereMoiloa	1 669	Blouberg	1 522
Sundays River Valley	493	Thembelihle	205	uMshwathi	1 493	Naledi-NW	676	Aganang	1 619
Baviaans	201	Siyathemba	281	uMngeni	1 006	Mamusa	772	Molemole	1 024
Kouga	770	Siyancuma	435	Mpofana	392	Greater Taung	2 755	Polokwane	4 493
Kou-Kamma	307	Mier	56	Impendle	547	Lekwa-Teemane	725	Lepele-Nkumpi	1 957
Mbhashe	3 429	Kai !Garib	566	The Msunduzi	6 122	Kagisano/Molopo	1 284	Thabazimbi	365
Mnquma	3 967	//KharaHais	871	Mkhambathini	913	Ventersdorp	816	Lephalale	816
Great Kei	474	!Kheis	179	Richmond	800	Tlokwe City Council	1 447	Mookgopong	212
Amahlathi	1 997	Tsantsabane	353	Indaka	1 464	City of Matlosana	4 216	Modimolle	446
Ngqushwa	1 116	Kgatelopele	178	Umtshezi	807	Maquassi Hills	1 040	Bela-Bela	410
Nkonkobe	1 934	Sol Plaatjie	2 275	Okhahlamba	1 904	Emfuleni	6 884	Mogalakwena	3 001
Nxuba	404	Dikgatlong	477	Imbabazane	1 540	Midvaal	684	Ephraim Mogale	1 122
InxubaYethemba	834	Magareng	332	Endumeni	625	Lesedi	964	Elias Motsoaledi	2 471
Tsolwana	527	Phokwane	875	Nqutu	2 488	Mogale City	2 500	Makhuduthamaga	2 129
Inkwanca	327	Letsemeng	452	Msinga	1 801	Randfontein	1 196	Fetakgomo	675
Lukanji	2 873	Kopanong	671	Umvoti	1 132	Westonaria	740	Greater Tubatse	2 335
IntsikaYethu	2 506	Mohokare	482	eDumbe	1 140	Merafong City	1 778	Total	468 067

Appendix 2: Distribution of deaths by age groups in district municipalities (unadjusted)

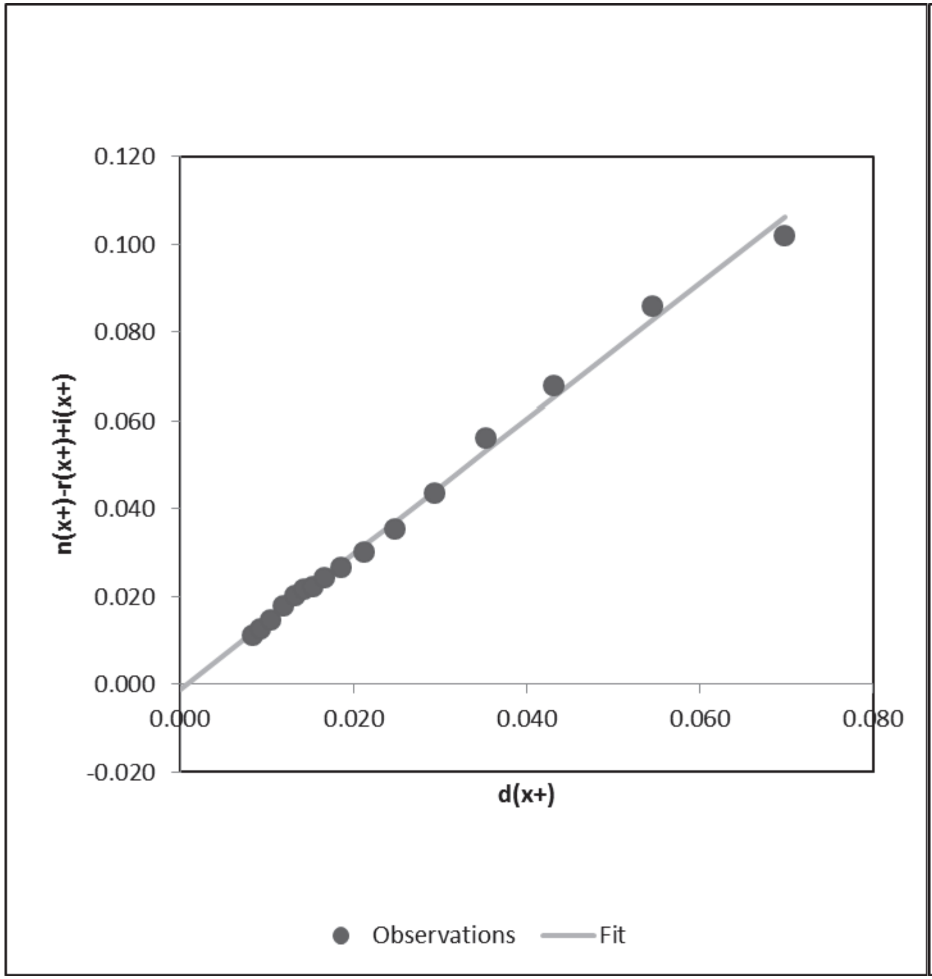
District	0-14	15-49	50-64	65+	Un-specified	Total	District	0-14	15-49	50-64	65+	Un-specified	Total
West Coast	280	692	626	735	15	**2 348**	Uthukela	1 500	4 024	1 320	1 595	287	**8 726**
Cape Winelands	446	1 355	1 064	1 480	11	**4 356**	Umzinyathi	1 206	2 162	629	884	234	**5 115**
Overberg	139	411	337	561	5	**1 453**	Umkhanyakude	1 743	4 254	1 451	1 812	446	**9 706**
Eden	368	1 082	862	1 337	23	**3 672**	Uthungulu	1 098	2 663	920	1 124	205	**6 010**
Central Karoo	80	212	157	193	5	**647**	Sisonke	1 323	2 472	932	1 108	211	**6 046**
City of Cape Town	2 042	7 318	4 818	7 267	104	**21 549**	Amajuba	951	3 225	1 229	1 239	138	**6 782**
Cacadu	409	1 687	887	1 196	91	**4 270**	Zululand	2 286	4 716	1 427	1 679	408	**10 516**
Amathole	1 319	5 546	2 369	3 792	295	**13 321**	iLembe	1 044	3 040	912	1 212	212	**6 420**
Chris Hani	1 260	5 399	2 255	3 095	332	**12 341**	eThekwini Metropolitan	3 821	13 095	5 194	7 037	1 166	**30 313**
Ukhahlamba	609	2 230	911	1 177	107	**5 034**	Bojanala	1 860	5 467	2 596	3 430	418	**13 771**
O.R.Tambo	2 440	6 861	2 169	2 889	404	**14 763**	NgakaModiriMolema	1 497	4 313	1 859	2 267	268	**10 204**
Alfred Nzo	2 034	5 425	1 676	2 247	334	**11 716**	Dr Ruth SegomotsiMompati	1 029	2 575	1 029	1 408	171	**6 212**
Buffalo City	559	3 196	1 552	2 004	197	**7 508**	Dr Kenneth Kaunda	1 147	3 131	1 507	1 556	178	**7 519**
Nelson Mandela Bay	768	4 002	2 397	2 985	226	**10 378**	Sedibeng	975	3 530	1 846	2 038	142	**8 531**
Namakwa	101	298	236	393	21	**1 049**	West Rand	786	2 618	1 290	1 359	160	**6 213**
PixleykaSeme	221	878	525	560	79	**2 263**	Ekurhuleni	3 117	9 380	4 432	5 044	517	**22 490**
Siyanda	264	807	488	576	68	**2 203**	City of Johannesburg	3 207	10 550	5 360	7 051	801	**26 969**
Frances Baard	418	1 569	842	1 006	125	**3 960**	City of Tshwane	2 032	6 120	3 334	4 676	474	**16 636**
John TaoloGaetsewe	468	1 059	438	552	45	**2 562**	GertSibande	2 173	5 454	1 911	1 843	273	**11 654**
Xhariep	216	828	440	441	43	**1 968**	Nkangala	1 582	5 193	2 347	2 641	339	**12 102**
Lejweleputswa	1 145	3 686	1 657	1 605	184	**8 277**	Ehlanzeni	2 428	6 591	2 194	2 684	291	**14 188**
Thabo Mofutsanyane	1 627	5 207	1 975	2 218	174	**11 201**	Mopani	1 305	3 424	1 451	1 908	169	**8 257**
FezileDabi	694	2 267	1 102	1 339	123	**5 525**	Vhembe	1 153	2 805	1 398	2 559	117	**8 032**
Mangaung	993	3 661	1 754	1 957	197	**8 562**	Capricorn	1 468	4 292	1 767	2 901	188	**10 616**
Ugu	1 224	3 937	1 326	2 044	328	**8 859**	Waterberg	882	2 168	850	1 249	101	**5 250**
UMgungundlovu	1 413	5 121	1 970	2 387	383	**11 274**	Greater Sekhukhune	1 345	3 605	1 425	2 184	172	**8 731**
Total	**64 495**	**195 601**	**85 443**	**110 524**	**12 005**	**468 068**	**Total**	**64 495**	**195 601**	**85 443**	**110 524**	**12 005**	**468 068**

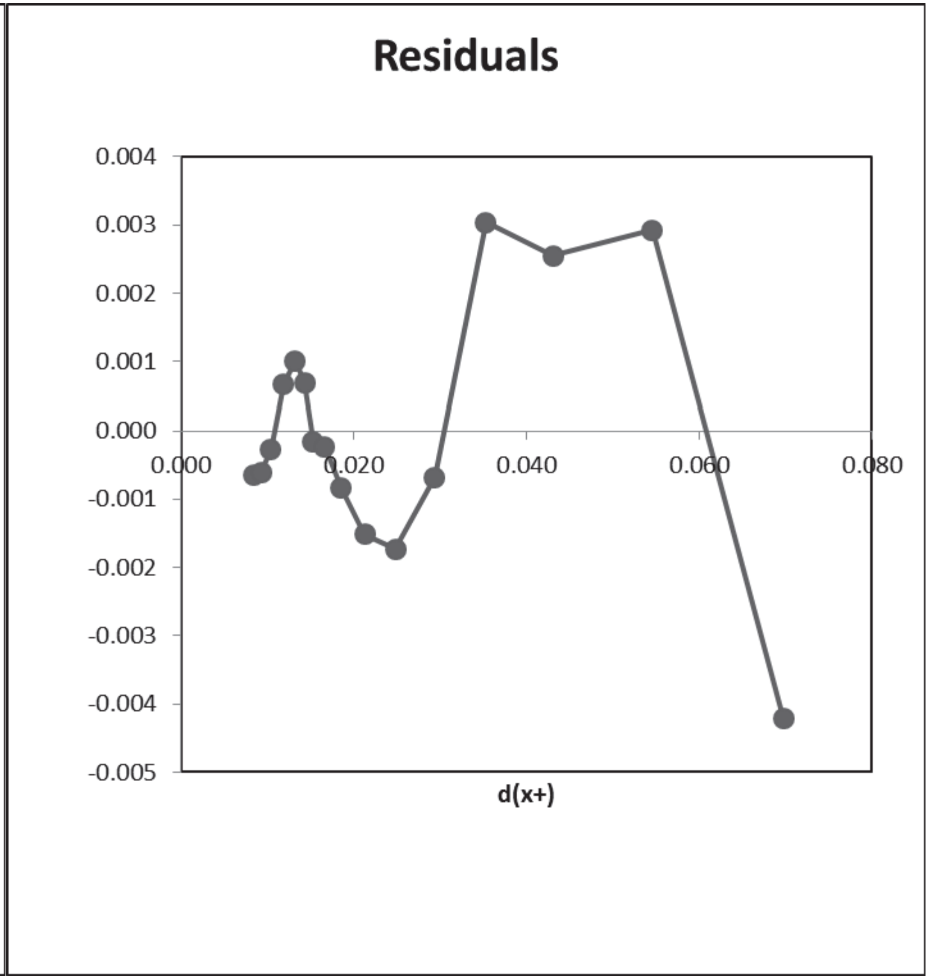
Appendix 3: Diagnostic plots: open interval of 85+, GGB, RSA Males



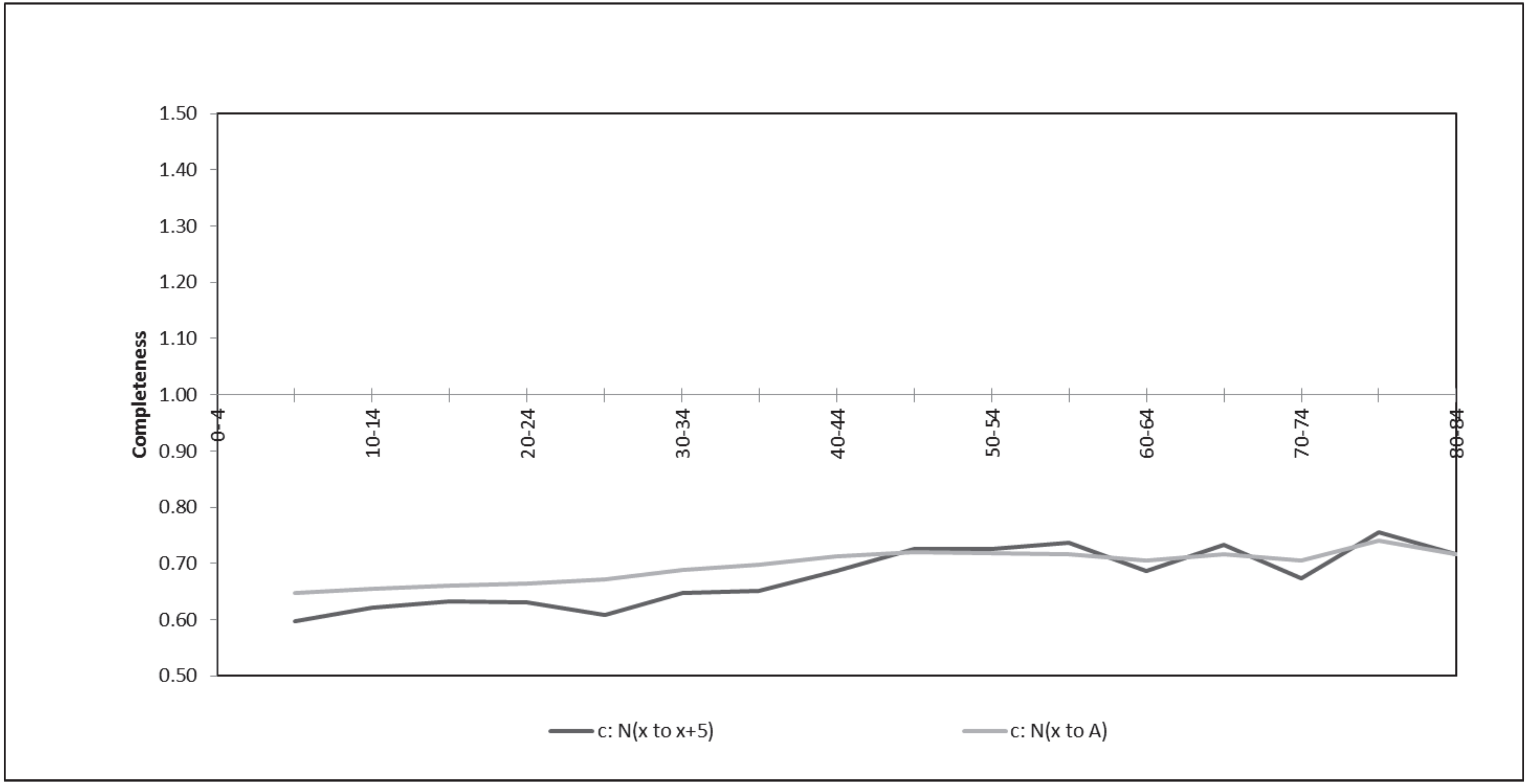


Appendix 4: Diagnostic plots: open interval of 85+, GGB, RSA Females

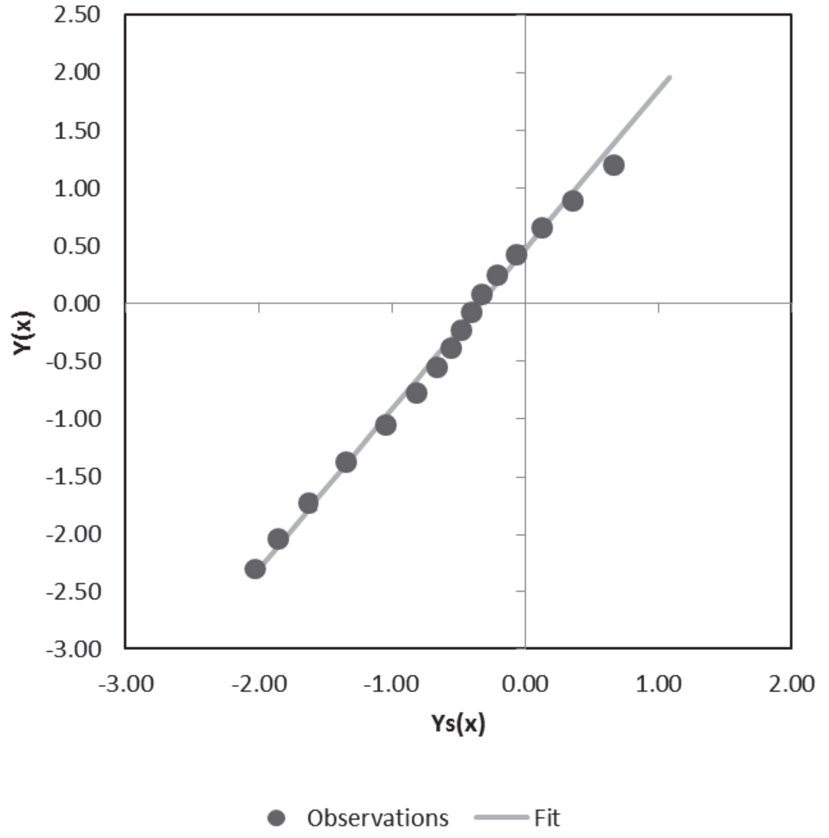


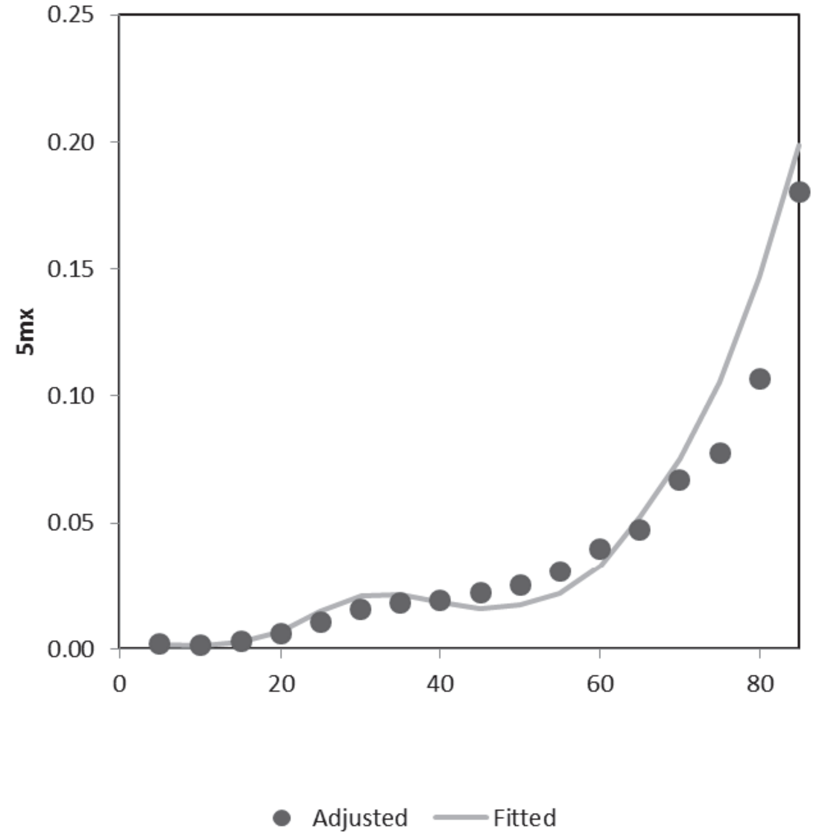


Appendix 5: Completeness: open interval of 85+, SEG RSA Males

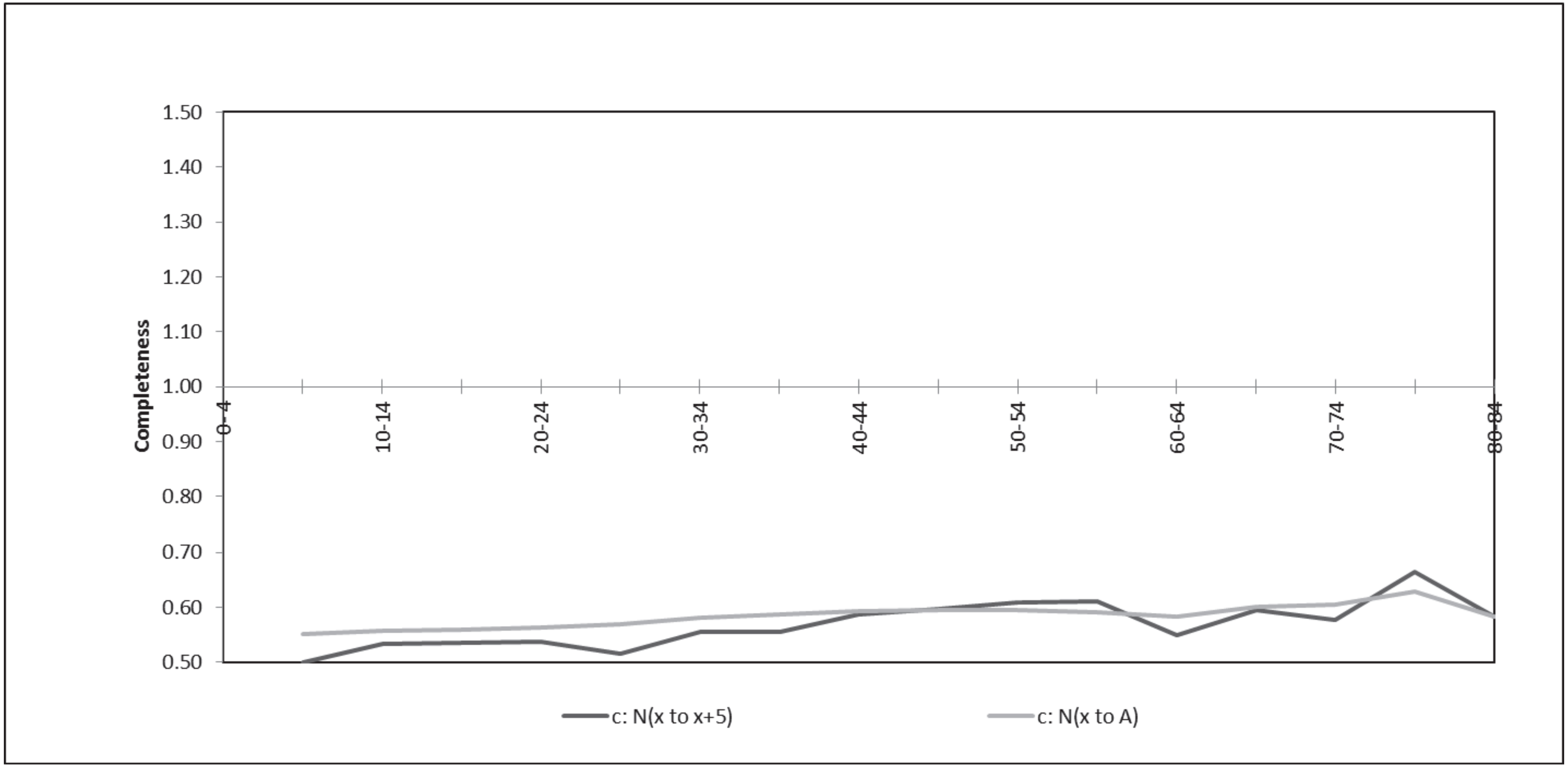


Appendix 6: Diagnostic plots: open interval of 85+, SEG RSA Males

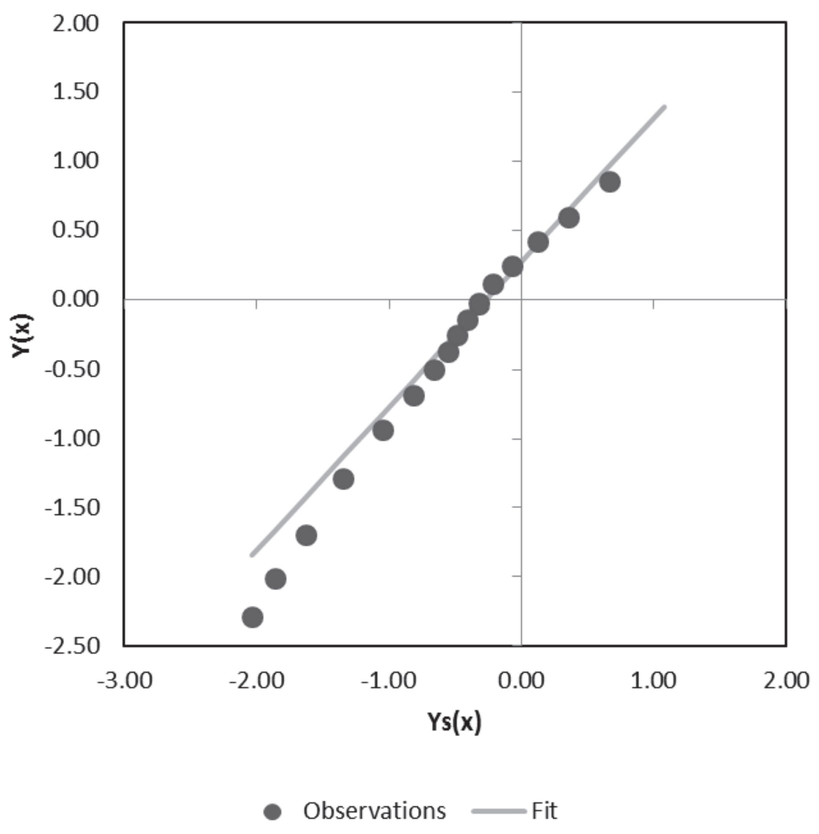


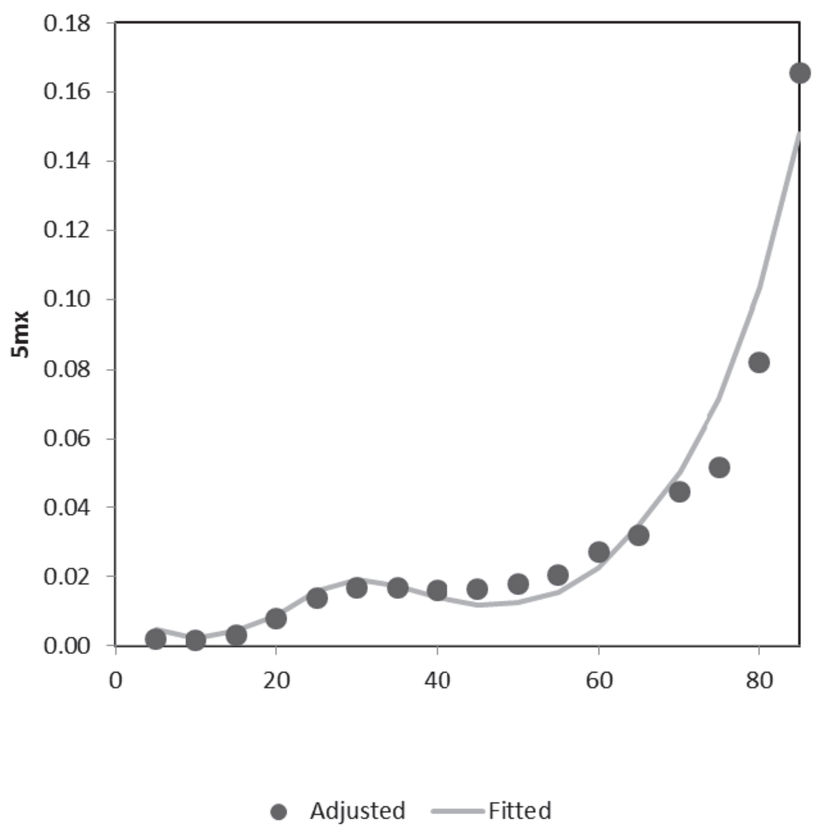


Appendix 7: Completeness: open interval of 85+, SEG RSA Females

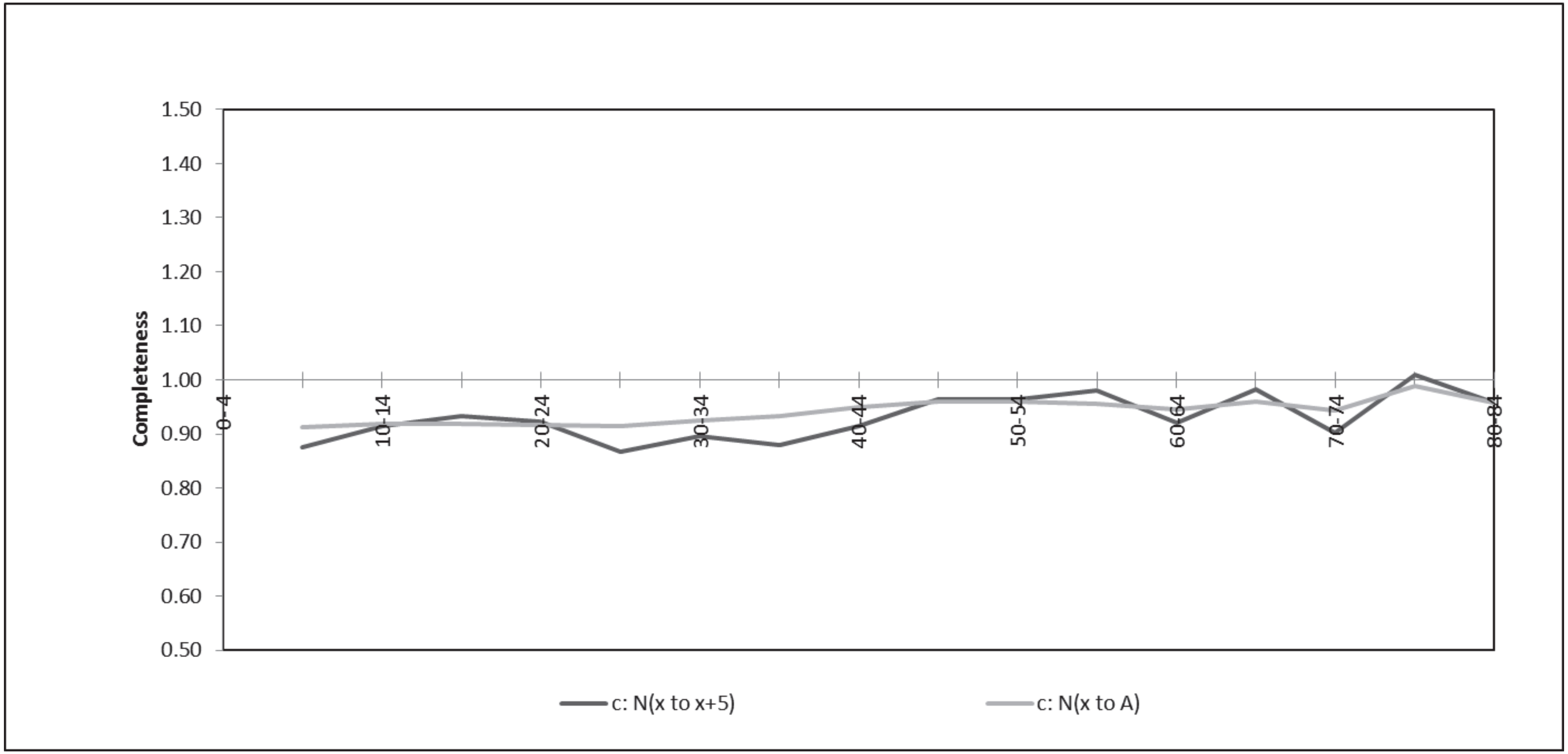


Appendix 8: Diagnostic plots: open interval of 85+, SEG RSA Females

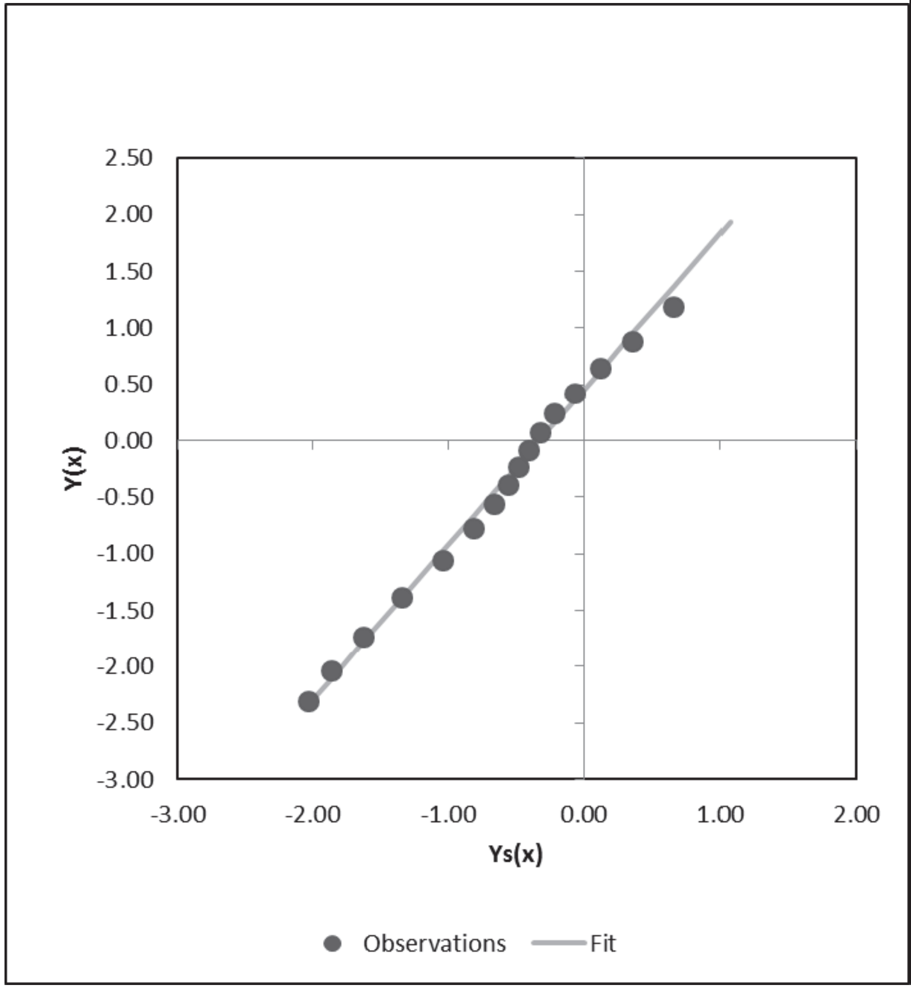


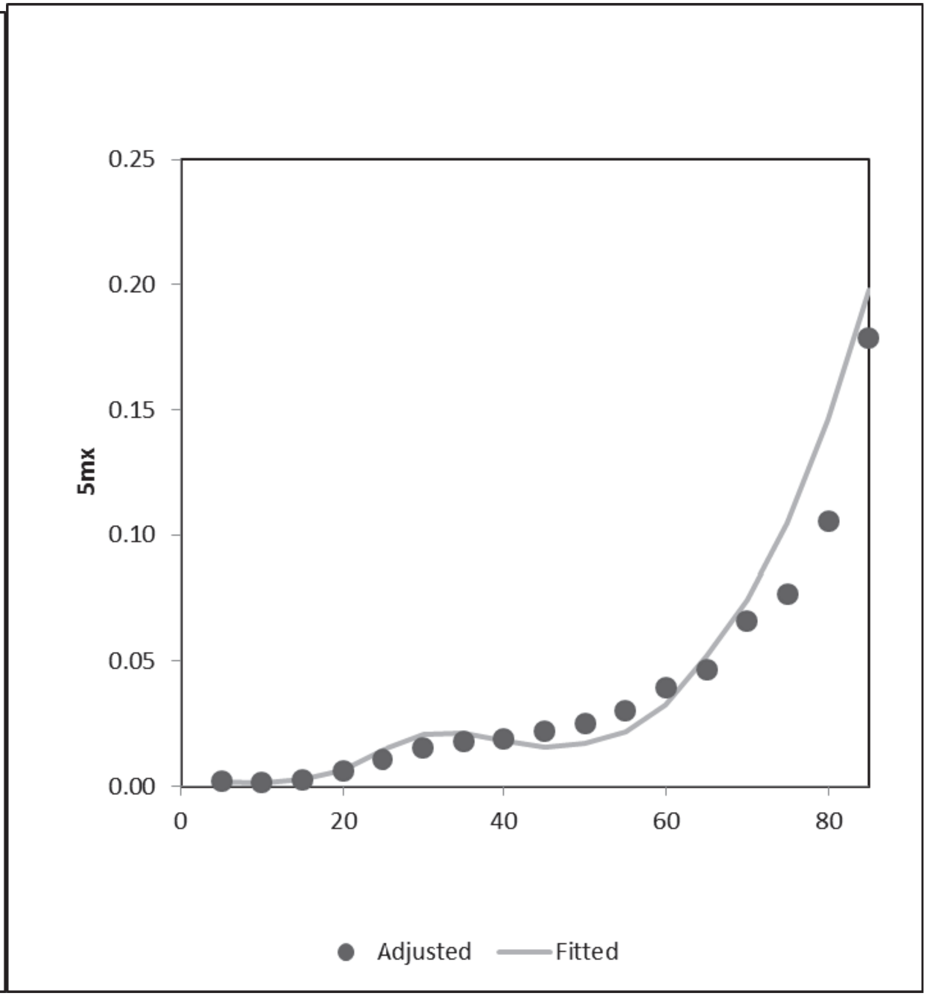


Appendix 9: Completeness: open interval of 85+, GGB+SEG RSA Males

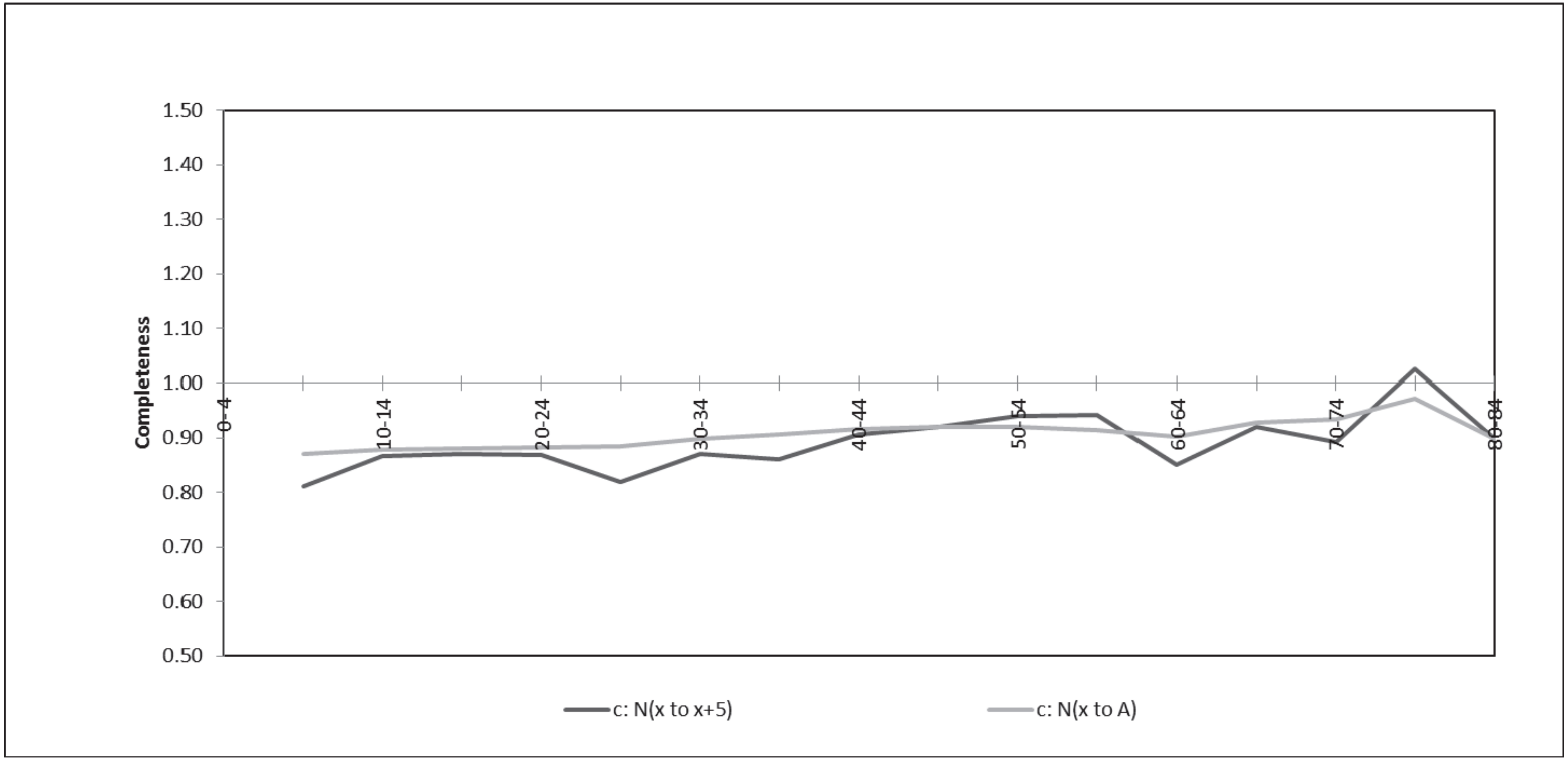


Appendix 10: Diagnostic plots: open interval of 85+, GGB+SEG RSA Males





Appendix 11: Completeness: open interval of 85+, GGB+SEG RSA Females



Appendix 12: Diagnostic plots: open interval of 85+, GGB+SEG RSA Females