RAPID MORTALITY SURVEILLANCE REPORT 2024

ROB DORRINGTON | NADINE NANNAN | TRACY GLASS | TOM MOULTRIE | QONDENI NDLANGAMANDLA | LETHU NTSHINGA | MAKANDWE NYIRENDA | DEBBIE BRADSHAW | PAM GROENEWALD

BURDEN OF DISEASE RESEARCH UNIT
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Rob Dorrington,
Nadine Nannan,
Tracy Glass,
Tom Moultrie,
Qondeni Ndlangamandla,
Lethu Ntshinga,
Makandwe Nyirenda,
Debbie Bradshaw,
Pam Groenewald

Burden of Disease Research Unit South African Medical Research Council

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CONTENTS

EXECUTIVE SUMMARY ... ii
KEY MORTALITY INDICATORS, RMS 2018 - 2024 ... ii
INTRODUCTION ... 1
DATA SOURCE ... 1
POPULATION ESTIMATES ... 2
ADJUSTMENTS ... 3
TRENDS IN NPR DATA ... 5
LIFE EXPECTANCY AND ADULT MORTALITY ... 8
CHILD MORTALITY (U5MR, IMR, NMR) ... 10
OLDER CHILDREN, ADOLESCENT AND YOUTH MORTALITY ... 13
MATERNAL DEATH ... 15
PREMATURE MORTALITY DUE TO NON-COMMUNICABLE DISEASES (30-69 YEARS) 16
COMPARISON WITH ESTIMATES FROM OTHER SOURCES ... 19
CHILD MORTALITY RATES (U5MR, IMR, NMR) ... 19
LIFE EXPECTANCY AT BIRTH ... 20
MATERNAL MORTALITY RATIO ... 21
ADULT MORTALITY ... 22
OLDER CHILDREN, ADOLESCENT AND YOUTH MORTALITY ... 22
CONCLUSIONS ... 23
REFERENCES ... 25
APPENDIX 1: ESTIMATION OF COMPLETENESS OF REPORTING OF DEATHS ... 30
INFANTS AND CHILDREN UNDER-5 YEARS ... 30
ADULTS 20+ YEARS ... 30
CHILDREN AND YOUTH 5-19 YEARS ... 30
POST-2011 ... 30
APPENDIX 2: NUMBER OF NATURAL (N), UNNATURAL (U) AND TOTAL (T) DEATHS IN NPR COMPARED WITH STATS SA DATA BY YEAR ... 32
APPENDIX 3: NUMBER OF NATURAL (N), UNNATURAL (U) AND TOTAL (T) DEATHS IN NPR IN BROAD AGE GROUPS COMPARED WITH STATS SA DATA BY YEAR ... 33
APPENDIX 4: TREND IN THE NUMBER OF NATURAL AND UNNATURAL DEATHS BY AGE AND SEX, NPR 2000-2024 ... 35

LIST OF TABLES

TABLE 1: ESTIMATED LIFE EXPECTANCY AT BIRTH (e_0), ADULT MORTALITY ($_{45}q_{15}$) AND LIFE EXPECTANCY AT AGE 60 (e_{60}), RMS 2018-2024 8

TABLE 2: ESTIMATED U5MR, IMR AND NMR PER 1 000 LIVE BIRTHS, RMS AND DHIS 2018-2024 12

TABLE 3 : ESTIMATED MORTALITY RATES OF OLDER CHILDREN & YOUNG ADOLESCENTS AND OLDER ADOLESCENTS & YOUTH, RMS 2018-2024 13

TABLE 4: ESTIMATED MMR PER 100 000 LIVE BIRTHS, RMS AND STATS SA 2016-2022.....16

TABLE 5 : ESTIMATED MORTALITY RATES (NCD $_{40}q_{30}$) DUE TO NON-COMMUNICABLE DISEASES (NCD), RMS AND STATS SA 2015-2022....17

LIST OF FIGURES

FIGURE 1: ESTIMATES OF THE NUMBER OF BIRTHS COMPARED TO THE NUMBERS FROM THE DHIS AND VR, 2000-2024....3

FIGURE 2: ESTIMATES OF THE NUMBER OF DEATHS COMPARED TO THE NUMBERS FROM THE NPR AND VR, 2000-2024....4

FIGURE 3: NPR DEATHS AS A PROPORTION OF STATS SA DEATHS BY AGE GROUP, 2000-2021....4

FIGURE 4: TREND IN THE NUMBER OF NATURAL (N), UNNATURAL (U) BY BROAD AGE GROUP, NPR 2000-2024....6

FIGURE 5: RATIO OF NPR TO VR DATA (%) BY NATURAL (N), UNNATURAL (U) AND TOTAL (T) CATEGORY, 2000-2022 6

FIGURE 6: RATIO OF NPR TO VR DATA (%) IN BROAD AGE GROUPS BY NATURAL (N), UNNATURAL (U) AND TOTAL (T) CATEGORY, 2000-2022....7

FIGURE 7: LIFE EXPECTANCY AT BIRTH (*e0*) FROM VR AND RMS, 2000-2024 (AFTER ADJUSTING FOR INCOMPLETENESS) 8

FIGURE 8: ADULT MORTALITY ($_{45}q_{15}$) FROM VR AND NPR, 2000-2024 (AFTER ADJUSTING FOR INCOMPLETENESS) 9

FIGURE 9: LIFE EXPECTANCY AT THE AGE OF 60 (e_{60}) FROM VR AND NPR, 2000-2024 (AFTER ADJUSTING FOR INCOMPLETENESS)....9

FIGURE 10: MONTHLY NUMBER OF CHILD DEATHS UNDER-5 YEARS FROM STATS SA AND NPR, 2019-2024 10

FIGURE 11: NUMBER OF CHILD DEATHS UNDER-5 YEARS OF AGE BY SELECTED CAUSE OF DEATH, STATS SA 2017-2022 10

FIGURE 12: NUMBER OF CHILD DEATHS UNDER-5 YEARS BY MONTH, NPR 2016-2024..11

FIGURE 13: STILLBIRTHS AND NEONATAL DEATHS FROM VR AND DHIS 2006-2024........11

FIGURE 14: UNDER-5 MORTALITY RATE (U5MR) AND INFANT MORTALITY RATE (IMR) FROM VR/RMS AND NEONATAL MORTALITY RATE (NMR) FROM VR/DHIS, 2000-2024 (AFTER ADJUSTING FOR INCOMPLETENESS)....12

FIGURE 15: ESTIMATE OF $_{10}q_5$, THE PROBABILITY OF FIVE-YEAR OLD DYING BEFORE AGE 15, FOR MALES, FEMALES AND BOTH, 2000-2024....14

FIGURE 16: ESTIMATE OF $_{10}q_{15}$, THE PROBABILITY OF 15-YEAR-OLD DYING BEFORE AGE 25, FOR MALES, FEMALES AND BOTH, 2000-2024....14

FIGURE 17 : ESTIMATE OF MMR FROM VARIOUS SOURCES, 1995-2022....15

FIGURE 18:TREND IN THE NUMBER OF MATERNAL DEATHS BY CAUSE, STATS SA 1997-2022....16

FIGURE 19 : ESTIMATE OF $_{40}q_{30}$, THE PROBABILITY OF 30-YEAR-OLD DYING BEFORE AGE 70, DUE TO NON-COMMUNICABLE DISEASES, FOR MALES, FEMALES AND BOTH, 2000-2022....17

FIGURE 20 : TREND IN CAUSE-SPECIFIC $_{40}q_{30}$, THE PROBABILITY OF 30-YEAR-OLD DYING BEFORE AGE 70, DUE TO NON-COMMUNICABLE DISEASES, FOR MALES AND FEMALES, 2000-2022 18

FIGURE 21: COMPARISON OF ESTIMATES OF THE UNDER-5 MORTALITY RATE (U5MR), 2000-2024 19
FIGURE 22: COMPARISON OF ESTIMATES OF THE INFANT MORTALITY RATE (IMR), 2000-2024 20
FIGURE 23: COMPARISON OF ESTIMATES OF NEONATAL MORTALITY RATES (NMR), 2000-2023 20
FIGURE 24: COMPARISON OF ESTIMATES OF LIFE EXPECTANCY AT BIRTH (e_0), 2000-2024 21
FIGURE 25: COMPARISON OF ESTIMATES OF MATERNAL MORTALITY RATIO (MMR), 2000-2024 21
FIGURE 26: COMPARISON OF ESTIMATES OF ADULT MORTALITY ($_{45}q_{15}$) FOR MALES AND FEMALES COMBINED, 2000-2024 22
FIGURE 27: COMPARISON OF ESTIMATES OF OLDER CHILDREN & YOUNG ADOLESCENT AND OLDER ADOLESCENT & YOUTH MORTALITY RATES ($_{10}q_5$ AND $_{10}q_{15}$), 2000-2023 22

ACRONYMS AND ABBREVIATIONS

e_0	-	life expectancy at birth
e_{60}	-	life expectancy at age 60
q_0	-	probability of a live birth dying before age 1 (infant)
$_5q_0$	-	probability of a live birth dying before age 5 (under-5)
$_{10}q_5$	-	conditional probability of a 5-year-old child dying before age 15 (older children and young adolescents)
$_{10}q_{15}$	-	conditional probability of a 15-year-old child dying before age 25 (older adolescents and young adults)
$_{45}q_{15}$	-	conditional probability of a 15-year-old person dying before age 60 (adult)
NCD $_{40}q_{30}$	-	conditional probability of a 30-year-old person dying before age 70 from non-communicable disease (NCD) i.e. premature mortality from NCDs
AIDS	-	acquired immune deficiency syndrome
ASSA	-	Actuarial Society of South Africa
CRVS	-	civil registration and vital statistics
HIV	-	human immunodeficiency virus
DHA	-	Department of Home Affairs
DHIS	-	District Health Information System
DNF	-	death notification form
HDACC	-	Health Data Advisory and Coordinating Committee
ICD	-	International Statistical Classification of Diseases and Related Health Problems
ID	-	Identity document
IGME	-	UN Interagency Group for Child Mortality Estimation
IMR	-	Infant mortality rate
MaCoD	-	Mortality and cause of death data
MMIEG	-	Maternal Mortality Interagency Estimation Group
MMR	-	maternal mortality ratio
MTDP	-	Medium Term Development Plan
NDOH	-	National Department of Health
MYPE	-	Mid-year population estimates
NCD	-	non-communicable disease
NMR	-	neonatal mortality rate
NPC	-	National Planning Commission
NPR	-	National Population Register
NSDA	-	Negotiated Service Delivery Agreement
PRMR	-	pregnancy-related mortality ratio
RMS	-	Rapid Mortality Surveillance
SAMRC	-	South African Medical Research Council
Stats SA	-	Statistics South Africa
U5MR	-	under-5 mortality rate
VR	-	vital registration
WPP	-	World Population Prospects

EXECUTIVE SUMMARY

The Rapid Mortality Surveillance (RMS) Report has been providing empirical estimates of the mortality-based high-level indicators for monitoring health and the performance of the Department of Health since 2012. It provides information to track the health goal to increase life expectancy at birth and other selected outcomes outlined in the National Development Plan (NDP), the Medium Term Development Plan (MTDP) for 2024-2029 and the Department of Health's Strategic Plan for 2020/21 – 2024/25.

Deaths registered on the National Population Register (NPR) by the Department of Home Affairs are the main data source for the most recent estimates. These are adjusted to account for under-registration. Estimates that require cause-specific information from Stats SA, such as the maternal mortality rate (MMR) and non-communicable disease (NCD) premature mortality rates, are less up to date (up to 2022, being the most recent year for which vital registration data have been released). The Neonatal Mortality Rate (NMR) is based on District Health Information System (DHIS) data up to 2024. Efforts to improve the completeness of death registration are still required and the delay in the release of cause-of-death statistics is a particular concern in the context of the limited improvements following the increase in deaths in 2021.

The report shows that in 2024***, the average life expectancy in South Africa was 66.4 years***. After having increased from 53.7 years in 2005 to 65.3 in 2019, due mainly to a decline in the mortality of both children and young adults, it fell to 61.6 years in 2021 at the height of the COVID-19 pandemic. ***The mortality shock caused by COVID-19 resulted in a drop in the average life expectancy of 3.4[1] years between 2019 and 2021***, with a greater decline occurring in 2021 than in 2020. This decline is a higher than has been measured in more developed countries, but lower than some countries in South America (Aburto *et al,* 2021, Heuveline, 2022, Cao *et al*, 2023). Furthermore, in contrast to the experience in many of these countries, the impact on life expectancy between 2019 and 2021 was greater for females (drop of 3.7 years) than for males (decrease of 3.1 years). The more muted impact of COVID-19 in 2020 was mainly due to the impact of the severe lockdown (restricting social interaction and travel) and non-pharmaceutical interventions (NPIs) on non-COVID mortality. In the case of males, the marked reduction in the number of deaths from unnatural causes during periods of stringent lockdowns including alcohol restrictions contributed to the lower decline in their life expectancy during 2020. ***Since 2021, life expectancy has increased by 4.8 years by 2024 with a greater increase for females (5.2 years) than for males (4.4 years).***

In contrast to the major improvements at other ages, life expectancy at age 60 changed very little between 2000 and 2019. However, associated with COVID-19, the life expectancy at age 60 dropped from 19.3 to 15.8 years for females, and from 15.2 to 12.5 years for males between 2019 and 2021, resulting in an overall decrease of 3.1 years. By 2024, the average life expectancy at age 60 was 19.2 years for females and 14.9 years for males, similar to levels experienced prior to 2019.

Infant and under-5 mortality rates reached lows of 23 and 30 deaths per 1 000 live births, respectively, in 2020. The lack of seasonal increases in the numbers of registered deaths suggest that the winter increases in respiratory syncytial virus (RSV) and other pneumonias as well as seasonal outbreaks of diarrhoea were absent in 2020 (due, at least in part, to the strict lockdown). ***However, the infant and under-5 mortality rates increased to 27 and 37 per 1 000 live births in 2022 before decreasing to 24 and 33, respectively, by 2024***. ***In contrast the neonatal mortality rate, at 12-13 deaths per 1 000 live births, continues to show little change***.

In keeping with childhood mortality, there was also a noticeable decline in the level of mortality of older children and young adolescents aged 5-14 years ($_{10}q_5$) between 2018 and 2020, again due to effects of lockdown on both natural and unnatural deaths. However, the rate increased to 6.2 per 1 000 in 2021 before falling to 5.2 per 1 000 by 2024. Mortality among older adolescents and youth (the probability of a 15-year-old dying before the age of 25 years) fell to 22.4 per 1 000 in 2020 for males and to 14.3 per 1 000 for females. A decrease in deaths from unnatural causes probably accounted for much of this decline. However, after this, mortality in males in this age group increased to above pre-COVID-19 levels in 2021 (26.1 per 1 000) and even higher in 2022 (27.7 per 1 000) before declining to 26.0 per 1 000 by 2024.

For this report the methodology for estimating the MMR was modified to consider information about the pregnancy status of female decedents reported on death notifications together with the underlying cause of death. There is still concern about the reliability and validity of this measure, but according to this approach, the MMR decreased to a low of 112 deaths per 100 000 births in 2018 and then increased to a high of 214 deaths per 100 000 births in 2021, associated with COVID-19, before falling. ***The MMR dropped to 146 per 100 000 births in 2022, but the SDG target of 70 per 100 000 births is still to be reached.***

The rates of premature mortality from preventable non-communicable diseases (NCDs) also declined from a high in 2003, mainly due to a decline in deaths due to cardiovascular disease, and cancers in the case of males. In 2020 and 2021 there were slight increases in mortality from diabetes and cardiovascular diseases while mortality from chronic respiratory diseases and cancer showed little change. By 2022, the levels appear to have almost reverted to pre-COVID-19 levels of mortality.

Despite the past improvements in the levels of mortality in South Africa, the targets set in the National Development Plan are unlikely to be met by 2030. Also, the growing lack of data to confirm estimates of the numbers of births and to estimate the completes of reporting of deaths, is a major concern. No data on fertility or mortality from the 2022 census were released meaning that the most recent surveys from which independent estimates could be produced are the South Africa Demographic and Health Survey and mid-Census Surveys were conducted in 2016/17.

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[1] Due to rounding, the difference does not correspond exactly to numbers in the table.

KEY MORTALITY INDICATORS, RMS 2018 - 2024

Life expectancy and adult mortality		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Life expectancy at birth	Total	64.5	65.1	64.1	61.6	64.9	65.8	66.4
	Male	61.5	62.1	61.5	59.0	61.6	62.5	63.4
	Female	67.6	68.1	66.8	64.4	68.3	69.1	69.6
Adult mortality ($_{45}q_{15}$)	Total	31%	30%	31%	36%	29%	27%	26%
	Male	37%	37%	36%	41%	35%	34%	32%
	Female	25%	24%	26%	30%	22%	21%	20%
Maternal mortality ratio[1]		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Maternal mortality ratio (MMR) per 100 000 live births		112	146	168	214	146		
Child mortality rates		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Under-5 mortality rate (U5MR) per 1 000 live births		33	32	30	33	37	34	33
Infant mortality rate (IMR) per 1 000 live births		24	23	23	25	27	25	24
Neonatal mortality rate (<28 days) per 1 000 live births		11	12	12	12	12	12	13
Mortality in older children, adolescent and youth		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Older children & young adolescents ($_{10}q_5$ per 1 000)	Total	6.5	6.2	5.5	6.2	6.0	5.7	5.2
	Male	7.3	7.0	6.2	6.9	6.6	6.2	5.7
	Female	5.7	5.4	4.8	5.7	5.5	5.2	4.6
Older adolescents & youth ($_{10}q_{15}$ per 1 000)	Total	20.6	20.2	18.3	21.0	21.4	20.7	20.4
	Male	25.2	25.3	22.4	26.1	27.7	26.6	26.0
	Female	16.0	15.0	14.3	15.8	15.0	14.9	14.8
Life expectancy at age 60		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Life expectancy at age 60 (e_{60})	Total	17.4	17.4	15.9	14.3	17.1	17.1	17.2
	Male	15.2	15.2	14.0	12.5	14.8	14.8	14.9
	Female	19.3	19.3	17.6	15.8	18.9	19.1	19.2
Non-communicable disease[1]		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
NCD $_{40}q_{30}$	Total	29%	28%	28%	29%	27%		
	Male	34%	32%	32%	33%	32%		
	Female	24%	23%	25%	25%	22%		
Cardiovascular disease $_{40}q_{30}$	Total	13%	14%	14%	14%	14%		
	Male	16%	16%	17%	17%	17%		
	Female	10%	11%	11%	11%	11%		
Cancer $_{40}q_{30}$	Total	9%	9%	8%	8%	8%		
	Male	10%	10%	9%	9%	9%		
	Female	8%	8%	7%	7%	7%		
Diabetes $_{40}q_{30}$	Total	4%	4%	3%	4%	3%		
	Male	6%	5%	5%	5%	5%		
	Female	2%	2%	2%	2%	2%		
Chronic respiratory disease $_{40}q_{30}$	Total	6%	5%	7%	7%	6%		
	Male	6%	5%	7%	7%	6%		
	Female	6%	5%	7%	7%	5%		

1. Data available till 2022

INTRODUCTION

This is the tenth in the series of annual reports, spanning 12 years, utilising the data from the Rapid Mortality Surveillance (RMS) database held by the SAMRC which consolidates basic demographic information about deaths registered onto the National Population Register (NPR) as described in the first report (Bradshaw, Dorrington and Laubscher, 2012). This report provides national estimates of high-level mortality indicators until 2024. Although work was underway to expand this report to include provincial estimates the foundational work for provincial estimates was interrupted by the COVID-19 pandemic, which necessitated concentrating on accelerating monitoring of key mortality statistics to a weekly basis. Since March 2020, the Department of Home Affairs (DHA) provides the SAMRC with weekly updates and with the assistance of UCT Centre for Actuarial Research a near real-time weekly report on the estimated numbers of deaths that have occurred in different regions of the country has been published (Bradshaw *et al*, 2020), providing invaluable insights into the impact of the COVID-19 pandemic and quantifying excess mortality.

These empirical-based estimates can be used to track the impact of indicators identified in the National Development Plan (NPC, 2011) for the health objective of a long and healthy life for all South Africans (DPM&E, 2014) and the current Medium Term Development Plan (MTDP) for 2024-2029 (DPME, 2025). In addition, the report provides estimates for several outcome indicators identified in the Department of Health's Strategic Plan 2025 – 2030 (NDOH, 2025). This report includes estimates of life expectancy at birth, the adult mortality index ${}_{45}q_{15}$, under-5 mortality rate, infant mortality rate (IMR) and the neonatal mortality rate (NMR), as well as for young adolescents aged 5-14 years (${}_{10}q_{5}$) and older adolescents and young adults aged 15-24 years (${}_{10}q_{15}$). Finally, the report also includes an estimate of the maternal mortality ratio (MMR), which lags the other indices because it relies on the cause-of-death data reported by Stats SA. For this report, estimates derived from the NPR data series have been updated to the end of 2024. However, indicators requiring cause-of-death data, namely the MMR and various non-communicable disease (NCD) indicators rely on the mortality and cause of death (MaCoD) data released by Stats SA and thus end in 2022.

Estimates of the population and the numbers of births, together with the numbers of deaths, are essential for calculating the indicators in this report. Uncertainty about the estimates has unfortunately grown in recent years due to various challenges in the demographic data systems. Apart from disruptions and delays caused by the COVID-19 pandemic and ever-tighter fiscal constraints, the 2022 census was unable to provide much needed contemporary information regarding the fertility and mortality (Stats SA, 2024), and the large undercount experienced in the census has created additional uncertainty around the estimates of the size of the population (Moultrie and Dorrington, 2024). The lack of good quality demographic data in South Africa has been exacerbated by the fact that the last South Africa Demographic and Health Survey was conducted in 2016.

Previous Rapid Mortality Surveillance reports used the mid-year population estimates derived from the ASSA2008 model, to be consistent with the 2011 Census population (Dorrington, 2013), projected forward to 2017 using unchanging migration, slightly declining fertility and mortality rates. Since we are currently estimating the true numbers of births and deaths as part of the RMS exercise, demographic consistency has been maintained by using these estimates of births and deaths together with estimates of migration that is consistent with an estimate the population in 2022 derived after correcting for what appear to be the most obvious distortions in the 2022 Census estimates, to project the population on a year-by-year basis from 2012 onwards.

DATA SOURCE

The Department of Home Affairs (DHA) is responsible for civil registration and the maintenance of a computerised National Population Register (NPR). Registered births are added to the register and an aggregation of all births registered from 1998 to the end of the immediately preceding year are published by Stats SA (Stats SA, 2025). These data on births, adjusted for an estimate of under- or late registration, are used to determine the denominator for the neonatal, infant, under-five and maternal mortality rates.

In the event of a death, a death notification form is submitted to the Department, which then issues a burial order and an abbreviated death certificate to the family of the deceased. For deaths of individuals who have a South African ID number or whose birth has been registered, the National Population Register is updated as part of the registration process.

Since 1999, the South African Medical Research Council has obtained monthly updates of the deaths registered on the National Population Register, which has been used to develop and maintain a consolidated database. Several steps in the data management process ensure that the confidentiality of the data is maintained. Ethics approval was obtained from the University of Cape Town. During COVID-19, the data transfer was affected more frequently, and adhering to careful data management procedures, data are now provided daily and consolidated on a weekly basis following an ethics approved protocol overseen by the SAMRC ethics committee.

These data are subject to two forms of under-reporting. The first is non-registration on the population register (because the deceased did not have a South African birth certificate or identity document). The second is the non-registration of the death, a common challenge experienced in developing countries.

As the NPR data only identifies cause-of-death as natural or unnatural, one needs to rely on the cause-of-death data from Stats SA to identify maternal deaths as well as deaths from non-communicable diseases. During 2025, two data sets became available, for the years 2021 (Stats SA, 2025) and 2022 (Stats SA, 2025)[2]. In addition, too few of the neonatal deaths are recorded in the NPR data to produce reliable estimates, and since there is a lag in the release of the cause-of-death data, we use data from the District Health Information System 2017-24 (DHIS) to estimate the number of neonatal deaths that occur in public hospitals to produce a more recent estimate.

POPULATION ESTIMATES

Demographic indicators require estimates of the population and births that should ideally:

- be available by single years of age to allow for more accurate estimation of the indicators,
- not change frequently by substantial amounts (to avoid having to recast the indicators), and
- be as consistent with the age distribution of the populations of the 2001 and 2011 Censuses, and reconsidered 2022 Census as is reasonable, allowing, inter alia, for possible undercounting of children and age exaggeration at old age in those censuses.

For the first RMS report, the population estimates produced by the ASSA2008 AIDS and Demographic projection model (ASSA, 2011) were used to calculate the mortality-related indicators in line with the recommendations of the Health Data Advisory and Coordination Committee of the Department of Health (HDACC, 2011). However, since then, the 2011 Census population estimates were released, and they suggested that not only has the trend in fertility been different from that assumed by ASSA model (and ALL other projection models) for 10-15 years prior to the 2011 census, but also that immigration has turned out to be somewhat higher than assumed by projection models. Thus, for reports covering the years 2012 to 2022, in the absence of new, suitable, empirical data, an alternative set of mid-year population estimates with an age distribution and population size consistent with those of the 2001 and 2011 Censuses (Dorrington, 2013) was used. Because this population estimate series ends with 2017, it was decided to replace the estimates of the population from 2012 onwards with estimates based on a different and internally more consistent methodology that makes use of the series of estimates of the true numbers of births and deaths used to determine the indicators in this report, and the net numbers of migrants by sex and age that produced the projected population that best matched an estimate of the population in 2022 that corrected for likely errors in the 2022 census estimates.

The official, annual, series of mid-year population estimates produced by Stats SA were considered for use as an alternative source of estimates. However, even though these too imply that the 2022 census overestimated the population by at least a million, this is due, in part at least, by projecting significantly lower estimates for the cohort aged 20-29 at the time of the census and significantly higher numbers at the old ages (Stats SA 2024 MYPEs) and then for the 2025 estimates reducing the numbers of births from 2011 onwards (Stats SA 2025 MYPEs). In addition, although numbers by single age are produced annually, they are not made available for public download.

The numbers of births were estimated by reconciling the following:

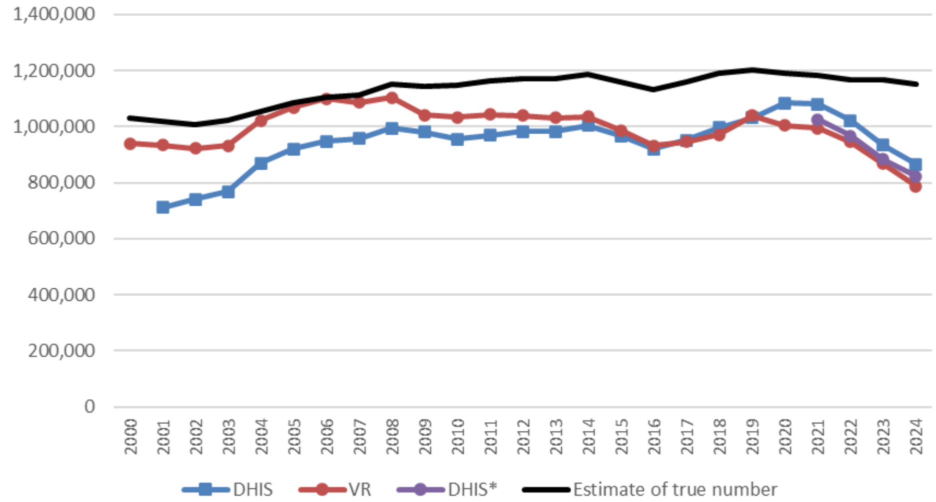
- estimates of the numbers of births (up to 2011) derived by back projecting the numbers surviving to the 2011 Census
- estimates of the numbers of births (up to 7 years prior to the date of the school data) derived from the numbers of children in school each year by age of child
- estimates of the number of births (up to 2024) from the registered births by year of birth corrected for estimates of the completeness of registration
- estimates of the number of births (up to 2024) derived from the number reported by the DHIS corrected for an estimate of the births that took place outside a public health facility (Dorrington and Moultrie 2015)[3]
- estimates of the number of births derived by applying fertility rates estimated from census and Community Survey data to the numbers of women aged 15-49 from the CARe 4.3 population projection model[4]
- estimates of the number of births (up to 2022) projected by the CARe 4.5 population projection model, and
- the consistency and plausibility of the implied level of completeness of registration by number of years of registration since the year of birth.

[2] Stats SA experienced extreme staff shortages for several years with consequent delays in the timeliness reporting and release of the annual series of mortality and cause of death information from vital registration.

[3] Estimate of the number of births outside public health facilities is based on the numbers under-1 who were covered by medical aid or private health insurance, plus the number of births which occur 'at home'.

[4] Unfortunately, no data on fertility from the 2022 census have been released by Stats SA so fertility rates were estimated by extrapolating the trend between 2011 and 2016/7.

These estimates are presented and compared to the numbers of births captured by the District Health Information System (DHIS), vital registration (VR), and for more recent years the NPR in Figure 1. It should be noted that the DHIS and VR suggest a decline in the total number of births in 2015 and 2016, followed by a slight increase from 2017 to a high in 2020 in the case of the DHIS and a high in 2019 in the case of VR. Both data sources decline from 2021 onwards.[5] Overall, the estimate of the true number shows a rapid increase from 2002 to 2008, and then a slight flattening until 2019, reaching about 1,2 million births per year. From 2021 onwards there has been a slight decrease in the estimated births.[6] For the last four years, Stats SA report on the number of births in facilities from the DHIS. These numbers do not include “born before arrival” babies which have been included in the DHIS series in **Figure 1**.



* as reported in Stats SA Reports on births

Figure 1: Estimates of the number of births compared to the numbers from the DHIS and VR, 2000-2024

ADJUSTMENTS

As was done in the previous reports, the NPR death data are adjusted in two steps. The first step is to account for the fact that the population register does not include the total population (i.e., not everybody has a national ID number). This is done by comparing the number of deaths from the NPR with the number of deaths reported by Stats SA up to the point of the most recent release, as all registered deaths should be included in the vital registration data regardless of whether the deceased had an ID number or not. This is done in single ages up to the age of 24 years and then in three broad age groups: 25-59, 60-89 and 90+ years for each sex, to approximate Stats SA vital registration (VR) data for each year from 2006 up to 2011. From 2012 to 2014 the adjustment was set as the maximum of that for the same age and the age below in the previous year, from 2015 to 2021 it was set as the maximum of these values and the ratio of NPR to VR for the age.

After this adjustment, the estimated numbers of deaths are adjusted for general under-notification (i.e., deaths with no death certificates). The second step is to account for under-notification of deaths to the Department of Home Affairs. A brief description of the approach used to estimate the completeness of registration of deaths is given in **Appendix 1**.

The total number of deaths from the NPR and from VR are shown in Figure 2 compared to the estimated true number of deaths after adjusting for completeness of registration. It is estimated that the true number of deaths increased by more than 58 000 from 2019 to 2020. Most of this increase in deaths (65%) were female. Although this largely reflects the impact of COVID-19 and the fact that there are many more women than men aged 60 and older, the proportion is also distorted by a much greater drop in unnatural deaths in males than females due to the implementation of the State of Disaster regulations, in particular the very strict lockdown in the early months of the pandemic. During the height of the COVID-19 pandemic the number of deaths is estimated to have increased by over 120 000 from 2020 to 2021. Most of these deaths are likely to have been COVID-19 deaths and the impact of the severe restrictions on access to health care.

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[5] This is difficult to interpret – it could signal a decline in registration or an increase in births in public facilities (due, for example, to a decline in medical scheme membership).

[6] The decline in the estimated births after 2021 is not as steep as the rapid decline in the number of births registered births and those recorded by health facilities, as they imply implausible changes in fertility rates. Unfortunately, in the absence of independent estimates from surveys (such DHS or Community Survey) or back projecting the numbers of learners (aged 7-12) attending school (adjusted for the proportion not attending), the uncertainty about the numbers of recent births will remain.

The gradual narrowing of the gap between the NPR data and the VR data shows that there has been a steady improvement in birth and ID registration. However, the very narrow gap observed in 2022 reflects late processing of documents in the system and the gap can be expected to widen if the late transfers of documents to Stats SA has been resolved by the time the data up to 2023 are released.

The comparison of the total number of deaths recorded by Stats SA (Stats SA, 2023) and the NPR to the numbers estimated after correcting for under registration is shown in **Figure 3**. The uptick in the ratio of the number of NPR deaths to VR deaths (Stats SA) in all age groups from 2020 to 2021 is due to the absence of 2021 deaths registered after the cut-off date for the report (i.e. late processed cases). It is possible that this may account for the ratio in some age groups reaching more than 100%. The low proportion of death notifications under the age of one being registered on the population register is mainly because many deaths in this age group occur before the birth is registered, with the result that neither the birth nor the death are registered on the NPR even if a death notification form was completed.

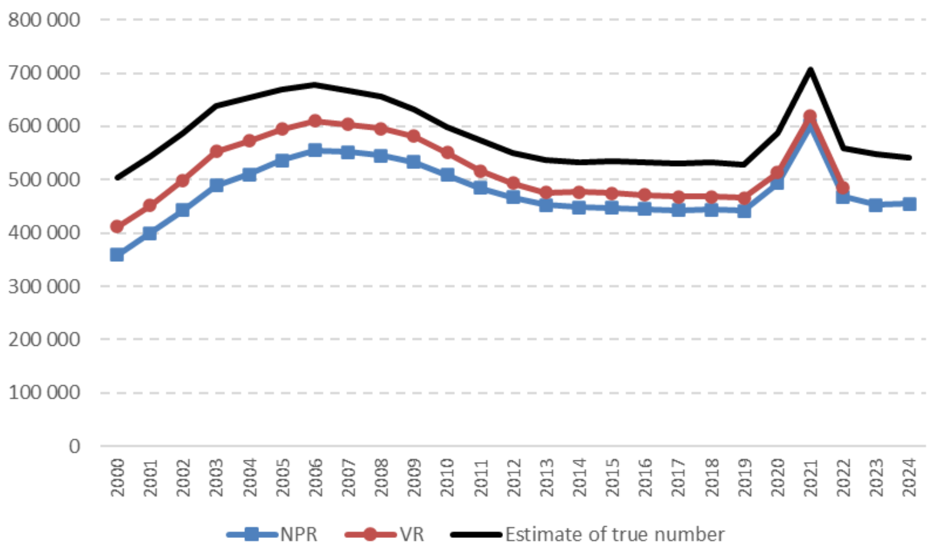

Figure 2: Estimates of the number of deaths compared to the numbers from the NPR and VR, 2000-2024

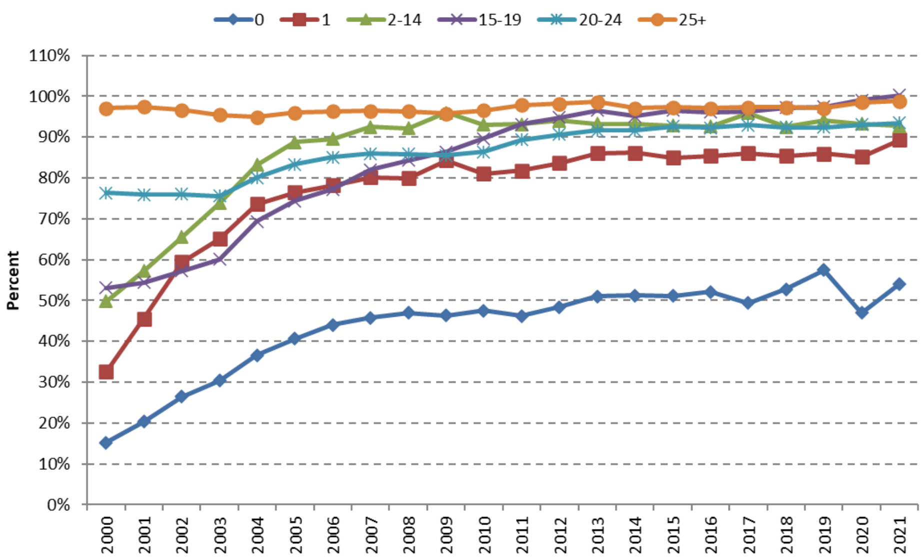

Figure 3: NPR deaths as a proportion of Stats SA deaths by age group, 2000-2021

The NPR data cannot be used to estimate neonatal deaths, because too few of these deaths are captured on the NPR (by 2011 less than 10% of the registered deaths in this age group are captured on the NPR, however, this percentage rose to 24% by 2019, fell to 14% in 2020, recovering to around 20% in 2022), possibly because deaths cannot be recorded on the NPR if the birth has not been recorded prior. Furthermore, this proportion has been increasing (possibly with improving birth registration) over time, which makes extrapolation difficult. Comparison of the number of neonatal deaths recorded in the

DHIS with those in the VR data suggests that an increasing proportion of the VR deaths are being captured by the DHIS[7,8]. As the number of neonatal deaths recorded by the DHIS has exceeded those recorded by the VR since 2012 (significantly so after 2014) it seemed more appropriate to assume that part, if not all, the decline in VR neonatal deaths is due to a decline in completeness of registration and not to a decline in neonatal mortality. Thus, as was the case for the previous report, we estimate the neonatal mortality from 2013 onwards directly from the DHIS record of neonatal deaths (instead of VR neonatal deaths) and live births delivered at district health facilities or before arrival. (While this excludes births not in the public-sector clinics, which probably have a lower NMR, it is also possible that not all neonatal deaths of public sector births are captured by the DHIS data, so the estimates are consistent with estimates in earlier years).

Aside from adjusting the vital registration cause-of-death data for under-notification of deaths and the high proportion of ill-defined causes, according to the practice of the UN advisory group on Maternal Mortality (MMIEG), the number of maternal deaths from vital registration is further increased by 50% to allow for misclassification of maternal causes of death. This adjustment is based on the median experience from some 22 studies that had estimated the extent in misclassification of maternal deaths in countries with good vital registration data (WHO, 2010). Subsequently WHO has adopted a Bayesian regression approach to estimate the misclassification for countries with vital registration data. The model fitted to data for the period 2000-2017 found overall 58% of the estimated maternal death were recorded in vital registration data (WHO, 2019) while the model for the most recent period 2000-2023 found 70% of the estimated maternal deaths were recorded in vital registration data (WHO, 2025). Based on these results there seems little reason to move away for the adjustment to allow for misclassification of causes of death.

TRENDS IN NPR DATA

The numbers of deaths (excluding late registrations) from the National Population Register are shown in **Appendix 2** for 2000-2024 alongside the numbers of deaths for the latest year from the Stats SA cause-of-death reports for 2000-2022. The total numbers (T) are broken down into natural deaths (N) and unnatural deaths (U). The total number of deaths in both series increased to a peak in 2006, driven by the elevated mortality arising from HIV/AIDS. The Stats SA numbers increased from 416 420 in 2000 to a peak of 613 108 in 2006, declining to 467 931 by 2017 and increasing to 620 394 in 2021 before dropping to 486 041 in 2022. The NPR numbers increased from 359 470 in 2000 to a peak of 555 081 in 2006 and declined to 442 563 by 2019 then increasing to 601 977 in 2021 whereafter deaths declined to 469 666 by 2024. It should be noted that changes in the number of deaths cannot be interpreted without considering the overall improvement in the completeness of death registration as well as, in the case of NPR data, the improved registration of births over this period. However, given the dearth of independent data that could be used to determine the trajectory of completeness the default assumption is that it has not changed materially since 2016/17, except for slight drop in completeness of registration in 2020, but more marked for infant deaths, and recovery after that.

In addition to the changing pattern and burden of HIV/AIDS mortality, the rapid decline in the number of deaths from the peak in 2006 down to the numbers in 2014 reflects a decline in completeness of reporting of the VR deaths by between 1% and 1.5% from 2011 to 2013 before a recovery to previous levels. In addition, investigations have identified evidence of some failures in the vital registration in the 2014-2017 period, which were corrected by late registrations in subsequent years.

The trends in the number of natural and unnatural deaths from the NPR are presented in **Appendix 3** and Figure 4 which shows a marked increase in adult natural deaths (particularly those over 60) from 2020 to a peak in 2021 and decreasing to 2022. For children under-15 the number of natural deaths declined in 2020 but rose in 2021 and 2022 decreasing again in 2023. Also noticeable is a decline in the number of unnatural deaths in 2020 for adults aged 15-59. However, these increased in 2021 and 2022 before levelling off from 2023. The steady increase in the number of natural deaths in 60+ age group up to 2019, exceeding those aged 15-59 from 2014, reflects the strong growth in the size of the population (impacted, too, by greater survival from HIV/AIDS over time in this, the 15-59 age group) in this age group rather than an increase in the rates of mortality. In total, the number of deaths in the 60+ age group exceeded those in the 15-59-year age group from 2018.

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[7] To the point that since 2013 the DHIS captures more neonatal deaths than are recorded by the VR cause-of-death data.

[8] In the past, in order to track neonatal mortality in parallel with the infant and under-5 mortality, the number of neonatal deaths that occurred in facilities and were captured by the DHIS was scaled up to estimate the number expected to be captured by the VR data. This result was then corrected for the same level of under-registration as is applied to infant deaths, in much the same way as the infant and under-5 deaths are estimated. For the years for which VR data are not yet available, the completeness of the neonatal deaths in the DHIS was estimated as the completeness for the previous year plus any increase in the ratio of neonatal deaths to stillbirths over the previous year. The rationale for this was that one would expect the ratio of neonatal deaths to stillbirths to remain fairly constant over time, so any increase in this ratio over time is probably due to an increase in completeness of coverage.

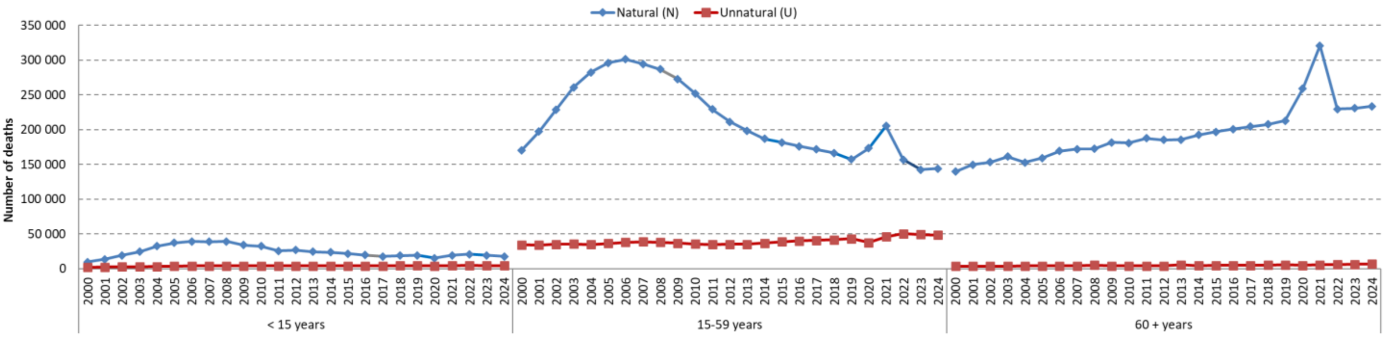


Figure 4: Trend in the number of natural (N), unnatural (U) by broad age group, NPR 2000-2024

The trend in the number of deaths from the NPR by 5-year age group and sex are presented in **Appendix 4.** Increases in the number of deaths from natural causes in 2020 are seen for males and females in the age groups 35 years and older, with marked increases for age groups 60 years and older. Striking differences in trends by gender are seen in the 15-19 and 20-24 age groups. For males, the numbers of unnatural deaths are somewhat higher than the number of natural deaths. For females, a rapid increase in the number of natural deaths is observed, reaching a high of nearly 12 000 deaths in 2006 in the 20-24 age group. Since then, the number of female deaths has declined steadily, falling below the number of deaths in 2000. Except for the oldest age group, the number of male unnatural deaths is higher than the number of female unnatural deaths.

As reported in previous reports the proportion of the VR deaths (dominated by deaths due to natural causes) captured by the NPR increased from 86.3% in 2000 to reach around 95% by 2012. Since then, it has increased slowly to reach 97% in 2021. (**Figure 5**, numbers of deaths given in **Appendix 2)**. The proportion of unnatural deaths captured by the NPR was at a constant level of approximately 80% until 2004, after which it increased gradually to above 90% for 2011 and then hovered between 89% and 94% after that.

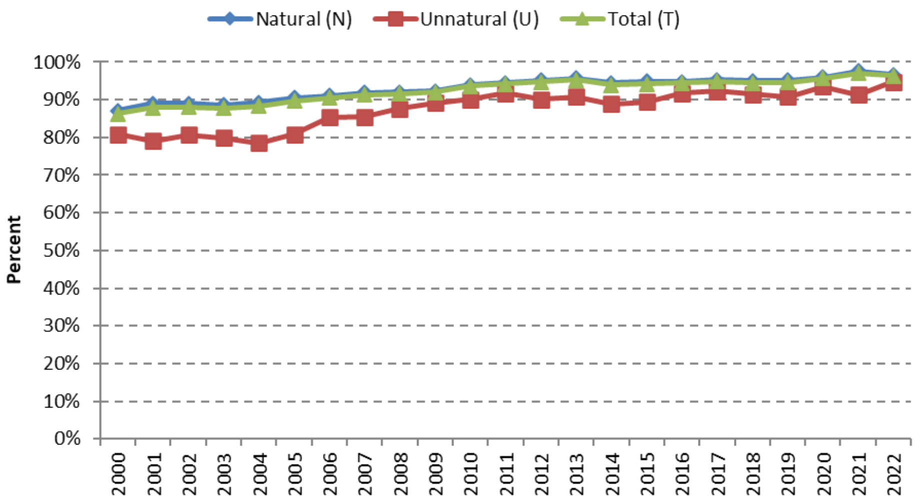
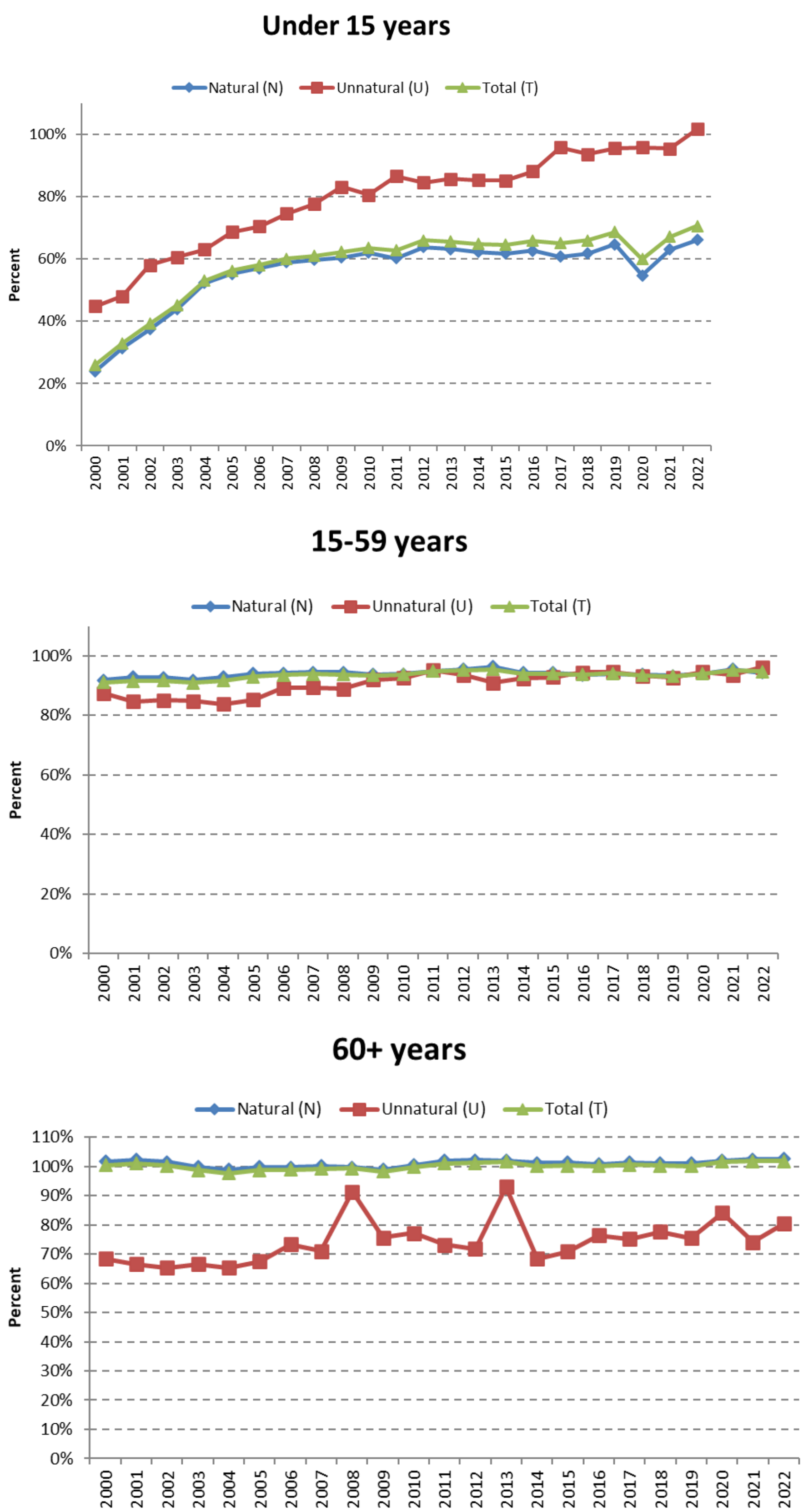


Figure 5: Ratio of NPR to VR data (%) by natural (N), unnatural (U) and total (T) category, 2000-2022.

Figure 6 shows the numbers of deaths in broad age groups, while the proportion of these VR deaths captured by the NPR is shown in for each age group (numbers reported in **Appendix 3**). There has been a considerable increase in this proportion for children <15 years which levelled off at about 60% prior to the uptick after 2012 and has reached 69% in 2019. The proportion of unnatural VR deaths captured by the NPR is higher than the proportion of natural deaths because in this age group most natural deaths occur at young ages often before the birth is registered (meaning that the death is not registered on the NPR) whereas the unnatural deaths tend to occur at older ages. While the proportions for the 15-59-year age group remained fairly level, there has been a noticeable increase for 2011 to over 96%, before dropping off slightly after that. This trend is also apparent in the proportions in the 60+ year age group, where the proportion has been (inexplicably) over 100% for the natural and total deaths from 2011 onwards. In the case of unnatural deaths in the 60+ year age group, although the proportion has increased since 2005 reaching 78% in 2010 and hovering between 70% and 80%, excepting in 2008, 2013 and again in 2020. In the processing of the NPR data, we allocate the cases which are classified as "Under investigation" to Unnatural causes while the coding standard in VR allocates them to natural causes, unless clear information is provided by the certifying doctor. This and the increases in the number of unnatural deaths in 2008 and 2013 of those aged over 60 years (shown in red in **Appendix 3**) suggest problems with classification of deaths in the NPR data, which require further investigation.



* The disruptions in 2008 and 2013 in 60+ appear to be the result of the anomalies in the NPR data, highlighted in Appendix 3.

Figure 6: Ratio of NPR to VR data (%) in broad age groups by natural (N), unnatural (U) and total (T) category, 2000-2022

LIFE EXPECTANCY AND ADULT MORTALITY

The life expectancy at birth (e_0) as well as the index of adult mortality, ${}_{45}q_{15}$, representing the probability of a 15-year-old person dying before the age of 60, are shown in **Table 1** for the period 2018-2024. The trends in these indicators since 2000 are shown in **Figure 7-9**.

Table 1: Estimated life expectancy at birth (e_0), adult mortality (${}_{45}q_{15}$) and life expectancy at age 60 (e_{60}), RMS 2018-2024

INDICATOR		2018	2019	2020	2021	2022	2023	2024
Life expectancy at birth (e_0)	Total	64.5	65.1	64.1	61.6	64.9	65.8	66.4
	Males	61.5	62.1	61.5	59.0	61.6	62.5	63.4
	Females	67.6	68.1	66.8	64.444	68.3	69.111	69.6
Adult mortality (${}_{45}q_{15}$)	Total	31%	30%	31%	36%	29%	27%	26%
	Males	37%	37%	36%	41%	35%	34%	32%
	Females	25%	24%	26%	30%	22%	21%	20%
Life expectancy at age 60 (e_{60})	Total	17.4	17.4	15.9	14.3	17.1	17.1	17.2
	Males	15.2	15.2	14.0	12.5	14.8	14.8	14.9
	Females	19.3	19.3	17.6	15.8	18.9	19.1	19.2

Life expectancy at birth (**Figure 7**) increased from 2005 to 2019 with particularly rapid progress to 2011, probably due to the extensive provision of ARVs which reduced both childhood and adult mortality rates from HIV/AIDS and associated causes. The improvement in e_0 up to 2019, was followed by a decrease to a low of 61.6 years in 2021 (a drop of 3.5 years) because of the COVID-19 pandemic. However, the change from 2019 to 2021 differs for males and females, with e_0 dropping by 3.1 years for males and 3.7 years for females. The reason for this difference by sex is due to two factors, the first being the reduction in 2020 in mortality due to the drop in deaths due to (mainly) unnatural causes (which are much more significant in males) and the second being the much higher number of deaths in the female population (mainly because of higher numbers surviving to old ages, which are more vulnerable to COVID-19 and related causes). By 2023, the levels of life expectancy at birth had rebounded back to pre-pandemic levels and showed further improvement in 2024. Life expectancy increased from the low in 2021 by 4.8 years by 2024 with a greater increase for females (5.2 years) than that for males (4.4 years).

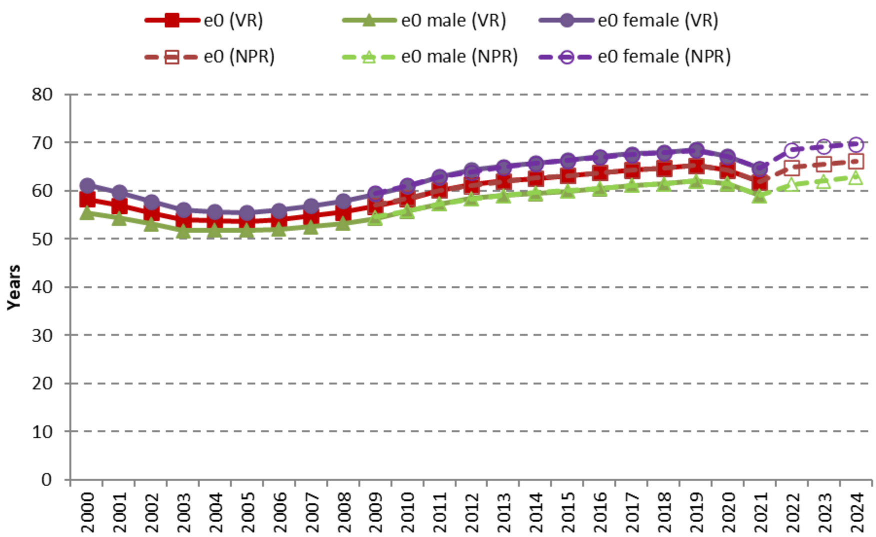


Figure 7: Life expectancy at birth (e0) from VR and RMS, 2000-2024 (after adjusting for incompleteness)

In keeping with the trends in life expectancy ($e0$), the estimate of premature mortality in adults (${}_{45}q_{15}$) decreased from 2006 to 2019 before increasing from 2019 to a peak in 2021 for both males and females, and then resuming the downward trend observed in the pre-pandemic period (**Figure 8**).

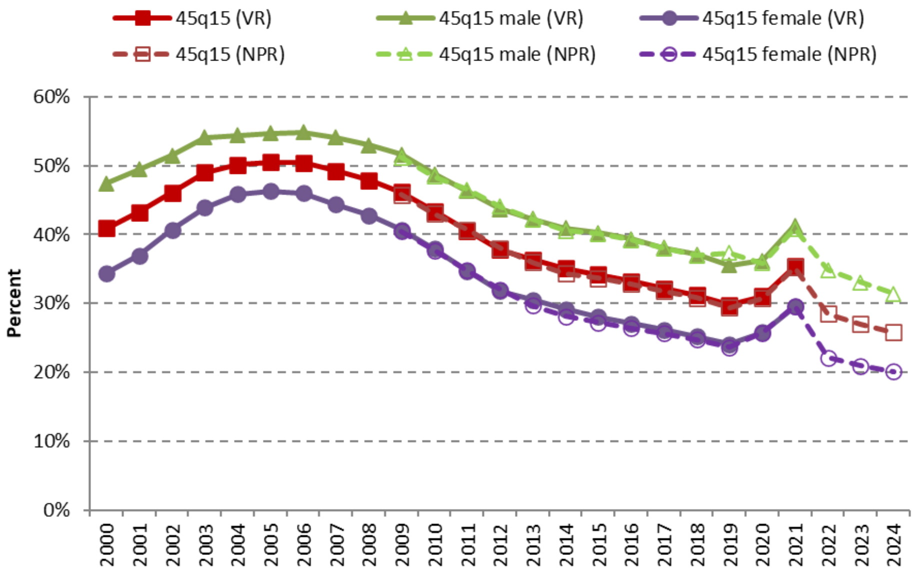


Figure 8: Adult mortality ($_{45}q_{15}$) from VR and NPR, 2000-2024 (after adjusting for incompleteness)

The trend in older-age mortality tracked using the index e_{60} (the average life expectancy of people who have survived to age 60) is shown in **Figure 9**. As can be seen from this figure, the mortality of older adults appears not to have changed much between 2000 and 2019, with the average life expectancy at the age of 60 remaining around 17.4 years from 2003 to 2019, at around 15.2 years for men, and 19.3 years for women over the same period. However, e_{60} declined by about 3.1 years to reach 14.3 years in 2021, and by 2.7 years to 12.5 years for men and by 3.5 years to 15.8 years for women in 2021. This reflects the severe impact the COVID-19 pandemic had on older-age mortality. Life expectancy at age 60 then returned to 2019 levels after the pandemic.

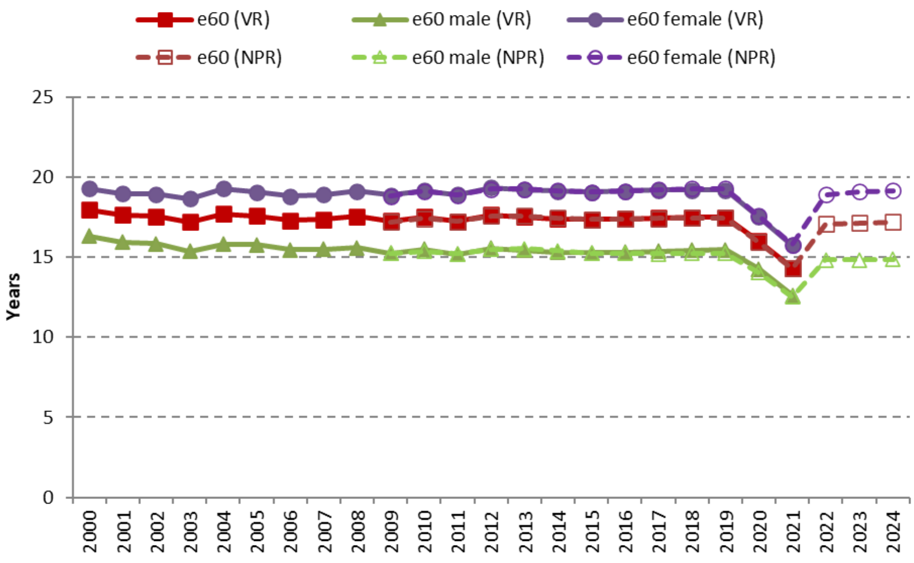


Figure 9: Life expectancy at the age of 60 (e_{60}) from VR and NPR, 2000-2024 (after adjusting for incompleteness)

CHILD MORTALITY (U5MR, IMR, NMR)

The annual number of deaths under-5 years of age on the NPR has declined from 34 006 in 2006 to 16 975 in 2024. The numbers of deaths by month, compared with the numbers of deaths reported by Stats SA for 2019-2021 (**Figure 10**) shows a high degree of correspondence between the two series, with the previously observed seasonal effect all but disappearing in 2020 but returning in 2021, with deaths higher over the winter months from May-August. The monthly numbers of deaths in 2020 were unusually low in April and May and show no seasonal trend in the following months probably the result of impact of lockdown in the early months of COVID-19 pandemic. The monthly NPR deaths in 2022, 2023 and 2024 indicate discernible variations in the timing of the seasonal variations.

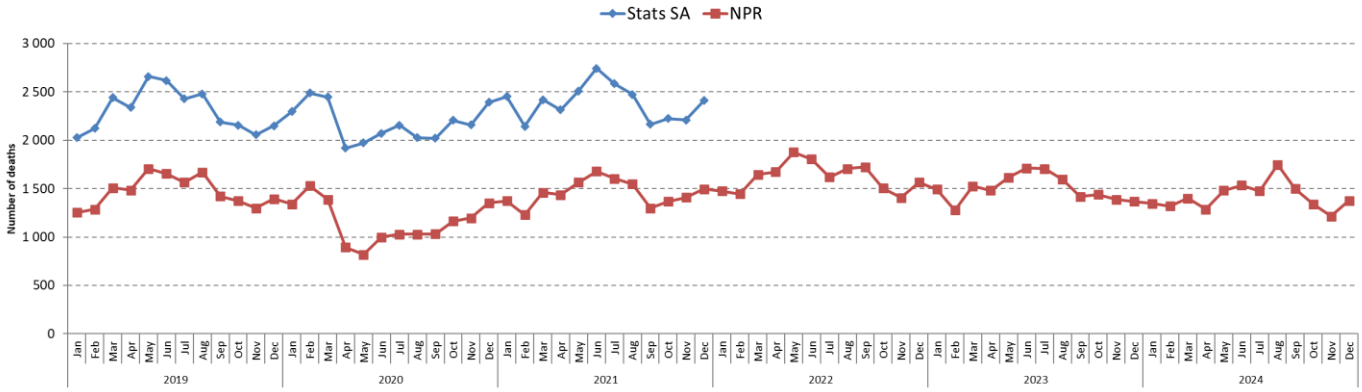


Figure 10: Monthly number of child deaths under-5 years from Stats SA and NPR, 2019-2024

The trends in the numbers of deaths by selected causes in the Stats SA data for 2017-2022, are shown in **Figure 11**. Previous RMS reports highlighted that the characteristics seasonal patterns for both diarrhoeal deaths (ICD code A09) and pneumonia deaths (ICD code J18) have attenuated over time. A summer peak in Feb-March for diarrhoeal deaths (ICD code A09) had almost disappeared in 2021 but reappeared in 2022. A winter peak in pneumonia deaths (ICD code J18) as well as deaths from diarrhoea (ICD code A09) persist. In 2022, pneumonia deaths (ICD code J18) showed a marked peak in May. The deaths from causes originating in the perinatal period (ICD codes P00-P99) generally do not follow any seasonal trend, while the deaths without any cause (ICD code R99) tend to follow the pneumonia pattern with a winter peak (excepting in 2020). The HIV deaths (ICD codes B20-B24), including pseudonyms (ICD codes B33 and D84), are low and may reflect a tendency of not disclosing HIV in the sequential cause of death data provided by medical attendants in the death notification forms. The monthly number of deaths from causes originating in the perinatal period (ICD codes P00-P99) were higher in 2020 and the first half of 2021 but declined thereafter. It should be noted that the fall-off in numbers of deaths in 2022 may be exaggerated by delayed transfer of death notifications from DHA to Stats SA.

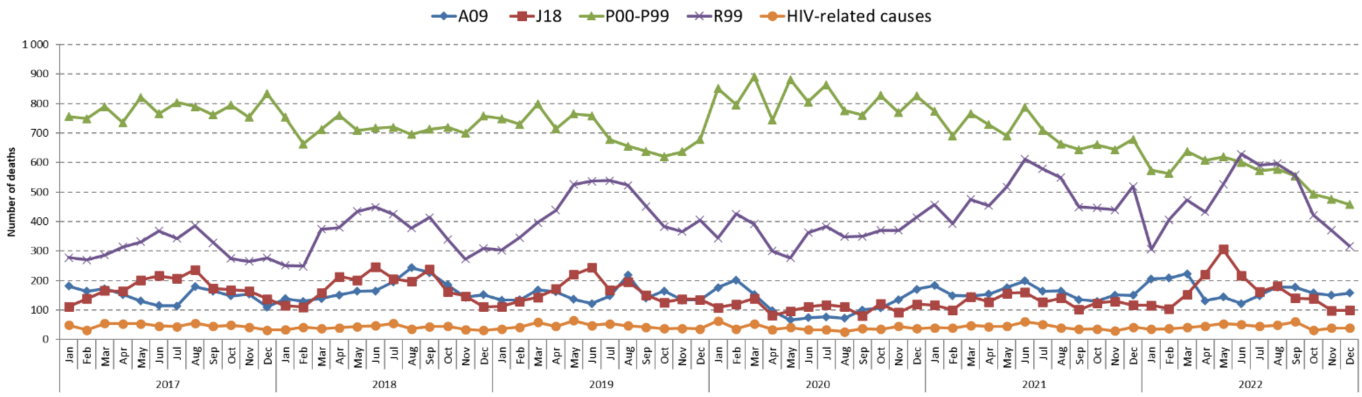


Figure 11: Number of child deaths under-5 years of age by selected cause of death, Stats SA 2017-2022

Figure 12 shows the monthly number of deaths under age 5 from the NPR by year (with the lines becoming darker as the years progress to 2024). The trend in 2020 was quite different from other years and is likely associated with the severe lock-down conditions during the first year of the COVID-19 pandemic. Health facility surveillance data show marked declined in influenza and respiratory syncytial virus (RSV) during 2020 (Tempia *et al*, 2021). However, it is likely that some of the drop in numbers in April and May is due to the halting of registration of births for part of that period. This is because a death is not recorded on the NPR if the child is not on the NPR, and the child will not be on the register if the birth is not registered. Thus, the NPR numbers understate the numbers of deaths in these two months. The number of deaths in 2022 peaked in May which is earlier than usual. **Figure 11** indicates that this was associated with high numbers of lower respiratory infections.

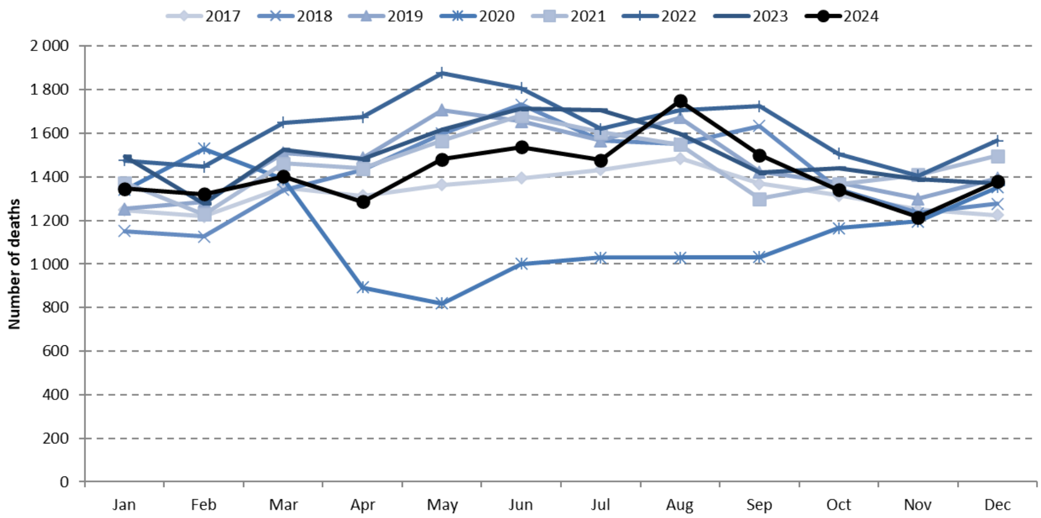


Figure 12: Number of child deaths under-5 years by month, NPR 2016-2024

When compared with the vital registration data from Stats SA, it is found that neonatal deaths on the NPR account for only a small proportion of the registered deaths in that age group. In addition, this proportion is not stable over time. For these reasons, it is necessary to consider an alternative data source, such as the health facility data from the DHIS, to monitor the level of the neonatal mortality rate (NMR).

Figure 13 shows the number of neonatal deaths and stillbirths from the DHIS (in blue) compared to the corresponding numbers from the cause-of-death vital registration (VR) data (in red). Also included on the figure are the early and late neonatal rates from the DHIS (in blue), based on deaths per 1 000 live births in the first 7 days and the next 21 days after birth, respectively. Neonatal deaths from the VR data (red diamond) were fairly steady from 2006-2009 but declined over the next four years after which they appear to have levelled off. The number of neonatal deaths in the DHIS (solid blue diamond), on the other hand, has increased steadily from 2008 to 2021, overtaking the VR deaths in 2012. At the same time the VR data of registered stillbirths (red squares) shows little change over the period at a level of about 15 000 with a dip in 2016 and a gentle increase to a peak in 2021 followed by a drop. Stillbirths captured by the DHIS (blue squares) declined from 2008 to 2016, before increasing to a peak in 2021 and declining again thereafter. The decline from 2015 to 2016 as well as the increase in 2021 match the trends in the VR stillbirths.

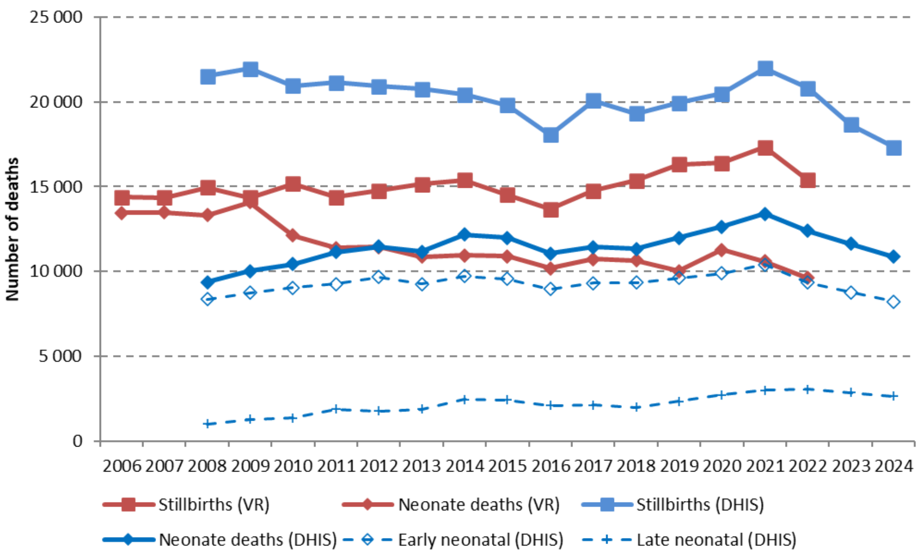


Figure 13: Stillbirths and neonatal deaths from VR and DHIS 2006-2024

The challenge with estimating the trends in neonatal deaths is that the VR system misses neonatal deaths that have not been registered, while the DHIS misses the deaths that occur in private sector facilities or at home. The completeness of neonatal deaths recorded in the DHIS appears to have increased during the beginning phase of the data series: in 2008, the DHIS captured 72% of the number of the VR neonatal deaths, 75% in 2009, and 86% in 2010. By 2011, the number of neonatal deaths in the DHIS matched the number of the VR neonatal deaths and since then the number has risen above the numbers of VR deaths in recent years. From 2016 onwards, the neonatal mortality is estimated directly from the DHIS record of neonatal deaths (instead of VR neonatal deaths) and live births recorded by the DHIS.

Estimates of the key indicators of mortality for children for the period 2018-2024 are shown in **Table 2. Figure 14** shows the U5MR, IMR and NMR for the period 2000-2024. The U5MR and IMR are calculated from VR data for the period 2000-2021 and from the NPR data for the period 2009-2024, once the data have been adjusted for under-registration by each data source. There was a slight increase in the IMR and U5MR in 2018, however while the IMR remained unchanged in 2020, and U5MR experienced a significant reduction in 2020 to 30 per 1 000 live births, probably as a consequence of the very restrictive lockdown implemented from the end of March 2020, which limited social interaction, and infection (through non-pharmaceutical interventions). The IMR and U5MR increased in 2022 to 27 and 37 per 1 000 live births and then dropped to 24 and 33 per 1 000 live births respectively in 2024.

Table 2: Estimated U5MR, IMR and NMR per 1 000 live births, RMS and DHIS 2018-2024

INDICATOR	2018	2019	2020	2021	2022	2023	2024
Under-5 mortality rate (U5MR)	33	32	30	33	37	34	33
Infant mortality rate (IMR)	24	23	23	25	27	25	24
Neonatal mortality rate (<28 days) (NMR)*	11	12	12	12	12	12	13

* NMR is calculated from DHIS data

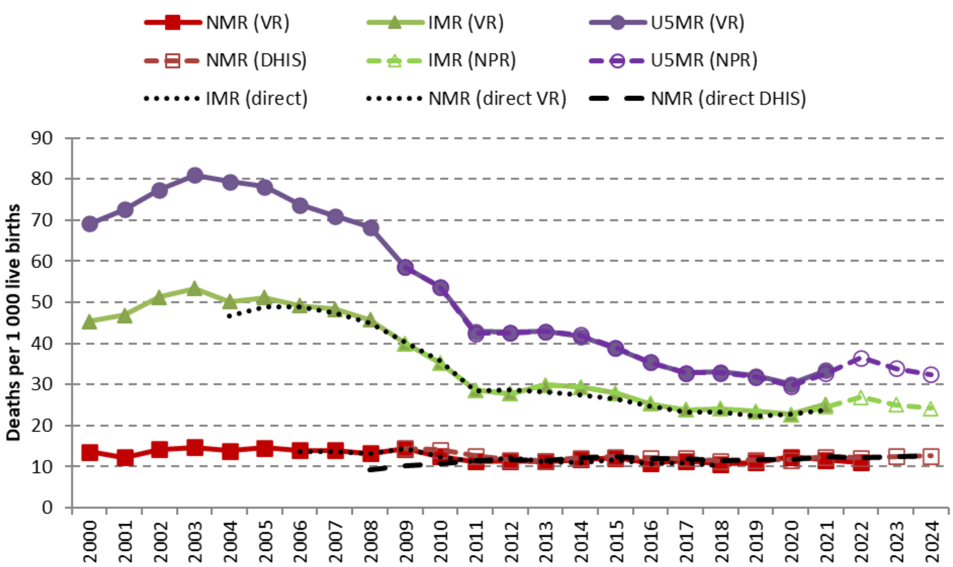


Figure 14: Under-5 mortality rate (U5MR) and infant mortality rate (IMR) from VR/RMS and neonatal mortality rate (NMR) from VR/DHIS, 2000-2024 (after adjusting for incompleteness)

The NMR is estimated from the registered deaths (adjusted for under-registration assumed to be at the same level as deaths under-1) for the period 2000-2022 and the DHIS (adjusted for under-coverage, relative to the registered deaths, and the incompleteness of the vital registration) for the period 2009-2024. From **Figure 14**, we can see that the estimates of the NMR derived from the DHIS are reasonably consistent with those derived later from the VR data, and that the NMR has declined gradually from 14 per 1 000 live births to 11 per 1 000 live births for the period 2009-2013, then increased slightly to 12 per

1 000 in 2014 and has remained at this level apart from a slight drop to 11 per 1 000 in 2018 and a slight increase to 13 per 1 000 in 2024.

Also included on the **Figure 14** are estimates of the IMR and NMR estimated directly from VR data (i.e., registered deaths without adjustment for incompleteness and the number of births registered up to the end of the registration year after the year of birth, also not corrected for incompleteness), as well as the direct estimation (without correction for incompleteness) of the NMR from DHIS deaths and births. These estimates confirm that it is possible to produce accurate estimates of the NMR and IMR from the recorded data directly. From 2013, the NMR is being estimated from the DHIS deaths

OLDER CHILDREN, ADOLESCENT AND YOUTH MORTALITY

This indicator has been included in this report owing to the growing interest in tracking the mortality of older children, adolescents and the youth (Hill, Zimmerman and Jamison, 2015 & 2017; Masquelier, Hug and Sharrow, 2018; UN IGME, 2018). From **Table 3** and **Figure 15** andFigure 16 one can note that although both indicators peak in 2004, ${}_{10}q_5$, the probability of a five-year old dying before age 15, is similar to under-5 mortality in that the male and female rates trend in parallel, with males higher than females. On the other hand, ${}_{10}q_{15}$, the probability of a 15-year-old dying before age 25, the trend in rates cross over, with female rates showing a distinctly higher peak in 2004 than males and then falling to below male rates from 2012. The sharp uptick in 2012 (and slight uptick in 2010) seen in the mortality of older children and young adolescents (${}_{10}q_5$) in **Figure 15** is associated with a higher number of deaths attributed to ill-defined natural causes in those years making an epidemiological interpretation impossible. It is possible that these increases were associated with campaigns to improve the registration of deaths. The rapid decline in mortality of older adolescent and youth (${}_{10}q_{15}$) among females since 2004 coincides with the provision of ARTs to pregnant women. This mortality rate is an essential impact indicator related to the "She Conquers" campaign[9] launched by government in June 2016 seeking to reduce HIV infections, improve overall health outcomes, and expand opportunities for adolescent girls and young women (AGYW). However, the rate of decline slowed down since 2014 despite the introduction of the campaign. The mortality rate among males aged 15-24 remained constant at around 25 per 1 000 from 2011 until 2019. The level decreased to 22.4 per 1 000 in 2020, reflecting the substantial reduction in unnatural deaths brought about by the severe limitations of travel and social interaction and alcohol consumption under the lockdown introduced in April 2020. However, the mortality rate among males aged 15-24 years increased to 27.7 per 1 000 in 2022 and, despite a slight decrease, has remained higher than the 2019 level at 26.0 per 1 000.

Table 3 : Estimated mortality rates of older children & young adolescents and older adolescents & youth, RMS 2018-2024

INDICATOR	2018*	2019*	2020*	2021*	2022	2023	2024
Older children & young adolescents (${}_{10}q_5$ per 1000)							
Total	6.5	6.2	5.5	6.3	6.0	5.7	5.2
Male	7.3	7.0	6.2	6.9	6.6	6.2	5.7
Female	5.7	5.4	4.8	5.7	5.5	5.2	4.6
Older adolescents & youth (${}_{10}q_{15}$ per 1000)							
Total	20.6	20.2	18.3	21.0	21.4	20.7	20.4
Male	25.2	25.3	22.4	26.1	27.7	26.6	26.0
Female	16.0	15.0	14.3	15.8	15.0	14.9	14.8

* Pre-2022 values are based on NPR+VR averages. Post-2022 values are based on NPR

[9] National Department of Health. She Conquers. Available: http://sheconquerssa.co.za. Accessed: 12 November 2024.

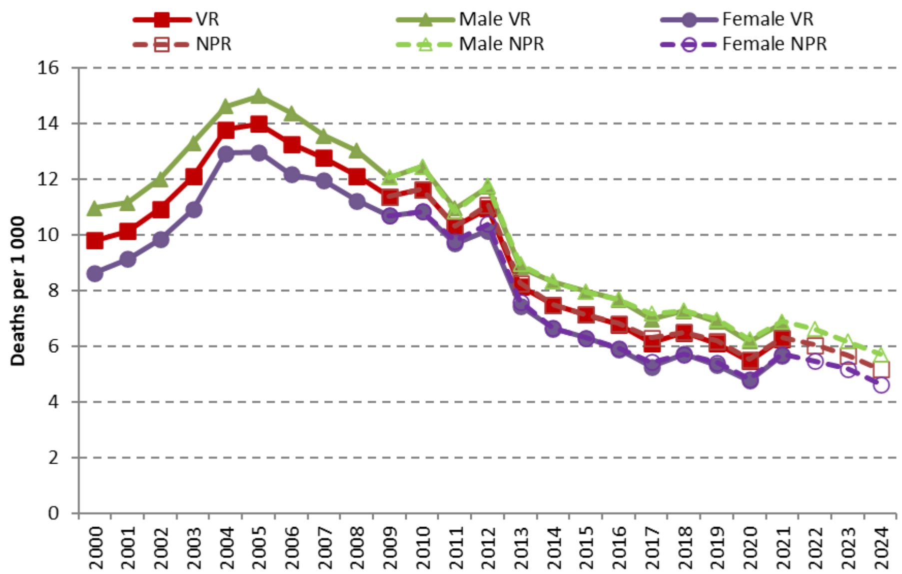


Figure 15: Estimate of $_{10}q_5$, the probability of five-year old dying before age 15, for males, females and both, 2000-2024

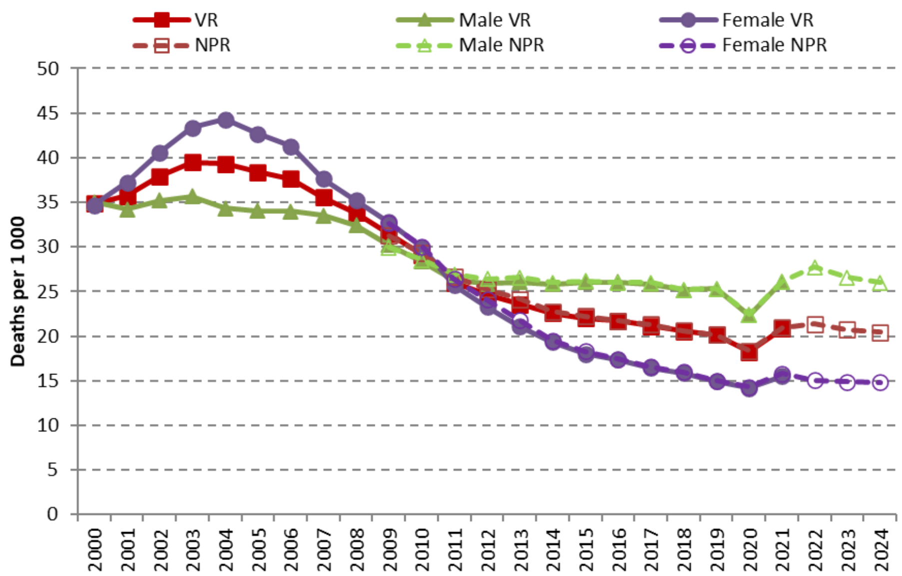


Figure 16: Estimate of $_{10}q_{15}$, the probability of 15-year-old dying before age 25, for males, females and both, 2000-2024

MATERNAL DEATH

The uncertainty about the level of maternal mortality is well-recognised (HDACC, 2011; Bradshaw and Dorrington, 2013; Stats SA, 2013b; Dorrington and Bradshaw, 2016). **Figure 17** shows the estimates of the maternal mortality ratios (MMRs) and pregnancy-related mortality ratios (PRMRs) produced from different data sources, including the institutional MMR (iMMR) based on confidential enquiry reported by the National Committee for Confidential Enquiry into Maternal Deaths (NCCEMD 2018; Moodley *et al*, 2020). By definition, MMR includes direct and indirect maternal causes of death, while the PRMR also includes incidental deaths during the pregnancy risk period. The RMS estimate of the MMR is based on the maternal deaths reported in vital registration, adjusted for completeness of reporting. Both series peaked in 2006, when the RMS estimate was just over 400 per 100 000 live births. In contrast the iMMR peaked in 2009, at a much lower level of nearly 200 per 100 000 live births. Strangely, the trough in the MMR occurred in 2018 for the vital registration data and hence the RMS estimate while it occurred in 2019 for the iMMR, and the estimated MMR was no higher than the iMMR for 2017 and 2018, possibly indicating that the base data from vital registration in these years was compromised.

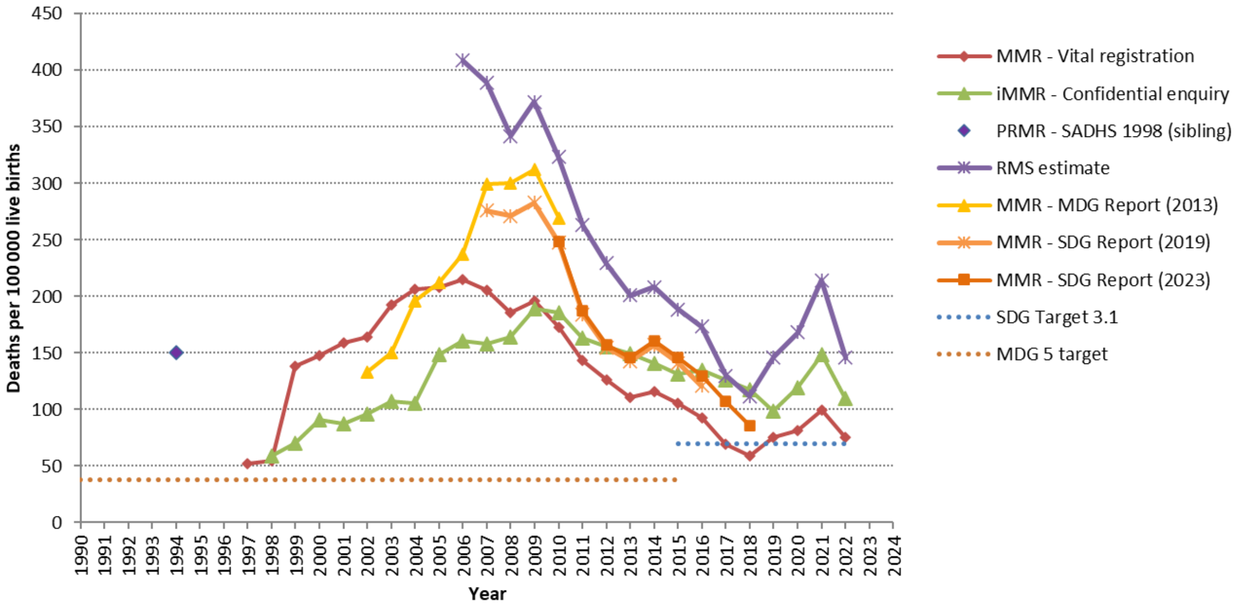


Figure 17 : Estimate of MMR from various sources, 1995-2022

The numbers of registered deaths from maternal causes, shown in **Figure 18,** indicate a marked increase in the number of indirect maternal deaths since 2000 followed by a decline from 2008 onwards. The decline in maternal deaths due to complications of non-pregnancy infections may primarily be the result of extensive provision of ARVs to pregnant women and the change in the ARV guideline to initiate HAART at a CD4 count of 350 cells/mm^3 (announced on 1 December 2009), as well as the move to use efavirenz instead of nevirapine when initiating women on HAART after the first trimester. Moodley *et al* (2020) highlight that by 2019, there had been a steady rise in early pregnancy deaths and deaths due to pre-existing medical and surgical conditions among the deaths reported to the confidential enquiry. Fawcus *et al* (2024) reported a 35% increase in the iMMR during 2020 and 2021, attributed to the direct and indirect effects of COVID-19. While the number of registered maternal deaths due to complications of other non-pregnancy increased during COVID-19, those due to other conditions showed a sudden increase in 2019, the year before the COVID-19 pandemic. It is difficult to interpret this suggesting that changes in coding and data processing may have made the series erratic. Regardless of the period 2017 – 2020 when the RMS estimate of the MMR appears erratic, the MMR reached a high of 214 per 100 000 live births in 2021, during COVID-19 and dropped to 146 per 100 000 live births in 2022 (**Table 4)**. Pillay and Moodley (2024) highlight the large provincial variations in maternal care and outcomes as reflected by the iMMR and stress the need to strengthen the NDOH leadership role to ensure that the country meets the SDG target for maternal mortality of no more than 70 deaths per 100 000 live births.

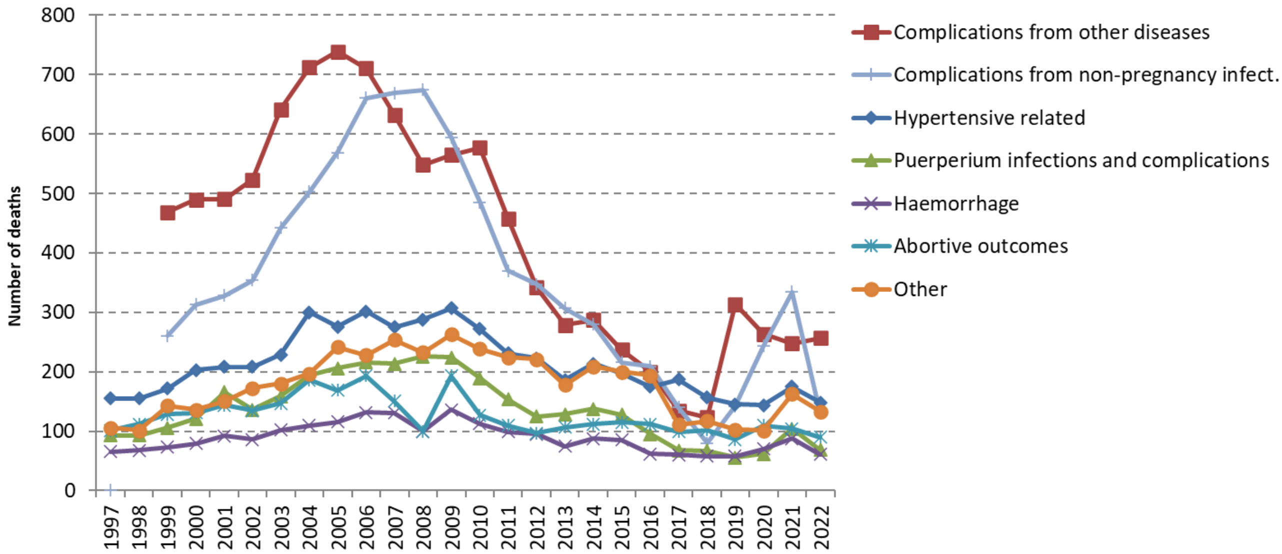


Figure 18 : Trend in the number of maternal deaths by cause, Stats SA 1997-2022

Table 4: Estimated MMR per 100 000 live births, RMS and Stats SA 2016-2022

INDICATOR	2016	2017	2018	2019	2020	2021	2022
Maternal mortality ratio (MMR)	173	130	112	146	168	214	146

PREMATURE MORTALITY DUE TO NON-COMMUNICABLE DISEASES (30-69 YEARS)

Since the 2017 report, an indicator for tracking premature mortality due to non-communicable diseases (NCDs) has been monitored. These indicators ($_{40}q_{30}$) are estimated by applying the proportions of deaths observed in the VR data due to cardiovascular disease (CVD; ICD-10 codes I00-I99), cancer (ICD-10 codes C00-C97), chronic respiratory disease (CRD; ICD-10 codes J30-J98) and diabetes (ICD-10 codes E10-E14), adjusted for a proportion on the ill-defined natural causes (ICD-10 codes R00-R99) to the estimated total number of deaths. A life table method is used to calculate the probability, expressed as a percentage, that a 30-year-old-person would die before their 70th birthday from cardiovascular disease, cancer, diabetes, or chronic respiratory disease, assuming that s/he would experience current mortality rates at every age, and s/he would not die from any other cause of death (e.g., injuries or HIV/AIDS). It should be noted that the South African National Burden of Disease Study (Pillay-van Wyk *et al,* 2014, Pillay-van Wyk *et al,* 2016) used a more complex methodology to adjust for additional forms of misclassification of causes of death and produces slightly different estimates for these indicators.

The overall NCD $_{40}q_{30}$ is shown in **Table 5** as well as the component for each disease category while **Figure 19** shows the trend in the estimates of the overall NCD $_{40}q_{30}$, for males, females and both sexes combined for the period 2000-2022. Although the rates for women are about 70 per cent of those for men, the trends over time are very similar, rising to a peak (of 37% for men and 28% for women) in 2003 and then declining to 33% for men and 24% for women by 2012, after which the rates remain more or less level until 2016 with a slight decline until 2019. Rates increased during 2020 and 2021, in line with the COVID-19 pandemic, but dropped to pre-COVID levels in 2022. However, these results should be treated with caution as they may be, in part at least, the result of a decline in completeness of reporting or increase in the proportion being recorded late, and some deterioration in the quality of attribution of cause of death in recent years indicated by an increase in the proportion of ill-defined natural causes.

Table 5 : Estimated mortality rates (NCD $_{40}q_{30}$) due to non-communicable diseases (NCD), RMS and Stats SA 2015-2022

INDICATOR		2016	2017	2018	2019	2020	2021	2022
NCD $_{40}q_{30}$	Total	29%	29%	29%	28%	28%	29%	27%
	Male	34%	34%	34%	32%	32%	33%	32%
	Female	25%	24%	24%	23%	25%	25%	22%
INDICATOR		**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Cardiovascular disease $_{40}q_{30}$	Total	14%	14%	13%	14%	14%	14%	14%
	Male	17%	17%	16%	16%	17%	17%	17%
	Female	11%	11%	10%	11%	11%	11%	11%
Cancer $_{40}q_{30}$	Total	9%	9%	9%	9%	8%	8%	8%
	Male	11%	11%	10%	10%	9%	9%	9%
	Female	8%	8%	8%	8%	7%	7%	7%
Diabetes $_{40}q_{30}$	Total	4%	4%	4%	4%	3%	4%	3%
	Male	6%	6%	6%	5%	5%	5%	5%
	Female	2%	2%	2%	2%	2%	2%	2%
Chronic respiratory disease $_{40}q_{30}$	Total	5%	5%	6%	5%	7%	7%	6%
	Male	5%	6%	6%	5%	7%	7%	6%
	Female	5%	6%	5%	5%	7%	7%	5%

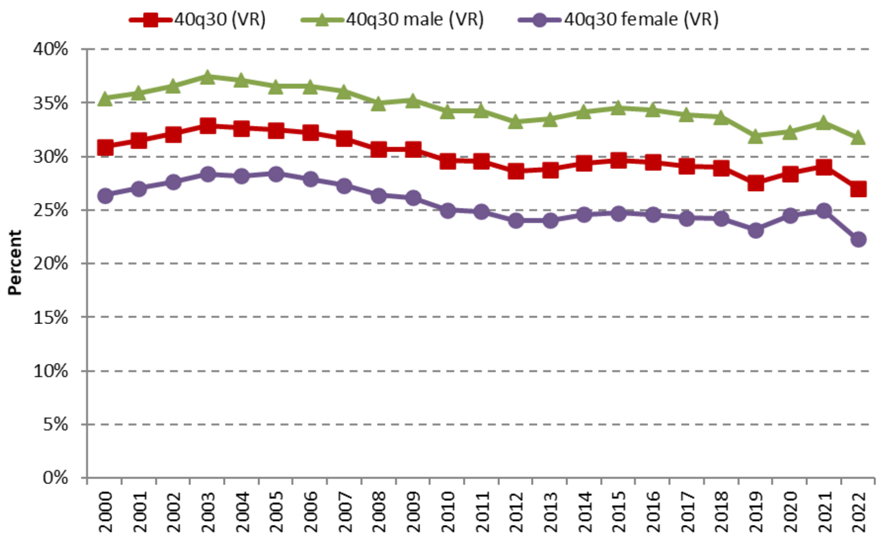


Figure 19 : Estimate of $_{40}q_{30}$, the probability of 30-year-old dying before age 70, due to non-communicable diseases, for males, females and both, 2000-2022

Figure 20 : Trend in cause-specific ${}_{40}q_{30}$, the probability of 30-year-old dying before age 70, due to non-communicable diseases, for males and females, 2000-2022 presents the mortality rates (${}_{40}q_{30}$) by major NCD causes for males and females separately for the period 2020-2022. The trends for each cause differ over time, both pre- and during-COVID-19. Before COVID-19, there were downward trends in CVD from a peak in 2003 and in CRD from a peak in 2005. Diabetes increased for both males and females up to 2018 while premature mortality from Cancer was more stable over the period for both males and females, before COVID-19. Premature mortality increased for CVD and Diabetes during 2020 and 2021, both being co-morbidities associated with COVID-19. In contrast, premature mortality from Cancer decreased. It is unclear whether the decrease resulted from disruption to health services resulting in less frequent cancer diagnoses or possibly mortality displacement (a harvesting effect) with people succumbing to death from other conditions before cancer could result in death.

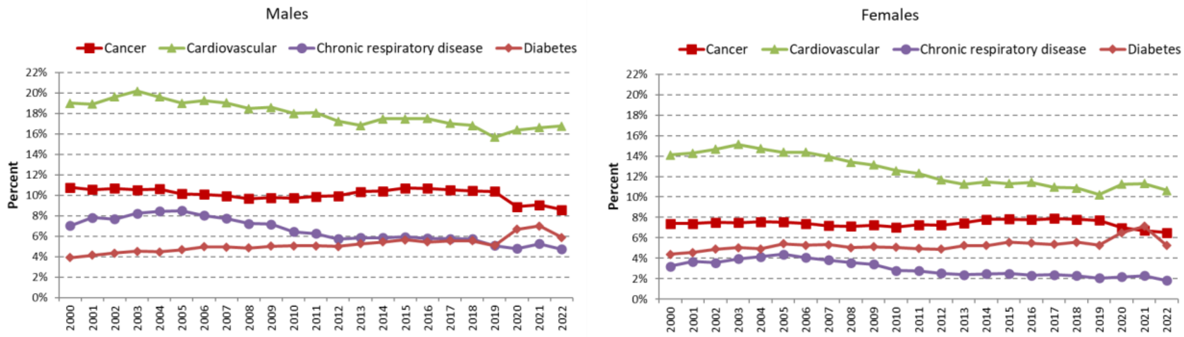


Figure 20 : Trend in cause-specific ${}_{40}q_{30}$, the probability of 30-year-old dying before age 70, due to non-communicable diseases, for males and females, 2000-2022

Regarding sex differences by cause, cancer premature mortality rates for females are about 73% of those for males over the whole period. For cardiovascular diseases, the female-to-male ratio falls from 75% in 2000 to 63% in 2022. Whereas for chronic respiratory diseases, the ratio rises from 46% in 2000 to above 50% in 2005/6 then falls to 39% by 2022. In the case of diabetes, the premature mortality rate for females is higher than that for males in the earlier period with the ratio starting at 112% in 2000 and falling to about 97% by 2017 and declining to 90% by 2022.

COMPARISON WITH ESTIMATES FROM OTHER SOURCES

As done previously, the estimates from the Rapid Mortality Surveillance are compared with updated estimates from Stats SA (from the official mid-year population estimates, the SDG and other ad hoc reports), UN agencies (WHO and UN Population Division), their advisory groups including the UN Inter-agency Group for Child Mortality Estimation (IGME) and the Maternal Mortality Estimation Interagency Group (MMEIG) and the Gates-funded Institute for Health Metrics and Evaluation (IHME) based at Washington State University (in particular the estimates from the 2013, 2015, 2016, 2017, 2019 and 2021 Global Burden of Disease (GBD) reports (not shown), and the GBD 2023 report). In addition, estimates of the under-5 and neonatal mortality from the 2016 South African Demographic and Health Survey (NDOH, Stats SA, SAMRC & ICF, 2017) are included.

Child mortality rates (U5MR, IMR, NMR)

Figure 21 compares the estimates of under-5 mortality. There is broad agreement between the RMS estimates and those of IGME (United Nations Interagency Group on Child Mortality Estimation 2024) and those of the World Population Prospects (WPP), 2024 revision (UN Population Division 2024) over much of the period to 2024, and the SDG (Stats SA 2017b) estimates for 2010 and 2011. While estimates from some of the previous releases of GBD estimates were consistent with the RMS estimates for a significant period of years (e.g. 2003 to 2010 for the GBD 2021 estimates) the GBD2023 estimates were only similar to the RMS up to 2004 after which the GBD2023 overestimates the mortality of children under-5, particularly through to 2013. Despite the most recent official mid-year population projection (Stats SA 2025) showing a very similar trend to the RMS estimates through to 2011, the official estimates fall somewhat below the RMS estimates for periods after that, particularly so over the COVID-19 years. On the other hand, the estimates derived from the 2011 census (Stats SA 2015b) and the SDG estimates after 2011 are lower than all other estimates, suggesting that these probably underestimate under-5 mortality. The similarity though of RMS to IGME estimates is probably because IGME now consider the RMS estimates when producing their estimates. However, a common feature of estimates produced by models is that they are unable to reproduce periods of stagnation or rapid changes in rates found in estimates derived from empirical data. The RMS estimates are not consistent with those from the 2016 SADHS (for the period 2002-2006), which is undoubtedly due to the bias in the SADHS estimates since women infected with HIV may have died and thus there is no record of the mortality of their children. Other than that, the estimates are largely consistent with those from the SADHS for the period 2009 to 2014, suggesting that the recent estimates from other sources are probably on the high side.

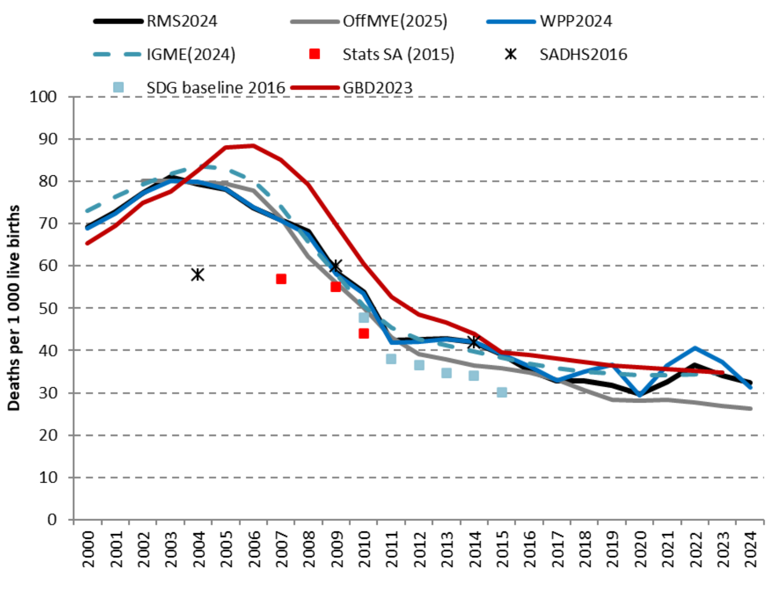


Figure 21: Comparison of estimates of the under-5 mortality rate (U5MR), 2000-2024

The RMS estimates for IMR are broadly similar with IGME estimates until 2011 **(Figure 22**). From 2012 onwards estimates of infant mortality rates in the RMS are lower than most other sources other than SDG 2016 estimates, which could suggest that the RMS estimates of IMR may be too low in recent years. However, further investigation suggests that it is possible that the SADHS misclassified stillbirths as neonatal deaths nationally. In addition, the SADHS underestimated the under-5 mortality substantially in KwaZulu-Natal. Correcting for these biases would produce estimates for the most recent period that are much more consistent with the RMS estimate. Estimates from the GBD 2023 and official mid-year estimates 2025 are both higher than the RMS estimates for the whole period, except between 2014 and 2024 when official estimates are similar to the RMS.

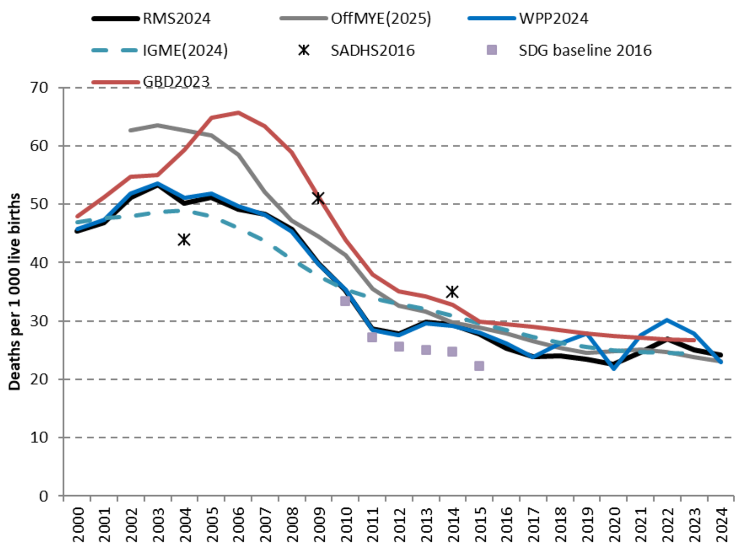


Figure 22: Comparison of estimates of the infant mortality rate (IMR), 2000-2024

The RMS estimates for neonatal mortality rates lie between those of GBD 2023 and IGME through to 2010 after which they are similar to the IGME estimates which are lower than the GBD 2023 estimates (**Figure 23**). Although it is difficult to be sure that the neonatal mortality in South Africa has been low throughout the period as estimated by the RMS, it is important to point out that the GBD 2023 are the lowest yet released by IHME, with estimates decreasing over the years with each new release since 2015 when the estimates implied implausible levels and trends in completeness of registration of deaths.

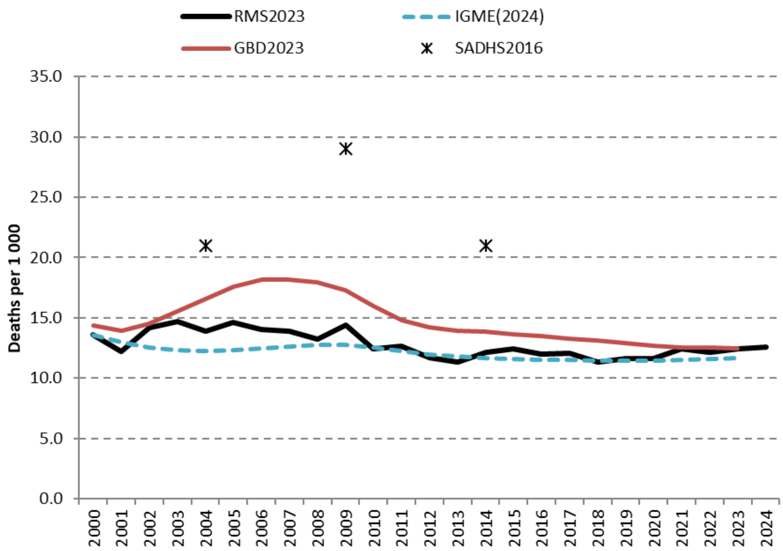


Figure 23: Comparison of estimates of neonatal mortality rates (NMR), 2000-2023

Life expectancy at birth

Figure 24 compares the life expectancy at birth with those from other sources. It shows that, while there is some consistency in the overall conclusion that life expectancy reached a minimum around 2004/2005, the GBD2023 estimates are very similar to those of the RMS apart from being a year or so higher through to 2005. Although the WPP 2024 estimates are similar to the RMS estimates at the minimum they are about 1 year higher from 2010 to 2020. The most recent official mid-year estimates (Stats SA, 2025) are similar to the RMS at the minimum but several years higher than the RMS estimates after that particularly at the height of the COVID-19 pandemic in 2021 (although the difference is exaggerated by having to average projection year estimates[10] to match calendar years used by the other estimates). In all cases, the life expectancy of females is higher than that of males throughout the period with the difference higher in 2000

[10] Published MYPEs for 'year' Y are those for the 12 months starting 1 July Y-1.

than in 2013 and beyond, declining to a minimum in 2005 (not presented). However, while according to the RMS the difference declined from 5.8 years in 2000 to 3.6 years in 2005 before rising to 5.2 years in 2010 and 6.6 in 2018 before falling to 5.7 during COVID-19 and recovering after that, the comparable figures for GBD 2023 (IHME 2025) were 6.5 years, 4.4 years, 5.4 years and 6.6 years, remaining between 6.4 and 6.5 years through COVID-19 and beyond.

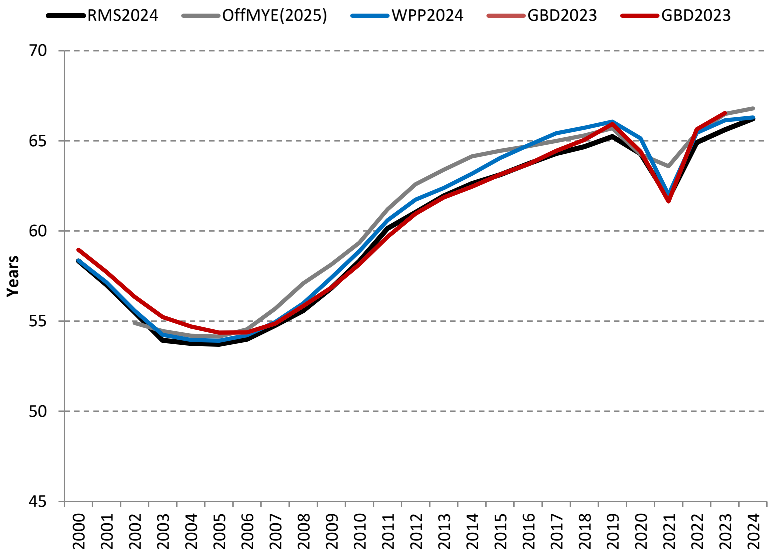


Figure 24: Comparison of estimates of life expectancy at birth (e_0), 2000-2024

Maternal mortality ratio

Although there is consistency between the RMS and SDG estimates of MMR, this is mainly because the same method and similar data were used for these estimates. In truth, as pointed out by Dorrington and Bradshaw (2015), there is a great deal of uncertainty surrounding the estimates of this indicator, and not all of it is random, as reflected by the four quite different estimates (not shown) produced by IHME (Hogan *et al,* 2010, Lozano *et al,* 2011, and Kassebaum *et al,* 2014, IHME 2015 and subsequent releases through to GBD 2023) two of which, GBD 2014 and GBD 2016 were quite close the current RMS estimates, and the quite different estimates produced by MMEIG (WHO *et al*, 2012 & 2014, and subsequent) (not shown) and the most recent estimate (MMEIG 2024). The latest GBD 2023 estimates from IHME peak later and somewhat lower than the RMS estimates ending up higher than the RMS estimates except for the peak in the COVID-19 years which the GBD estimates ignore. However, although the most recent revision of the RMS MMR is in the upper range of the 'cloud' of other estimates in the early years they are sufficiently close to the higher estimates to suggest they are at least as reliable as any of the estimates shown in **Figure 25**. Surely, they are more sensible than estimates that suggest that HIV/AIDS had little or no impact on maternal mortality or estimates that suggest the ratio peaked several years before adult mortality rates peaked because of HIV/AIDS.

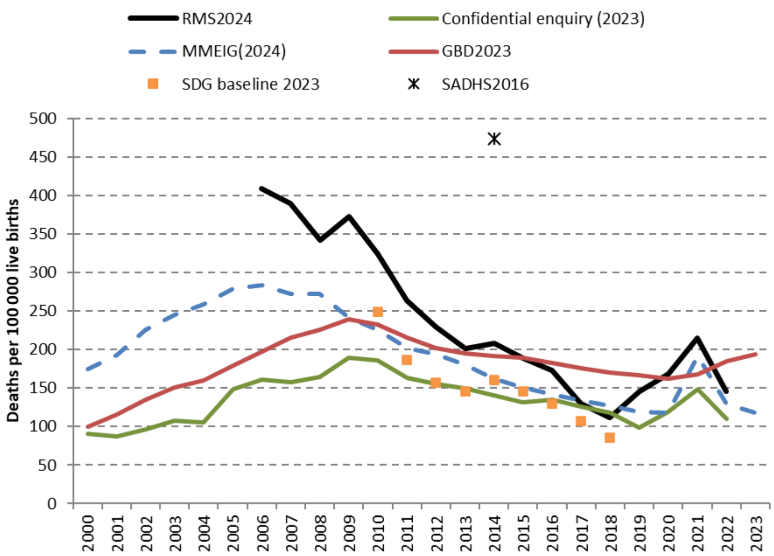


Figure 25: Comparison of estimates of maternal mortality ratio (MMR), 2000-2024

Adult mortality

As far as adult mortality (i.e. probability of a 15-year-old dying by age 60 ($_{45}q_{15}$)) is concerned, the RMS estimates lie above the IHME's GBD 2023 estimates over the HIV/AIDS peak but are close and very close to the WPP estimates, albeit the most recent point which is decidedly odd (**Figure 26)**. As indicated above, the IHME estimates of life expectancy at birth are lower than all the other estimates, which is consistent with their estimates of adult mortality being quite a bit higher than both the RMS and the WPP estimates, except for the improbable decline in rates from 2017 to 2018 (**Figure 24**).

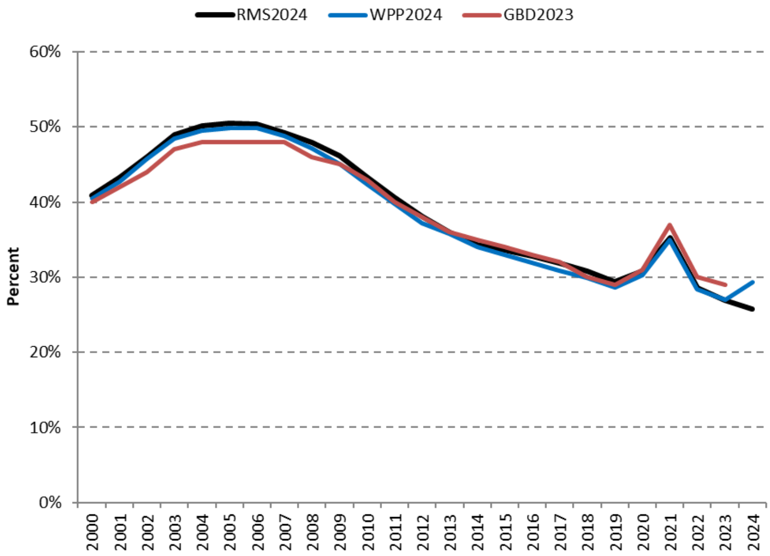


Figure 26: Comparison of estimates of adult mortality ($_{45}q_{15}$) for males and females combined, 2000-2024

Older children, adolescent and youth mortality

Finally, the RMS estimates of the $_{10}q_5$ and $_{10}q_{15}$ are reasonably consistent with estimates from WPP 2024 and IGME 2023, but less so with GBD 2021 (**Figure 27**). The GBD 2023 estimates for young children and young adolescent ($_{10}q_5$) shown in left-hand panel of Figure 27 are lower than the RMS and other sources until 2005 after which they become higher than all other estimates before falling below again during and after COVID-19. For older adolescent and youth (right-hand panel of Figure 27), IHME estimates start off below all other sources until 2011, after which they are similar to other estimates falling below only during and after COVID-19.

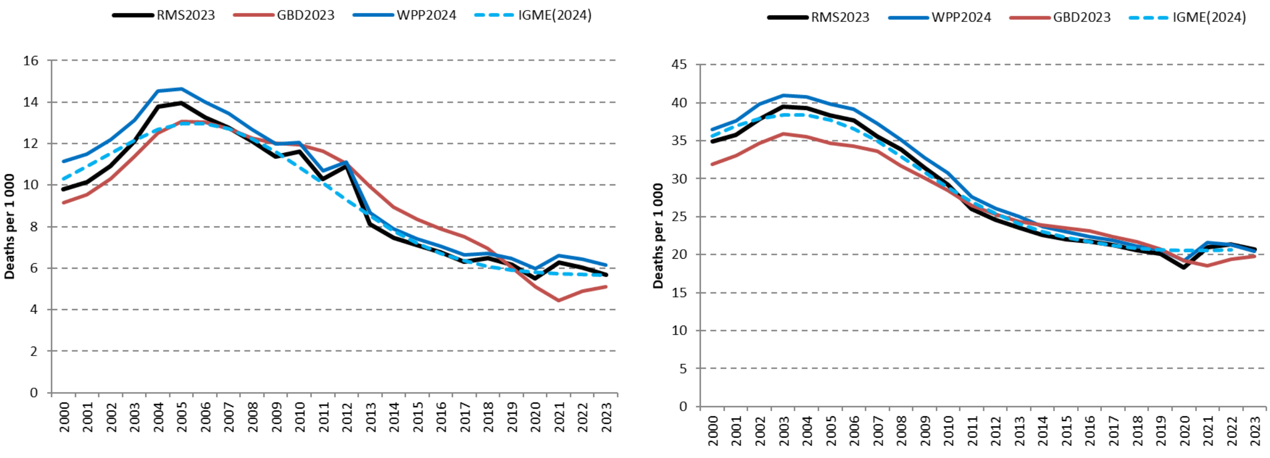


Figure 27: Comparison of estimates of older children & young adolescent and older adolescent & youth mortality rates ($_{10}q_5$ and $_{10}q_{15}$), 2000-2023

CONCLUSIONS

The mortality estimates show that South Africa's progress in extending life expectancy and reducing mortality since 2005 was interrupted by the SARS-CoV-2 pandemic. Estimates derived from empirical data indicate that life expectancy increased by more than ten years from the low of 53.7 years in 2005 to reach 65.1 in 2019 only to fall to 61.8 years in 2021. By 2024, the improving trend in life expectancy had recovered, reaching 66.2 years. The drop in life expectancy in South Africa associated with COVID-19 in 2020 was less than has been the case where it has been measured in other, mostly developed, countries, but lower than a few selected countries (Cao *et al*, 2023). In addition, in contrast to the experience in the majority of countries reported by Aburto *et al* (2021) and Cao *et al* (2023), the impact on life expectancy in South Africa has been greater for females who experienced a drop of 3.7 years than for males who experienced a drop of 3.2 years in life expectancy between 2019 and 2021. The muted impact of COVID-19 is mainly due to the impact of the severe lockdown (restricting social interaction and travel) and non-pharmaceutical interventions (NPIs) on non-COVID mortality. In the case of males, the marked reduction in the number of deaths from unnatural causes during periods of stringent lockdowns including alcohol restrictions (Moultrie *et al,* 2021, Barron *et al,* 2024) has contributed to their improved life expectancy. However, the drop in life expectancy experienced in South Africa between 2020 and 2021 of 2.4 and 2.3 years for males and females respectively was more severe than reported for other countries (Polozzi *et al*, 2025). By 2022, life expectancy had increased by 3.8 years for females and 2.6 years for males respectively, but the annual increase experienced in 2023 and 2024 reverted to levels of 0.4-0.9 years. At this pace of improvement, South Africa is unlikely to meet the NDP target of 70 years by 2030.

Life expectancy at age 60 is a useful summary of the mortality experienced by older South Africans. For the first time since 2000, there have been marked changes in older age mortality. The life expectancy at age 60 has been about 17.4 years (15.2 years for men and 19.3 years for women) prior to 2019, but dropped in 2020 and reached a low in 2021 when the average life expectancy at age 60 years fell to 14.3 years (12.5 years for men and 15.8 years for women respectively), reflecting the impact of COVID-19 mortality. The drop over the two-year period was greater for females (3.5 years) than for males (2.7 years). Even before the COVID-19 pandemic, South Africa's life expectancy at age 60 was well below the global average life expectancy at age 60 years of around 20.4 years for 2020 as estimated by the UN (2024). The stark switch-over in 2018 with the numbers of deaths of older persons (60+ years) exceeding the numbers of deaths of young adults (15-59 years), emphasises the need for the country to carefully consider how to improve the health of older people in South Africa and the implications for health care.

Infant and under-5 mortality has been declining since 2003, except for periods of stagnation between 2011 and 2014 and 2017 and 2019, reaching new national lows of 23 and 30 deaths per 1 000 live births in 2020 respectively. While childhood mortality does not appear to have been impacted by COVID-19, the strong lockdown during 2020 appears to have helped reduce childhood mortality. Of concern is that infant and under-5 mortality rates increased in 2022 which may be associated with disruptions in the provision of health services resulting from the COVID-19 pandemic. It is therefore pleasing to see that mortality rates declined in 2023 and 2024. In contrast, the neonatal mortality rate had shown little change since 2010 and remained at 12 deaths per 1 000 in 2020 with a slight increase to 13 deaths per 1 000 in 2024. As highlighted previously, by 2011, neonatal causes of death had overtaken HIV/AIDS as the leading causes of death among under-5-year-olds. A further reduction in child mortality will require further efforts to improve and equitably implement across districts, the basic health services aimed at preventing neonatal deaths, elimination of mother-to-child transmission of HIV, the Expanded Programme of Immunisation as well as reducing the incidence of pneumonia and diarrhoea (Nannan *et al*, 2019). In addition to strengthening primary health care, promoting exclusive breast-feeding and addressing environmental and social factors associated with poor infant and child health are needed (Goga *et al*, 2019). Analysis of routinely collected health service data highlighted the detrimental impact of COVID-19 lockdowns on primary health care, calling for urgent intervention if the SDG targets are to be met (Pillay *et al*, 2022).

An indicator of the mortality of older children and young adolescents aged 5-14 years ($_{10}q_5$) was introduced in the 2017 Rapid Mortality Surveillance Report. Global estimates have highlighted concerns that although mortality is low, most of these deaths are preventable and thus the public health community must not lose sight of the fact that decades of growth and development in the transition to adulthood also involve complex processes and crucial ages or periods in the life cycle that are sensitive to intervention (Bundy *et al*, 2018). Although the mortality rates of older children and young adolescents have declined in South Africa, greater attention is needed to prevent illness and injury and promote optimal health, growth and development which include key challenges of malnutrition, HIV, violence and mental health conditions (Lake *et al*,, 2019). The growing burden of mental health of young people is of major global public health concern (Lakasing & Mirza, 2021; Racine *et al,* 2021). The 3rd Disease Control Priorities project has identified two cost-effective and scalable health interventions including a school package promoting healthy behaviours, preventing diseases, and connecting students with necessary health services during older childhood years (5–9 years) and phase-specific support during adolescence (10–19 years) enabling substantial catch-up from early growth failure and support brain maturation (Bundy *et al*, 2018). In South Africa, mortality of older children and young adolescents has declined from a (HIV/AIDS related) peak in 2004 with the provision of ARVs, although, for males the rate stagnated from 2011 to 2019, it dropped significantly in 2020 due to the impact of strict lockdown on unnatural deaths, in particular. Mortality in this age group reverted to higher levels in 2021 before resuming a continued decline. Increased attention to preventing injury deaths is likely needed to reduce the higher rates experienced by males.

The MMR was estimated at 146 per 100 000 live births in 2022. While it is clear that the MMR has decreased from a high in 2006, and that there was a distinct increase in the MMR associated with COVID-19, there is uncertainty in the actual level of the MMR resulting from erratic numbers from vital registration for the period 2017- 2019 as well as the adjustment we have applied for misclassification of maternal deaths. Since there is no South African data on which to base the adjustment for misclassification, we have been guided by the approach used by the UN advisory group on Maternal Mortality (MMIEG) but have kept it constant for the whole period. Despite the uncertainty of true level of the MMR, South Africa still has some way to go to reach the SDG target of 70 per 100 000 live births by 2030. In an analysis of the data collected by the NDoH, Pillay and Moodley (2024) point to the large provincial variations in maternal care and outcomes and stress the need to strengthen the NDOH leadership role to ensure that the country meets the SDG target for maternal mortality of no more than 70 deaths per 100 000 live births by 2030.

Premature mortality from NCDs has decreased from the high of 33% in 2003, to a level of 29% in 2022. The drop has not been consistent over time showing stagnation over the period 2011-2017 and sudden changes during COVID-19. The risk of a 30-year-old dying before age 70 from the selected NCDs considered to be preventable is 33% for males and 25% for females. The risk factors associated with these NCDs, including overweight and obesity, raised blood pressure, increased blood glucose levels and non-optimal blood cholesterol levels (particularly raised LDL cholesterol), which are considered modifiable through changes in behaviours or medications. The key behaviours that would reduce the risk factors for NCDs are eating a healthy diet, participating in regular physical activity, not using tobacco and avoiding harmful use of alcohol. The 2016 SADHS has identified concerning levels of raised blood pressure, overweight and obesity, tobacco use and alcohol use (NDOH, Stats SA, SAMRC & ICF, 2017). These were also observed in the 2012 SANHANES, including a high prevalence of diabetes and low levels of physical activity (Shisana *et al*, 2014). Renewed focus on NCDs is required to reduce premature mortality from these conditions. The National Strategic Plan for the Prevention and Control of Non-Communicable Diseases (NDOH, 2022; NDOH, 2013) identified important policy options to influence these risk factors which need to be implemented together with community-based interventions as well as improving primary health care to diagnose and manage these risk factors and their complications. Unfortunately, there is no recent population-based data on the risk factors to assess trends.

During 2020, the RMS was modified to track the weekly number of deaths and thereby provide critical insight into the impact of COVID-19 in near-real time (Bradshaw *et al*, 2021; Moultrie *et al*, 2021, Dorrington *et al*, 2021, Bradshaw *et al*, 2025). Tracking excess deaths also highlighted the need for Government to fast track cause-of-death information and to **revamp the administrative system to ensure that the NDOH has access to cause-of-death information at the time of death registration** to inform public health actions (Bradshaw *et al*, 2021). The outbreak of foodborne illness associated with pesticide poisonings in September 2024, resulting in 890 foodborne illness incidents nationally and 22 child deaths in Soweto, once again highlighted the need for the civil registration and vital statistics (CRVS) system to provide timely cause-of-death information for public health actions. A national disaster was declared in November 2024 which enabled cabinet to identify several initiatives to address the problem, including the development of an electronic medical certification of the cause of death (eMCCD) system. Nannan *et al* (2025) have called for careful planning of such a system and ensures that it is aligned and co-ordinated with the country's CRVS system, and has strong quality assurance processes built in.

An estimate of the numbers of births is required for the denominator for the childhood mortality rates and the maternal mortality ratio. It has become increasingly challenging to interpret the rapid decline in the number of births since 2020 reported in the DHIS given that the last South Africa Demographic and Health Survey was conducted in 2016, the high under-count in the 2022 census and that it failed to collect usable independent measures of fertility. It is critical for South Africa to identify a way to collect, and make available, more timely demographic information that can be used to assess the routinely collected information.

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APPENDIX 1: ESTIMATION OF COMPLETENESS OF REPORTING OF DEATHS

Completeness of reporting of deaths is estimated separately using different approaches for three different age ranges: infants and children under the age of 5 years, adults (2020+ years) and finally the completeness of reporting of deaths aged 5--19 years. The process of estimating completeness of reportedreported deaths, particularly infant and child deaths was quite intricate and is described here only in broad terms. A more detailed description appears in the technical report on the second South African National Burden of Disease Study (Pillay-van Wyk *et al*, 2014).

Infants and children under-5 years

The numbers of registered deaths, under the ages of one and five, were compared to the number expected based on estimates of the rates (q_0 and ${}_5q_0$) for specific years and applied to estimates of births for the same year. The estimates of the rates (q_0 and ${}_5q_0$) were derived from several sources including the deaths reported by households (2001 and 2011 Censuses and the 2007 Community Survey) and reports of women on the survival of their children (1998 DHS, 1996, 2001 and 2011 Censuses, and the 2007 Community Survey). The completeness of reporting of deaths under the age of one year rose from around 63% in 2000 to around 81% in 2005, 85% for 2006 to 2011, then 82% for 2012 and 75.5% thereafter (to allow for what appears to be a fall in completeness of registration of infant deaths in recent years).

The number of births by calendar year was estimated as the number required to be consistent with the number of surviving children at each age at the time of the 2011 Census, the number recorded by the District Health Information System (DHIS) as having occurred in public health facilities, the number of children in school and the fertility rates derived from the numbers of births, ever born and in the past 12 months, reported by women in the censuses and Community Surveys.

The completeness in individual years between the years of the point estimates of the expected number of deaths was estimated, in general,[11] by assuming that the completeness changed linearly with time between the years of the point estimates.

Completeness of reporting of childhood (1-4) deaths was derived from the differences between reported and expected deaths under the ages of five and one. More recently, a fall in completeness of registration of deaths under the age of one (by about 10 percentage points between 2011, and 2013 and beyond) has been allowed for[12].

Adults 2020+ years

Completeness of reporting of adult deaths was estimated by first estimating completeness for the following intercensal periods using death distribution methods: 1996-2001, 2001-2007 and 2001-2011 applied to data from the 1996, 2001, and 2011 censuses, and the 2007 Community Survey. As these estimates represent averages for each period, estimates for single years were derived by fitting a logistic curve to estimates of completeness by year, derived on the assumption that it changed linearly over each period.

However, because of what appears to be a decline in completeness of the registration of adult deaths after 2010, completeness was reduced to 92% for 2011-2013. After 2013 it returned to 93% for ages up to 39 but drops below that to as low as 86% for females and 87% for males to reflect a drop in VR relative to NPR that has been observed (and is assumed to reflect a fall in completeness of VR data).

Children and youth 5-19 years

Completeness of reporting by single years of age for ages 5-19 were derived from Beers interpolation from completeness for ages 2, 7, 12, 17 & 22+ (derived as a separate exercise).

Post-2011

Previously the assumption was that completeness remained constant post 2011. However, in 2017 the estimates were amended slightly to allow for what appears to be a decline in registration of deaths in the period 2011-2013 for adult mortality and 2013 and beyond for childhood mortality (Dorrington *et al*, 2021) after considering estimates from the 2016 Community Survey (Stats SA, 2016) and the 2016 SADHS (NDOH *et al,* 2019).

Unfortunately, there have been no further useable demographic (i.e. fertility, mortality and of population numbers) estimates independent of registered births and deaths to inform further updating of the estimates of completeness, so they have been assumed to remain at the same levels as 2017.

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[11] There were one or two years where this assumption implied implausible change in rates between one year and the next, in which case the drastic change in the reported number of deaths was assumed to be due to a change in completeness rather than rate of mortality.

[12] To allow for a sudden increase in the ratio of VR to NPR numbers under-1 and to be consistent with the estimate of IMR from the 2016 Community Survey data.

As far as births/fertility is concerned, the lack of useful data fertility from, and the implausible age distribution of the numbers of children under age 10 estimated by, the 2022 census eliminated it from consideration. This, together with an inexplicable lack of stability in the time trends in the DHIS and VR data complicate the estimation of recent trends in the numbers of births. Given this lacuna in data, we have assumed the true estimates trend towards the estimates of the numbers of births derived by applying a linear extrapolation of 2011 to 2016 fertility rates to the numbers of women of reproductive ages projected by the RMS projection of the population.

APPENDIX 2: NUMBER OF NATURAL (N), UNNATURAL (U) AND TOTAL (T) DEATHS IN NPR COMPARED WITH STATS SA DATA BY YEAR

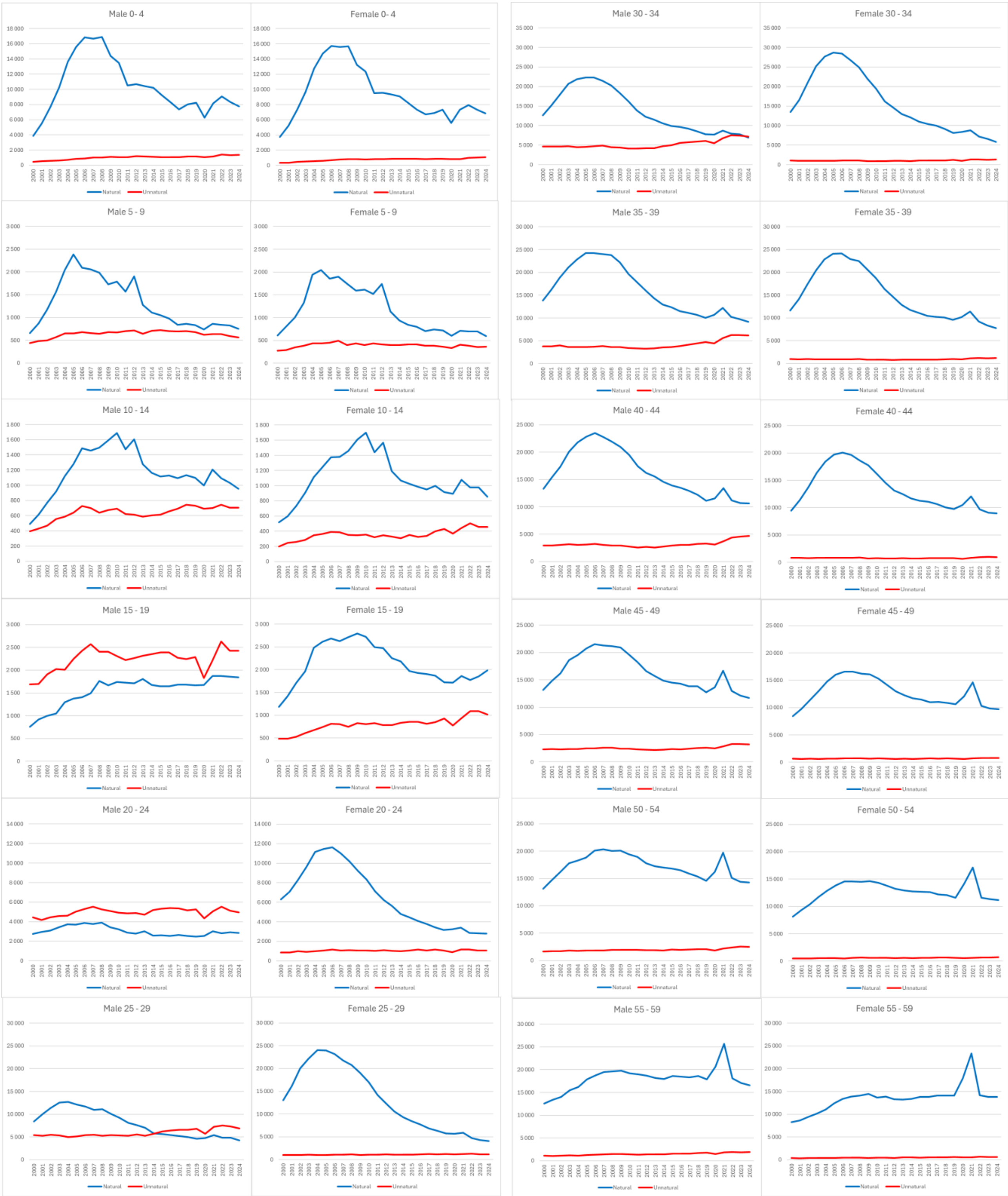
	NATIONAL POPULATION REGISTER			STATS SA CAUSE-OF-DEATH DATA		
YEAR	Natural (N)	Unnatural (U)	Total (T)	Natural (N)	Unnatural (U)	Total (T)
2000	319 228	40 242	359 470	366 633	49 787	416 420
2001	360 348	39 835	400 183	404 775	50 351	455 126
2002	401 098	41 563	442 661	450 851	51 486	502 337
2003	446 580	42 204	488 784	504 148	52 850	556 998
2004	467 889	41 928	509 817	523 676	53 366	577 042
2005	492 688	43 645	536 333	544 344	53 977	598 321
2006	509 636	45 445	555 081	559 873	53 235	613 108
2007	505 367	46 606	551 973	549 875	54 496	604 371
2008	498 699	46 771	545 470	542 274	53 350	595 624
2009	488 305	44 860	533 165	529 428	50 283	579 711
2010	465 363	43 597	508 960	495 479	48 377	543 856
2011	444 925	42 991	487 916	471 005	46 846	517 851
2012	425 257	43 655	468 912	446 673	48 447	495 120
2013	409 864	44 944	454 808	428 116	49 526	477 642
2014	404 072	45 031	449 103	427 572	50 663	478 235
2015	401 025	47 545	448 570	422 912	53 144	476 056
2016	397 647	49 135	446 782	419 785	53 523	473 308
2017	394 483	49 726	444 209	414 077	53 854	467 931
2018	393 496	51 265	444 175	413 989	56 077	470 066
2019	389 815	52 748	442 563	409 446	58 087	467 533
2020	447 609	46 501	493 910	466 151	49 740	515 891
2021	546 237	55 740	601 977	559 395	60 999	620 394
2022	407 100	61 209	468 305	421 464	64 577	486 041
2023	392 435	60 075	468 160			
2024	395 438	59 542	469 666			

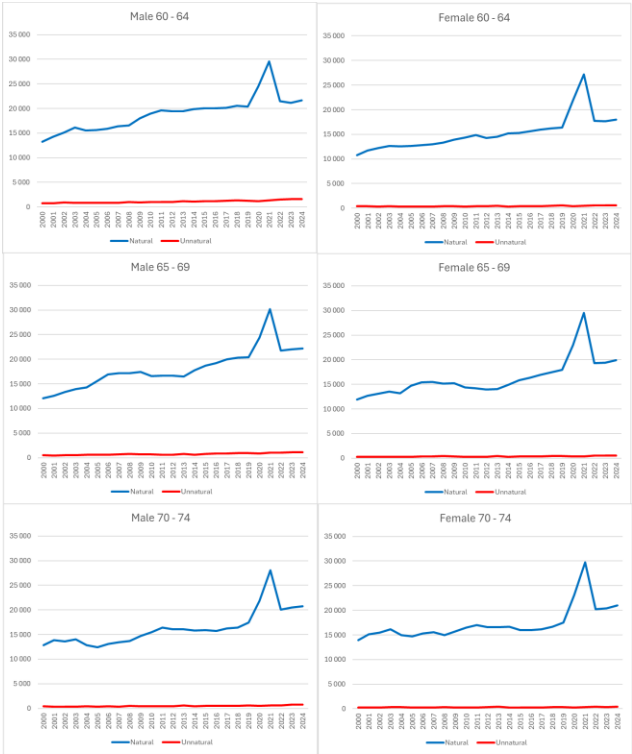
APPENDIX 3: NUMBER OF NATURAL (N), UNNATURAL (U) AND TOTAL (T) DEATHS IN NPR IN BROAD AGE GROUPS COMPARED WITH STATS SA DATA BY YEAR

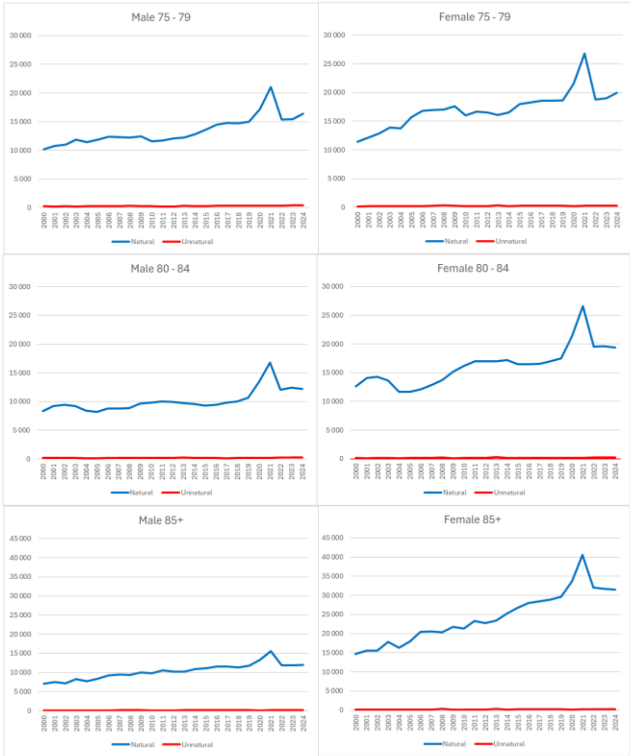
	NATIONAL POPULATION REGISTER			STATS SA CAUSE-OF-DEATH DATA		
YEAR	Natural (N)	Unnatural	Total (T)	Natural (N)	Unnatural (U)	Total (T)
	<15 years					
2000	9 891	2 049	11 940	41 310	4 565	45 875
2001	13 637	2 245	15 882	43 416	4 665	48 081
2002	18 737	2 571	21 308	49 950	4 427	54 377
2003	24 639	2 847	27 486	56 056	4 690	60 746
2004	32 601	3 214	35 815	62 354	5 097	67 451
2005	37 250	3 487	40 737	67 354	5 073	72 427
2006	39 398	3 797	43 195	69 036	5 380	74 416
2007	39 107	3 971	43 078	66 331	5 323	71 654
2008	39 265	3 862	43 127	65 697	4 972	70 669
2009	34 142	4 016	38 158	56 357	4 829	61 186
2010	32 642	3 922	36 564	52 622	4 860	57 482
2011	25 997	3 926	29 923	43 091	4 531	47 622
2012	27 078	4 095	31 173	42 396	4 840	47 236
2013	24 602	3 961	28 563	38 934	4 616	43 550
2014	23 567	3 994	27 561	37 784	4 676	42 460
2015	21 484	4 034	25 518	34 746	4 735	39 481
2016	19 535	4 032	23 567	31 173	4 572	35 745
2017	17 641	4 005	21 646	29 049	4 177	33 226
2018	18 652	4 264	22 916	30 174	4 547	34 721
2019	19 127	4 215	23 342	29 534	4 405	33 939
2020	15 094	3 882	18 976	27 562	4 046	31 608
2021	19 311	4 158	23 469	30 597	4 354	34 951
2022	20 577	4 679	25 256	31 123	4 598	35 721
2023	19 195	4 468	23 663			
2024	17 687	4 513	22 200			
	15-59 years					
2000	170 519	34 393	204 912	185 527	39 294	224 821
2001	197 896	33 873	231 769	212 958	39 987	252 945
2002	229 544	35 171	264 715	247 475	41 339	288 814
2003	261 713	35 582	297 295	284 863	41 904	326 767
2004	283 468	34 909	318 377	305 366	41 654	347 020
2005	296 955	36 318	333 273	315 600	42 603	358 203
2006	302 034	37 756	339 790	320 589	42 284	362 873
2007	295 365	38 591	333 956	312 416	43 194	355 610
2008	288 007	37 840	325 847	304 762	42 544	347 306
2009	273 945	36 754	310 699	292 321	39 945	332 266
2010	253 330	35 711	289 041	269 806	38 595	308 401
2011	230 931	35 005	265 936	243 359	36 762	280 121
2012	212 695	35 426	248 121	222 680	37 851	260 531
2013	199 465	35 304	234 769	206 877	38 804	245 681
2014	187 886	36 835	224 721	199 295	39 848	239 143
2015	182 385	38 798	221 183	193 473	41 760	235 233
2016	176 929	40 274	217 203	188 979	42 633	231 612
2017	171 828	40 833	212 661	182 724	43 174	225 898
2018	166 592	41 691	207 697	177 638	44 684	222 322
2019	157 388	43 140	200 528	168 733	46 529	215 262
2020	173 383	37 794	210 977	184 438	39 956	224 394
2021	205 408	46 040	251 448	215 033	49 160	264 193
2022	156 736	50 451	207 183	166 214	52 416	218 630
2023	142 472	49 061	207 183			
2024	144 065	48 432	207 183			
	60+ years					
2000	139 754	3 572	143 137	137 425	5 226	142 651
2001	149 887	3 385	153 272	146 631	5 092	151 723
2002	153 864	3 550	157 414	151 697	5 433	157 130
2003	161 273	3 588	164 861	161 646	5 392	167 038
2004	152 797	3 687	156 484	154 576	5 648	160 224
2005	159 409	3 718	163 127	159 769	5 508	165 277
2006	169 183	3 756	172 939	169 792	5 118	174 910
2007	171 918	3 953	175 871	171 775	5 562	177 337
2008	172 534	4 998	177 532	173 166	5 474	178 640
2009	181 655	4 066	185 721	183 648	5 380	189 028
2010	180 906	4 063	184 969	180 196	5 264	185 460
2011	187 997	4 060	192 057	184 555	5 553	190 108

2012	185 484	4 134	189 618	181 597	5 756	187 353
2013	185 797	5 679	191 476	182 305	6 106	188 411
2014	192 619	4 202	196 821	190 493	6 139	196 632
2015	197 156	4 713	201 869	194 693	6 649	201 342
2016	201 183	4 829	206 012	199 633	6 318	205 951
2017	205 014	4 888	209 902	202 304	6 503	208 807
2018	208 252	5 310	213 562	206 177	6 846	213 023
2019	213 300	5 393	218 693	211 179	7 153	218 332
2020	259 132	4 825	263 957	254 151	5 738	259 889
2021	321 518	5 542	327 060	313 765	7 485	321 250
2022	229 787	6 079	235 866	224 127	7 563	231 690
2023	230 768	6 546	237 314			
2024	233 686	6 597	240 283			

APPENDIX 4: TREND IN THE NUMBER OF NATURAL AND UNNATURAL DEATHS BY AGE AND SEX, NPR 2000-2024




Male 60 - 64
Female 60 - 64
Male 65 - 69
Female 65 - 69
Male 70 - 74
Female 70 - 74
Natural
Unnatural


Male 75 - 79
Female 75 - 79
Male 80 - 84
Female 80 - 84
Male 85+
Female 85+
Natural
Unnatural

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