RAPID MORTALITY SURVEILLANCE REPORT 2018

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SOUTH AFRICAN MEDICAL RESEARCH COUNCIL

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A copy of this report is available on the Internet at: www.mrc.ac.za/bod/reports.htm

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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 5-year-old child dying before age 15 (older children and young adolescents)
${}_{10}q_{15}$	-	conditional probability 15-year-old child dying before age 25 (older adolescents and young adult)
${}_{45}q_{15}$	-	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)
AIDS	-	acquired immune deficiency syndrome
ASSA	-	Actuarial Society of South Africa
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
MMIEG	-	Maternal Mortality Interagency Estimation Group
MMR	-	maternal mortality ratio
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 (2017 revision)

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 Outputs 1 and 2 of the health-related targets of the Negotiated Service Delivery Agreement (NSDA) and health-related targets of the Medium Term Strategic Framework (MTSF). Deaths registered on the National Population Register by the Department of Home Affairs are the main data source for the most recent estimates while earlier estimates of the MMR and non-communicable disease premature mortality rates are based on adjusted data from cause-of-death data from Stats SA up to 2016 (being the most recent year for which vital registration data have been released). The Neonatal Mortality Rate is based on adjusted data from the District Health Information System (DHIS) up to 2018. Efforts to improve the completeness of death registration are still required and the delay in the release of cause of death report is a concern.

The 2018 report shows that the ***average life expectancy in South Africa is now over 64.8 years***, having increased by more than 10 years since the low of 53.7 in 2005. The increase in life expectancy is due particularly to the decrease in child mortality as well as young adult mortality and reflects that the 2019 target of 64.2 years has been met. In 2000, the probability of a 15-year old female dying before the age of 25 years was 35.1 per 1 000. After this it increased rapidly to a peak of 44.4 per 1 000 in 2004 and has subsequently declined to a level of 16.4 per 1 000 in 2018 due to the provision of ARVs to mothers, but the pace of decline has slowed in the past 4 years. Life expectancy at age 60, a useful indicator of the mortality experienced by older South Africans has shown little change since 2000. In 2018, the life expectancy at age 60 is 19.6 years for females and 15.9 years for males with an overall average of 17.9 years.

Infant and under-five mortality rates reached a low of 23 and 32 per 1 000 live births, respectively, in 2017 but increased to 25 and 34 per 1 000 livebirths in 2018, respectively. This appears, from the NPR data for 2017, to be due to an absence of the winter increase generally associated with pneumonia and diarrhoea among infants 1-11 months old. In contrast the neonatal mortality rate continues to show little change at 11 per 1 000 live births.

Despite a downward trend, levels of mortality of older children and young adolescents aged 5-14 years (${}_{10}q_5$) indicate that extra efforts are also needed in this age group. Literature on the cost-effectiveness of interventions highlights the value of integrated school-based interventions to address nutrition and health.

There is no new data to update the maternal mortality ratio which peaked in 2009 and declined to 134 per 100 000 live births in 2016, as reported previously. There is also no new data to update the rate of premature mortality from preventable non-communicable diseases (NCDs). The risk of a 30-year old dying before age 70 from the selected NCDs considered preventable is 35% for males and 24% for females indicating the renewed focus on NCDs is required to reduce premature mortality from these conditions.

KEY MORTALITY INDICATORS, RMS 2012- 2018

LIFE EXPECTANCY AND ADULT MORTALITY (OUTPUT 1)								
INDICATOR	**TARGET 2019[1]**	**Baseline 2012[2]**	**2013[2]**	**2014[2]**	**2015**	**2016**	**2017**	**2018**
Life expectancy at birth Total	64.2 (Increase of 3 yrs)	61.4	62.1	62.7	63.3	63.9	64.6	64.8
Life expectancy at birth Male	61.5 (Increase of 3 yrs)	58.4	59.1	59.5	60.1	60.9	61.6	61.9
Life expectancy at birth Female	67.0 (Increase of 3 yrs)	64.4	65.2	65.9	66.6	66.9	67.6	67.9
Adult mortality (${}_{45}q_{15}$) Total	34% (10% reduction)	38%	36%	35%	34%	33%	32%	31%
Adult mortality (${}_{45}q_{15}$) Male	40% (10% reduction)	44%	42%	41%	40%	39%	38%	37%
Adult mortality (${}_{45}q_{15}$) Female	28% (10% reduction)	32%	30%	29%	28%	27%	26%	25%
MATERNAL AND CHILD MORTALITY (OUTPUT 2)								
INDICATOR	**TARGET 2019**	**Baseline 2012[2]**	**2013[2]**	**2014[2]**	**2015**	**2016**	**2017**	**2018**
Under-5 mortality rate (U5MR) per 1 000 live births	33* (20% reduction)	42	43	42	39	36	33	34
Infant mortality rate (IMR) per 1 000 live births	23	28	29	29	28	26	23	25
Neonatal mortality rate[3] (<28 days) per 1 000 live births	8	11	11[3]	12[3]	12[3]	12	12	11
INDICATOR	**TARGET 2018**	**Baseline 2011[5]**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Maternal mortality ratio[4] (MMR) per 100 000 live births	Downward trend below 100	198	164	153	166	153	134	Data not available

1. Target values for 2019 have been revised relative to the current 2012 estimate
2. Based on NPR data rather than VR data because of apparent significant under-recording by the VR data
3. Method changed to derive directly from the DHIS neonatal deaths and birth data
4. Stats SA data
5. Baseline for MMR set at 2011 due to lag in availability of cause-of-death data

NEW INDICATORS: OLDER CHILD, ADOLESCENT AND YOUTH, LIFE EXPECTANCY AT AGE 60 AND NON-COMMUNICABLE DISEASES								
OLDER CHILDREN & YOUNG ADOLESCENTS (5-14 YEARS)								
INDICATOR	**TARGET**	**Baseline**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Older children & young adolescents ($_{10}q_5$ per 1 000) Total	None	10.9	8.0	7.3	7.0	6.5	6.0	6.2
Older children & young adolescents ($_{10}q_5$ per 1 000) Male	None	11.7	8.7	8.2	7.8	7.4	7.0	7.0
Older children & young adolescents ($_{10}q_5$ per 1 000) Female	None	10.1	7.3	6.5	6.2	5.6	5.1	5.3
OLDER ADOLESCENTS & YOUTH (15-24 YEARS)								
INDICATOR	**TARGET**	**Baseline**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Older adolescents & youth ($_{10}q_{15}$ per 1 000) Total	None	24.5	23.5	22.6	22.3	21.7	21.4	20.8
Older adolescents & youth ($_{10}q_{15}$ per 1 000) Male	None	25.7	26.0	25.8	26.3	25.8	26.0	25.2
Older adolescents & youth ($_{10}q_{15}$ per 1 000) Female	None	23.2	21.1	19.5	18.4	17.5	16.9	16.4
LIFE EXPECTANCY AT AGE 60								
INDICATOR	**TARGET**	**Baseline**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Life expectancy at age 60 (e_{60}) Total	None	17.7	17.7	17.7	17.6	17.7	17.8	17.9
Life expectancy at age 60 (e_{60}) Male	None	15.7	15.7	15.7	15.6	15.7	15.7	15.9
Life expectancy at age 60 (e_{60}) Female	None	19.4	19.3	19.3	19.3	19.4	19.5	19.6
NCD MORTALITY ATTRIBUTED TO CARDIOVASCULAR DISEASE, CANCER, DIABETES OR CHRONIC RESPIRATORY DISEASE (30-69 YEARS)								
INDICATOR	**TARGET**	**Baseline**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NCD $_{40}q_{30}$ Total	None	29%	29%	29%	30%	30%	29%	Data not available
NCD $_{40}q_{30}$ Male	None	34%	34%	34%	35%	35%	34%	Data not available
NCD $_{40}q_{30}$ Female	None	25%	24%	24%	24%	24%	24%	Data not available
INDICATOR	**TARGET**	**Baseline**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Cardiov. disease $_{40}q_{30}$ Total	None	15%	14%	14%	14%	14%	14%	Data not available
Cardiov. disease $_{40}q_{30}$ Male	None	18%	18%	17%	18%	18%	17%	Data not available
Cardiov. disease $_{40}q_{30}$ Female	None	12%	12%	11%	11%	11%	11%	Data not available
Cancer $_{40}q_{30}$ Total	None	9%	9%	9%	9%	9%	9%	Data not available
Cancer $_{40}q_{30}$ Male	None	10%	10%	11%	11%	11%	10%	Data not available
Cancer $_{40}q_{30}$ Female	None	7%	7%	7%	8%	8%	8%	Data not available
Diabetes $_{40}q_{30}$ Total	None	5%	5%	5%	5%	5%	5%	Data not available
Diabetes $_{40}q_{30}$ Male	None	5%	5%	5%	6%	6%	5%	Data not available
Diabetes $_{40}q_{30}$ Female	None	5%	5%	5%	5%	5%	5%	Data not available
Chronic resp. disease $_{40}q_{30}$ Total	None	4%	4%	4%	4%	4%	4%	Data not available
Chronic resp. disease $_{40}q_{30}$ Male	None	6%	6%	6%	6%	6%	6%	Data not available
Chronic resp. disease $_{40}q_{30}$ Female	None	3%	3%	2%	2%	2%	2%	Data not available

1. Baseline for NCD mortality set at 2011 due to lag in availability of cause-of-death data

INTRODUCTION

This is the eighth in the series of annual reports utilising the data from the Rapid Mortality Surveillance (RMS) database based on deaths registered onto the National Population Register (NPR) as described in the first report (Bradshaw, Dorrington and Laubscher, 2012) and follows the same format as the previous report. Briefly, the report provides estimates of several mortality indicators after correcting for incompleteness of registration of deaths and births. These can be used to track the impact indicators identified for Output 2 of the Medium Term Strategic Framework (MTSF) - a long and healthy life for all South Africans (DPM&E, 2014), a key objective of the National Development Plan (NPC, 2011).

The indicators in the report include life expectancy, the adult mortality index ${}_{45}q_{15}$, under-5 mortality rate, infant mortality rate and the neonatal mortality rate, and young adolescents aged 5-14 years (${}_{10}q_{5}$) as well as older adolescents and young adults age 15-24 years (${}_{10}q_{15}$). 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, the NPR data series has been updated to the end of 2018, but the cause-of-death data has not been updated from last year's report as no further data were released in 2019. Thus, indicators requiring cause-of-death data, namely the MMR, the various non-communicable disease (NCD) indicators and comparisons of cause-of-death data to those from the NPR end in 2016.

Estimates of the population and the numbers of births are essential for calculating the indicators in this report. In previous reports, the mid-year population estimates, derived to be consistent with the 2011 Census population (Dorrington, 2013), projected forward to 2017 using unchanging migration, slightly declining fertility, and survival factors since the census derived from the ASSA2008 model. However, as this series has come to an end and since we are currently estimating the true numbers of births and deaths as part of the RMS exercise, it seems more sensible (not to mention more internally consistent) to use these estimates of births and deaths together with the migration assumptions from the Thembisa/CARe models to project the population on a year-by-year basis. Thus, this is how the population numbers for the years after 2011 (to ensure consistency over time) have been determined. This change has led to some light changes in the past estimates of the indicators, but nothing of much consequence.

DATA SOURCE

The Department of Home Affairs 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 is published by Stats SA (Stats SA, 2019a). 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 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.

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 identify cause-of-death as natural or unnatural, one needs to rely on the cause-of-death data from Stats SA to identify the maternal deaths. The latest available data are for the year 2016 (Stats SA, 2018)[1]. In addition, too few 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[2], we use data from the District Health Information System 2009-18 (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)

[1] Stats SA is experiencing extreme staff shortages and no mortality report was released in 2019.
[2] In addition, it appears that completeness of the VR data relative to the DHIS has been declining in recent years.

- be as consistent with the age distribution of the populations of the 2001 and 2011 Censuses as is reasonable, allowing, *inter alia*, for possible undercounting of children and age exaggeration at old age.

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 since then up to last year, in the absence of a suitable alternative, 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) has been used. Because this series ends with 2017, it was decided to replace the estimates of the population since 2011 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 assumed in the Thembisa and CARe models.

Although the official mid-year estimates were considered as an alternative source of estimates, even though they were constructed to match in total the population size of the 2011 Census (Stats SA, 2013a), they, initially at least, were not constructed with a series of births and migration that replicates the age distribution of the population of the Census under age 30. This has been largely corrected in the releases of mid-year estimates from 2017 onwards (Stats SA 2017a), however, these estimates are not available by single ages or for ages above age 80 and are based on estimates of births and deaths which are not, necessarily consistent with those used in this report.

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 2004) derived from the numbers of children in school in 2011 by age of child
- estimates of the number of births (up to 2018) from the registered births by year of birth corrected for estimates of the completeness of registration
- estimates of the number of births (up to 2018) 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 4.2 population projection model
- estimates of the number of births (up to 2018) projected by the CARe 4.2 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.

These estimates are presented and compared to the numbers of births captured by the District Health Information System (DHIS) and vital registration (VR) in Figure 1 below. Because it manifests in the estimates of some indicators it should be noted that it appears as if the total number of births declined in 2015 and 2016 before increasing slightly in 2017 and 2018[4].

[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] 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).

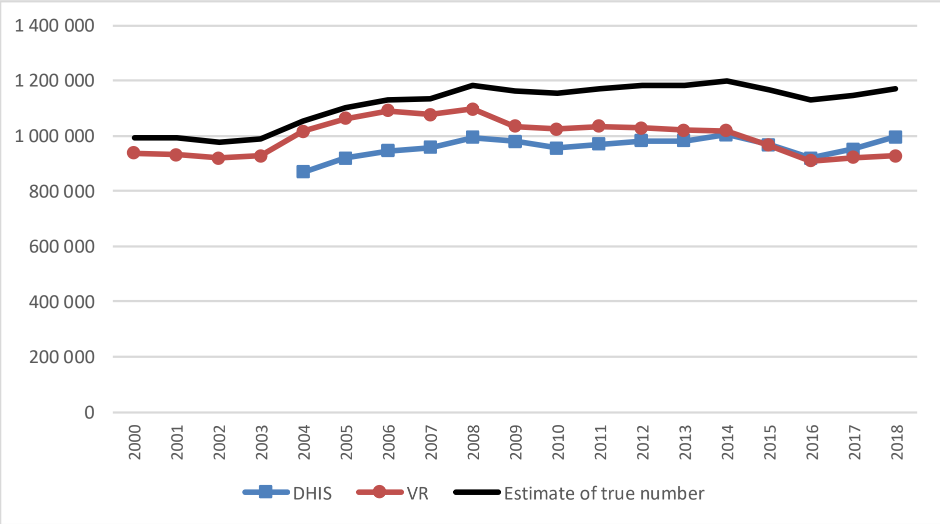


Figure 1: Estimates of the number of births compared to the numbers from the DHIS and VR, 2000-2018

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 2018 the adjustment was set as the maximum of that for the same age and the age below in the previous year, except for 2015, where it was set as the maximum of these values and the ratio of NPR to VR for the age in 2015. 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. 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 2016 reflects late processing of documents in the system and can be expected to be widened if the late transfers of documents to Stats SA has been resolved before they next release data.

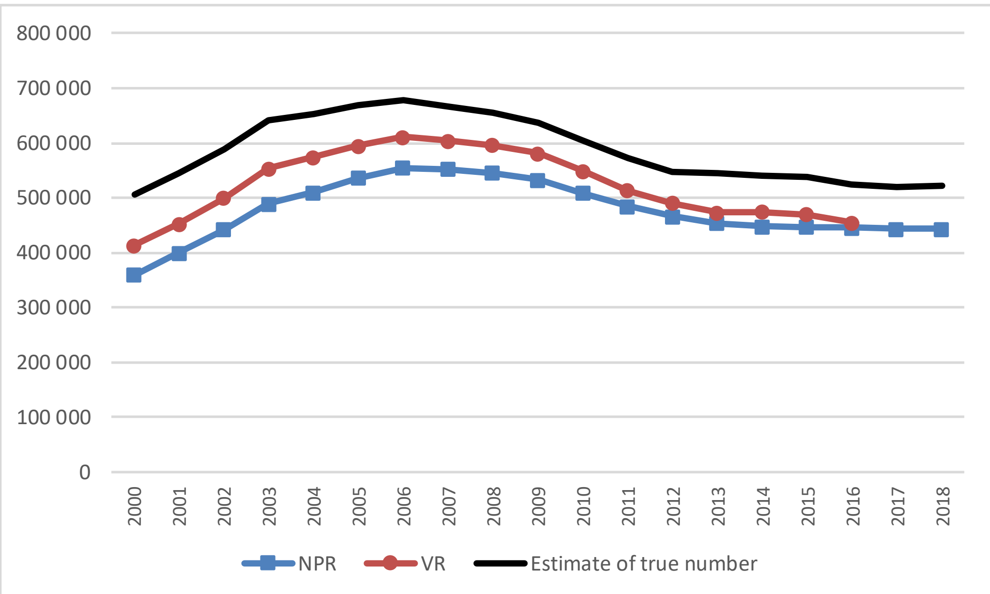


Figure 2: Estimates of the number of deaths compared to the numbers from the NPR and VR, 2000-2018

The comparison of the total number of deaths recorded by Stats SA (Stats SA, 2018) and the NPR to the numbers estimated after correcting for under registration is shown in Figure 3. This is the same as the figure in the previous report, since no further VR data were released this year. As was reported in the previous report, it can be seen that close to 100% of the death notifications of people aged 25 and over, and between 90% and 95% of all other ages except those in the first year of life, are on the NPR. 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.

While the uptick in in the ratio of the number of NPR deaths to VR deaths (Stats SA) in all age groups from 2015 to 2016 is due to the absence of 2016 deaths registered after the cut-off date for the report (i.e. late registrations), the higher-than-average ratios for deaths aged 25+ in 2011, 2012 and 2013, and deaths aged under 1 for 2012 to 2015, indicate what is probably a slight drop in completeness of recording of deaths by Stats SA in these age groups in these years. This is allowed for in the estimation of the estimates of mortality in this report.

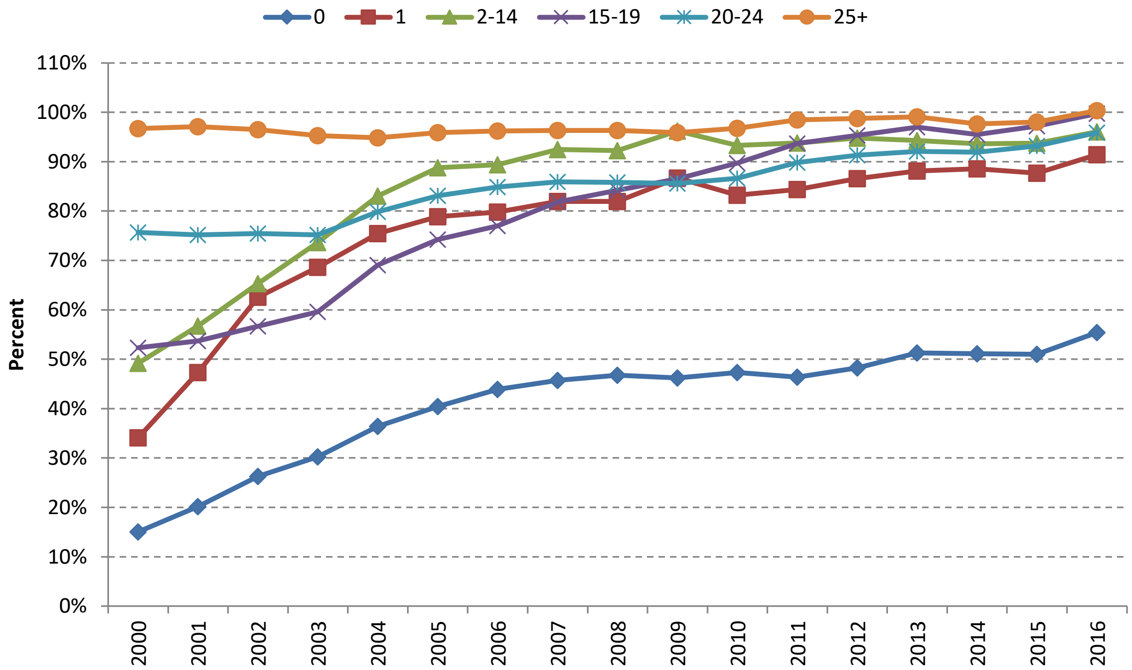


Figure 3: NPR deaths as a proportion of Stats SA deaths by age group, 2000-2016
Note: Unchanged from previous RMS report

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), possibly because the birth was not registered before the death. Furthermore, this proportion appears to have 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[5,6]. 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 year's 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).

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

Aside from adjusting the VR 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 continues to be increased by 50% to allow for the general under-notification of maternal causes. This practice is based on the experience of some 22 studies estimating the extent in under-notification in countries with good VR data (WHO, 2010).

TRENDS IN NPR DATA

The numbers of deaths (excluding late registrations) from the National Population Register are shown in Table 1 for 2000-2018 alongside the numbers of deaths for the latest year from the Stats SA cause-of-death reports for 2000-2016. The total numbers (T) are broken down into natural deaths (N) and unnatural deaths (U). It can be seen that the total number of deaths in both series increased to a peak in 2006. The Stats SA numbers increased from 416 420 in 2000 to a peak of 613 108 in 2006 and declined to 456 612 by 2016. The NPR numbers increased from 359 470 in 2000 to a peak of 555 081 in 2006 and declined to 443 490 by 2018. It should be noted that the changes in the number of deaths cannot be interpreted without taking into account the general improvement in the completeness of death registration (which appears to have stalled in the most recent years), and in the case of the NPR data, improved birth registration, over the period.

Table 1: 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	442 291	42 732	485 023	459 813	45 990	505 803
2012	423 129	43 524	466 653	442 569	48 531	491 100
2013	408 397	44 801	453 198	411 714	47 219	458 933
2014	402 969	44 763	447 732	404 864	47 327	452 191
2015	399 953	47 291	447 244	408 217	50 797	459 014
2016	398 414	47 031	445 445	405 370	51 242	456 612
2017	393 659	49 540	443 199			
2018	392 481	51 009	443 490			

The rapid decline in the number of deaths from the peak in 2006 to 2014 makes it important to investigate whether there are any indications of registration failure. Although subtle changes in completeness of recording are quite difficult to detect, preliminary investigations suggest that the completeness of reporting of the VR deaths may have declined by between 1% and 1.5% from 2011-2013 before recovering to previous levels. In addition, investigations have identified evidence of some failures in the vital registration in 2015 and 2016, which hopefully will be corrected by late registrations in subsequent years. This will need to be monitored going forward.

The trends in the number of natural and unnatural deaths from the NPR are presented in Figure 4 which shows a continuation of the marked decline since 2006 in the number of deaths due to natural causes in the young adult age group, albeit slowing down in the most recent years. This decline is mirrored for children <15 years with a levelling off over a few more years. The steady increase in the number of deaths in 60+ age group reflect the strong growth in the size of the population in this age group. Furthermore, 2014 was a change point when the number of natural deaths among 60+ years exceeded the number of natural deaths 15-59 years. However, the total number of deaths in the 15-59-year age group remains slightly higher than the total in the 60+ year age group. The trend in the number of deaths from the NPR are shown by 5-year age group and sex in Appendix 2. Striking gender trends 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. 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.

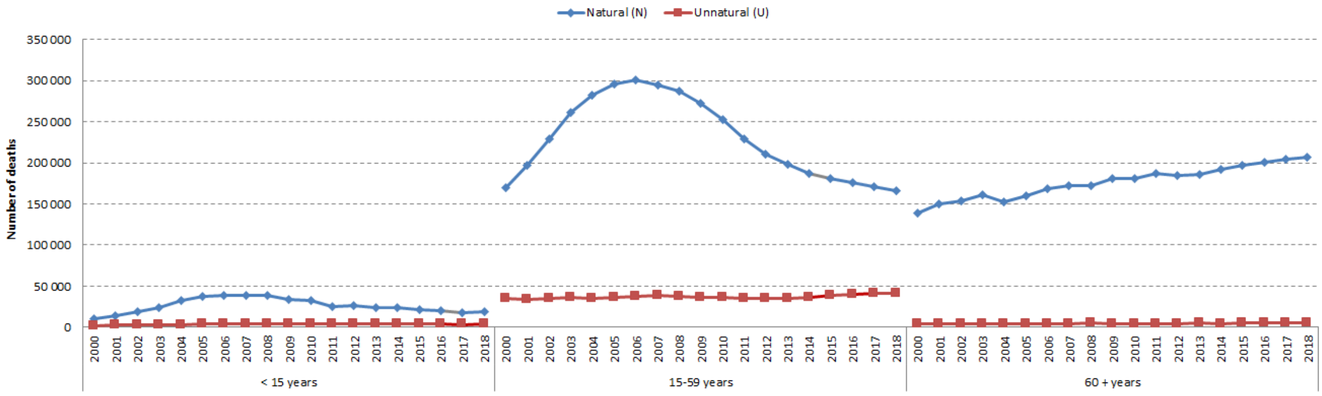


Figure 4: Trend in the number of natural (N), unnatural (U) by broad age group, NPR 2000-2018

As reported in the previous report the proportion of the VR deaths captured by the NPR increased from 86.3% in 2000 to 99% in 2014 then fell to 97.6% in 2016 (Figure 5). 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 fell back to around 90% in 2012 before increasing further to nearly 95% in 2013 and 2014, and then dropping to 92% in 2016.

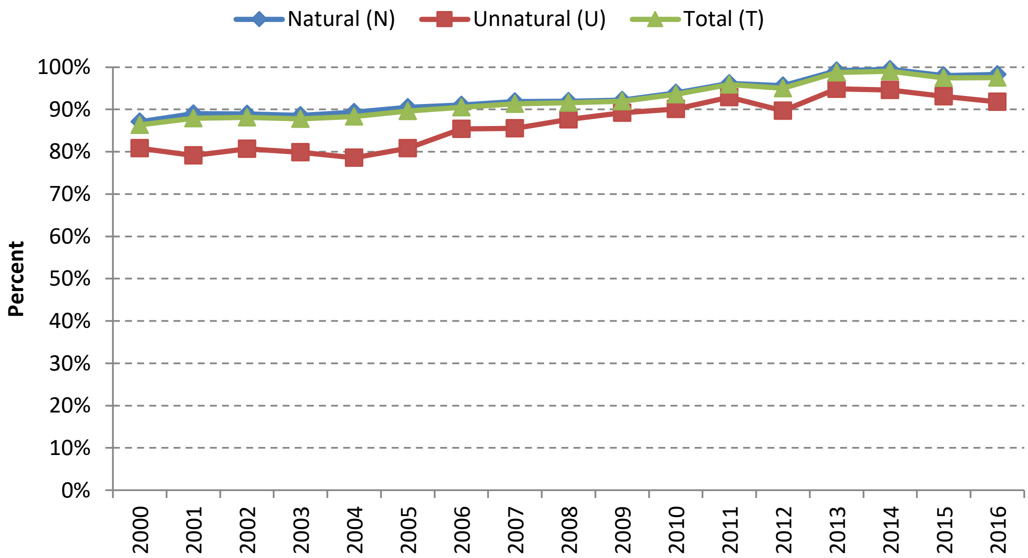


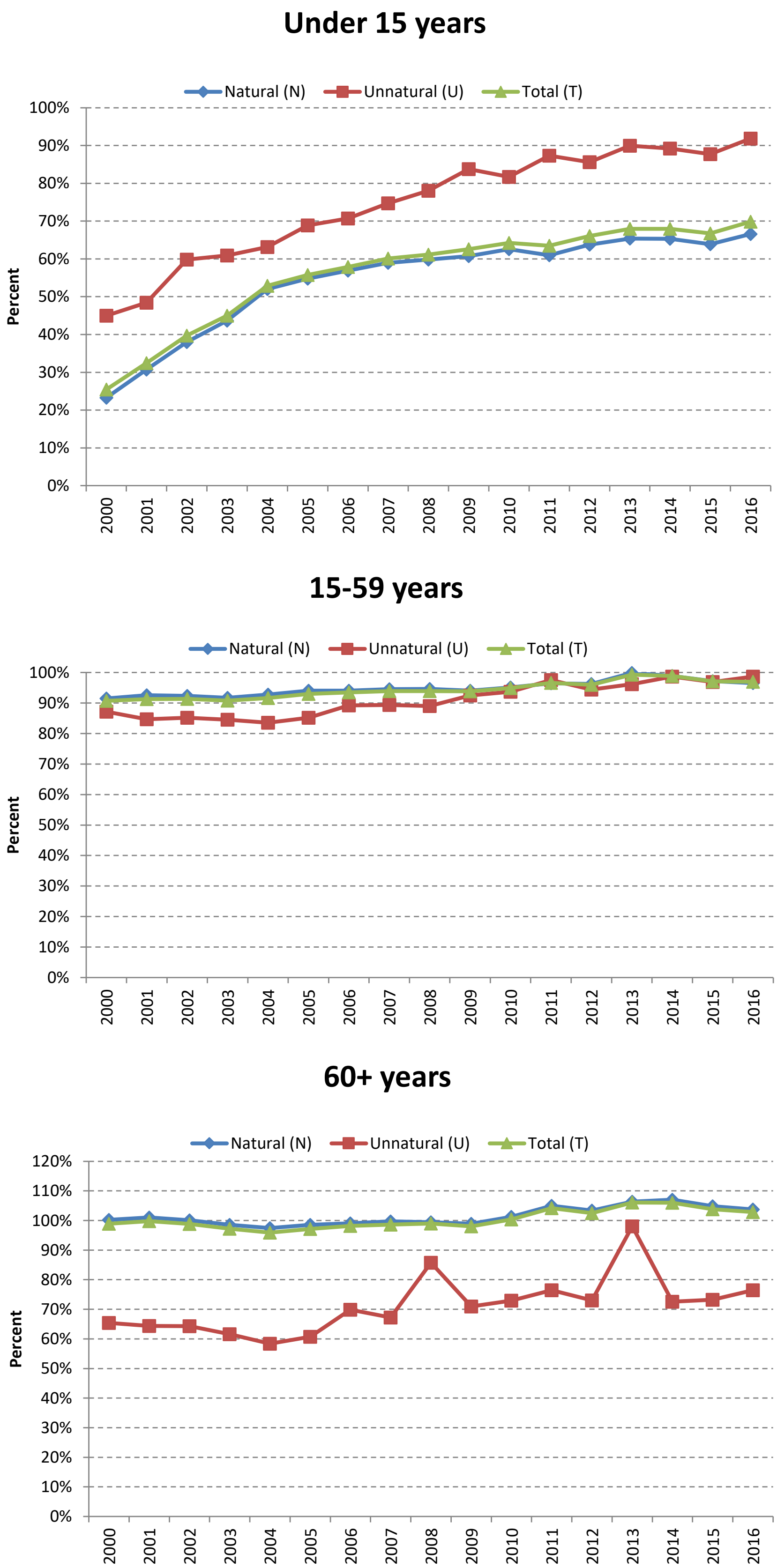
Figure 5: Ratio of NPR to Stats SA data (%) by natural (N), unnatural (U) and total (T) category for all ages, 2000-2016
Note: Unchanged from previous RMS report

Table 2 shows the numbers of deaths (excluding late registrations) in broad age groups, while the proportion of these VR deaths captured by the NPR is shown in Figure 6 for each age group. There has been a considerable increase in this proportion for children <15 years which then seemed to have been levelling off at about 60% prior to the uptick after 2012. 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 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%, and by 2013 and 2014 close to 99%, 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 75% in 2011 and hovering around 70% after that, it is unclear why it is so low given the near complete match for natural deaths. This and the blips in the number of unnatural deaths in 2008 and 2013 (shown in red in the table) suggest problems with classification of deaths in the NPR data, which require further investigation.

Table 2: 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 (U)	Total (T)	Natural (N)	Unnatural (U)	Total (T)
	<15 years					
2000	9 682	2 075	11 757	41 548	4 615	46 163
2001	13 378	2 283	15 661	43 534	4 712	48 246
2002	18 995	2 617	21 612	50 006	4 376	54 382
2003	24 439	2 873	27 312	55 995	4 715	60 710
2004	32 401	3 232	35 633	62 263	5 120	67 383
2005	37 031	3 498	40 529	67 593	5 078	72 671
2006	39 168	3 815	42 983	68 856	5 394	74 250
2007	38 859	3 973	42 832	65 924	5 316	71 240
2008	39 058	3 875	42 933	65 288	4 964	70 252
2009	33 833	4 022	37 855	55 679	4 800	60 479
2010	32 341	3 904	36 245	51 669	4 777	56 446
2011	25 374	3 853	29 227	41 633	4 412	46 045
2012	26 687	4 103	30 790	41 829	4 794	46 623
2013	24 412	3 959	28 371	37 337	4 400	41 737
2014	23 540	3 973	27 513	36 044	4 453	40 497
2015	21 440	4 020	25460	33 571	4 583	38 154
2016	19 527	4 021	23 548	29 326	4 379	33 705
2017	17 666	4 000	21 666			
2018	18 681	4 258	22 939			
	15-59 years					
2000	170 044	34 532	204 576	185 872	39 611	225 483
2001	197 284	34 089	231 373	213 129	40 262	253 391
2002	228 815	35 302	264 117	247 697	41 442	289 139
2003	260 984	35 652	296 636	284 618	42 164	326 782
2004	282 753	34 944	317 697	304 713	41 816	346 529
2005	296 196	36 393	332 589	314 932	42 720	357 652
2006	301 284	37 811	339 095	320 223	42 376	362 599
2007	294 608	38 615	333 223	311 530	43 206	354 736
2008	287 152	37 832	324 984	303 474	42 481	345 955
2009	272 906	36 724	309 630	290 139	39 684	329 823
2010	252 244	35 615	287 859	265 233	38 011	303 244
2011	228 128	34 743	262 871	236 509	35 617	272 126
2012	211 243	35 272	246 515	219 489	37 342	256 831
2013	198 414	35 158	233 572	198 577	36 546	235 123
2014	187 034	36 598	223 632	189 093	37 099	226 192
2015	181 597	38 583	220 180	186 817	39 812	226 629
2016	176 155	40 050	216 205	182 377	40 584	222 961
2017	171 486	40 664	212 150			
2018	166 260	41 437	207 697			
	60+ years					
2000	139 502	3 635	143 137	139 213	5 561	144 774
2001	149 686	3 463	153 149	148 112	5 377	153 489
2002	153 288	3 644	156 932	153 148	5 668	158 816
2003	161 157	3 679	164 836	163 535	5 971	169 506
2004	152 735	3 752	156 487	156 700	6 430	163 130
2005	159 461	3 754	163 215	161 819	6 179	167 998
2006	169 184	3 819	173 003	170 794	5 465	176 259
2007	171 900	4 018	175 918	172 421	5 974	178 395
2008	172 489	5 064	177 553	173 512	5 905	179 417
2009	181 566	4 114	185 680	183 610	5 799	189 409
2010	180 778	4 078	184 856	178 577	5 589	184 166
2011	188 789	4 136	192 925	179 821	5 410	185 231
2012	185 199	4 149	189 348	179 108	5 684	184 792
2013	185 571	5 684	191 255	174 491	5 799	180 290
2014	192 395	4 192	196 587	179 727	5 775	185 502
2015	196 916	4 688	201 604	187 829	6 402	194 231
2016	200 890	4 802	205 692	193 667	6 279	199 946
2017	204 507	4 876	209 383			
2018	207 540	5 314	212 854			



* The disruptions in 2008 and 2013 in 60+ appear to be the result of the anomalies in the NPR data, highlighted in Table 2.

Figure 6: Ratio of NPR to Stats SA data (%) in broad age groups by natural (N), unnatural (U) and total (T) category, 2000-2016

Note: Unchanged from previous RMS report

CORRECTING FOR INCOMPLETENESS

Figures 7 to 12 compare the numbers of deaths, in total and for various age ranges, as reported by Stats SA (VR), from the National Population Register (NPR), together with the VR adjusted for incompleteness of registration (Adj VR), the NPR adjusted for registered deaths of people not on the National Population Register (Est VR) and this number further adjusted for incompleteness of registration of deaths (Est Adj VR). They all tell a similar story, namely, that, adjusting for late registrations, there is a great deal of consistency between the NPR and VR data.

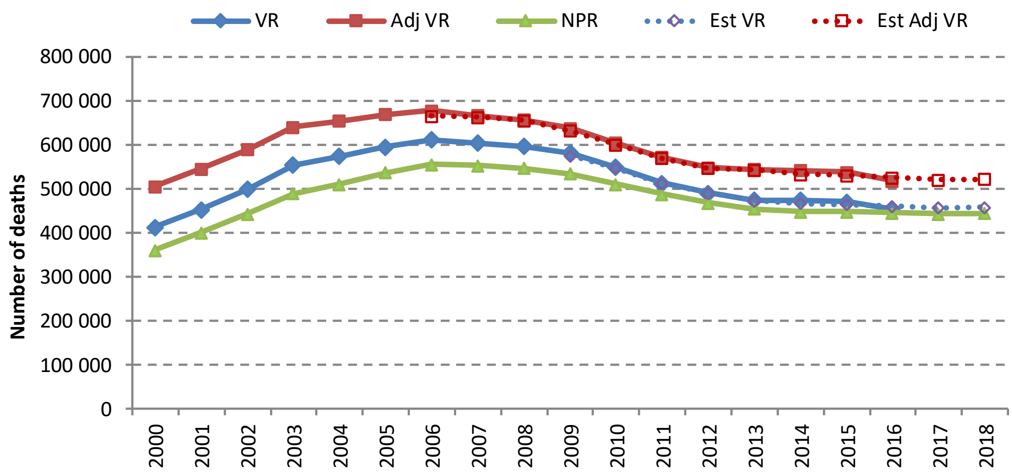


Figure 7: VR, VR adjusted for incompleteness of reporting, NPR, estimated VR, estimated adjusted VR: Total deaths

While there were slight differences for the period 2006-2008 in the other age ranges, in total (Figure 7) and for ages 15-59 (Figure 11), the adjustments to the NPR data appear to work very well. The slight difference in the number 60+ (Figure 12) after 2013 found in previous reports are less pronounced. Once again, for some, yet to be investigated reason, the numbers of VR deaths in these age groups is lower than expected, based on the NPR data. Since the only ways for the VR data to be lower than estimated from the NPR data are for there to have been an increase in the proportion of births being registered, which does not seem likely, particularly for adults, or for some deaths recorded on the NPR not being processed by Stats SA, this difference is puzzling. This issue needs further investigation.

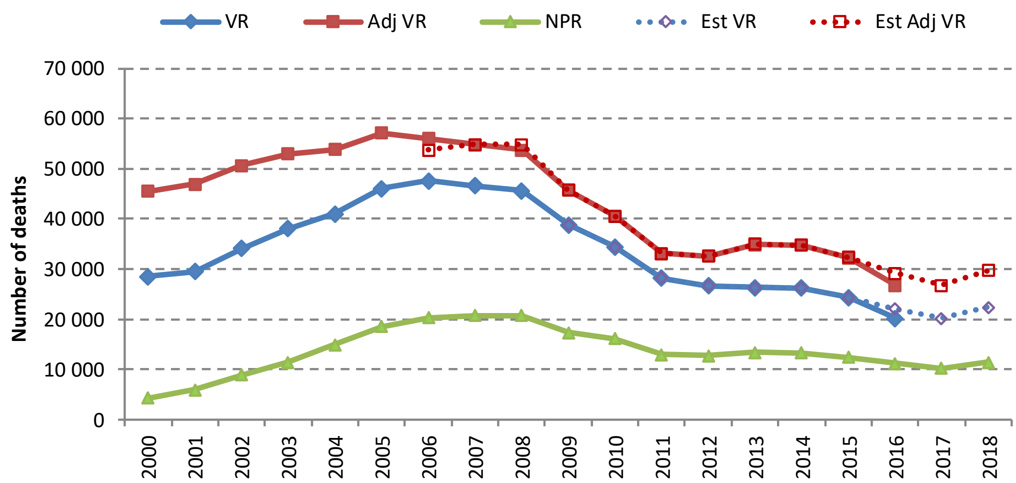


Figure 8: VR, VR adjusted for incompleteness of reporting, NPR, estimated VR, estimated adjusted VR: Deaths < 1

The comparison of the number of deaths under the age of 1-year (Figure 8) indicate the large (but declining over time) adjustment required for deaths of babies not on the NPR. However, despite the uncertainty introduced by having to make such a large adjustment, the estimates produced from the NPR data appear quite reasonable (after now adjusting for what appears to have been a slight drop in completeness of registration since 2013). Thus, according to the NPR data the number of deaths under age 1 year (but not ages 1-4 years (Figure 9)) appear to have increased in 2018.

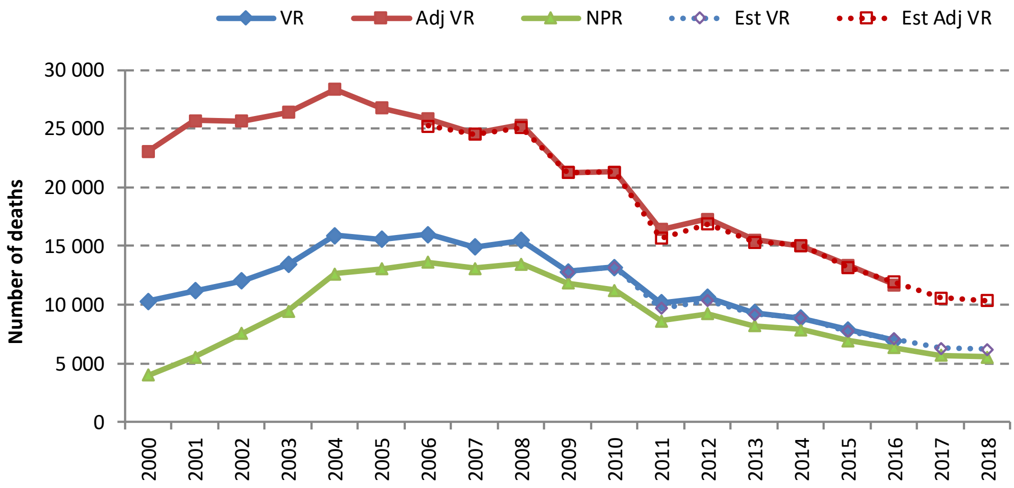


Figure 9: VR, VR adjusted for incompleteness of reporting, NPR, estimated VR, estimated adjusted VR: Deaths 1-4

The adjustment required to account for deaths of children under the age of 15, particularly those under the age of one, produces estimates that are slightly out for the years 2006-2008 (Figures 8 to 10). However, after this period, the estimates appear to be very consistent, with only a slight difference in the Adj VR for ages 1-4 years in 2011 and 2012.

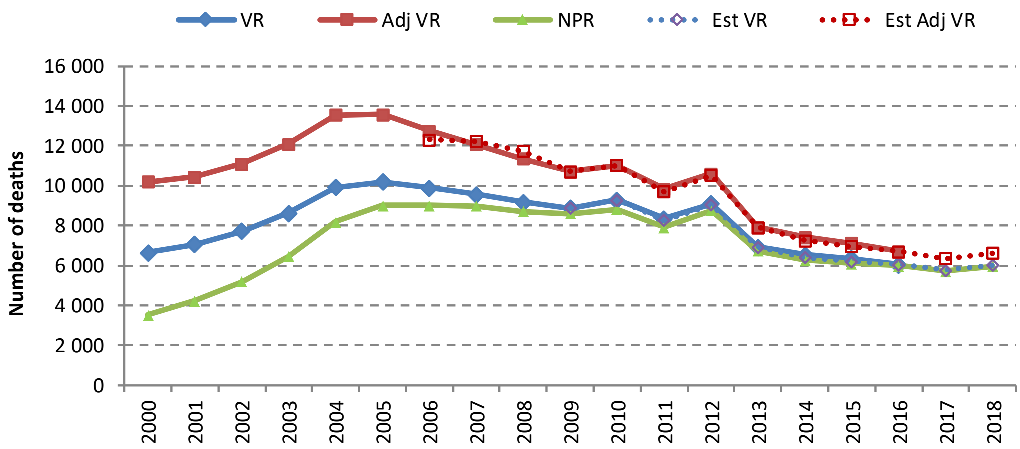


Figure 10: VR, VR adjusted for incompleteness of reporting, NPR, estimated VR, estimated adjusted VR: Deaths 5-14

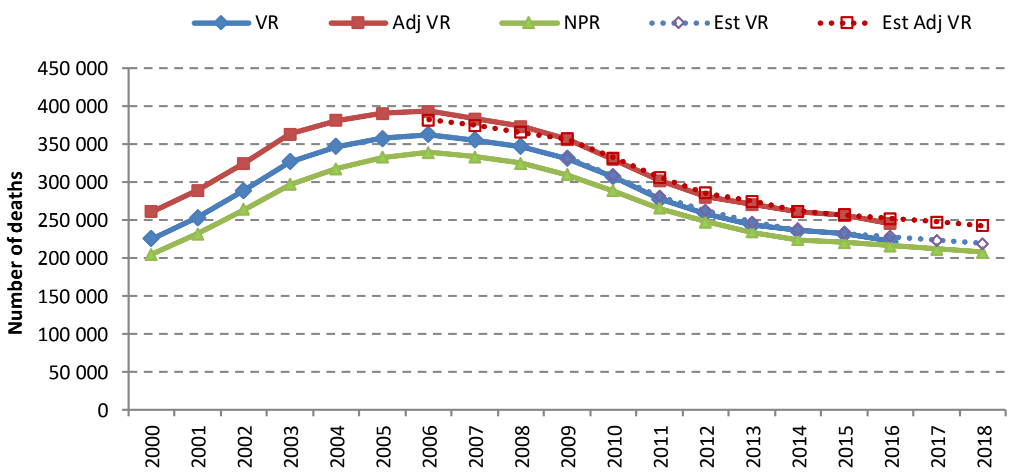


Figure 11: VR, VR adjusted for incompleteness of reporting, NPR, estimated VR, estimated adjusted VR: Deaths 15-59

As shown in Figure 12, it appeared as if up until 2010 the number of deaths captured on the NPR was virtually the same as those ultimately reported by Stats SA, suggesting that virtually everyone aged 60 and above is on the NPR. However, once again, something appears to have changed since then, with the NPR capturing noticeably more deaths than are reported by Stats SA.

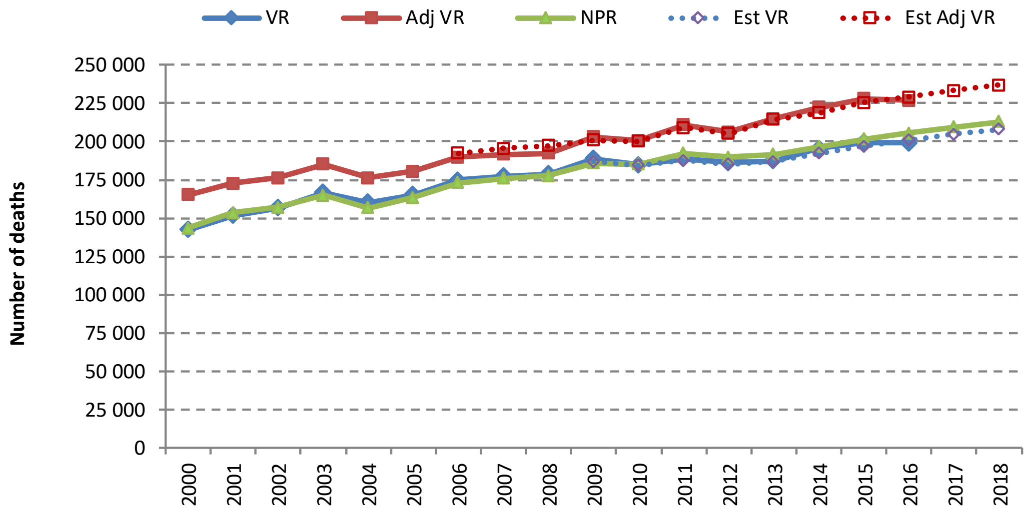


Figure 12: VR, VR adjusted for incompleteness of reporting, NPR, estimated VR, estimated adjusted VR: Deaths 60+

LIFE EXPECTANCY AND ADULT MORTALITY

The life expectancy at birth (e_0) as well as the adult mortality index, ${}_{45}q_{15}$, representing the probability of a 15-year-old person dying prematurely before the age of 60, are shown in Table 3 for the period 2012-2018. The trends in these indicators since 2000 are shown in Figures 13 and 14. It can be seen that life expectancy increased since 2005 with particularly rapid progress between 2010 and 2011. This is mainly due to a significant decline in the mortality of those under the age of 1 but is also due to a decline in adult mortality, both probably as a result of the extensive roll-out of ARVs. The improvement in e_0 is only marginal between 2017 and 2018, largely because of an increase in infant mortality recorded by the NPR.

The estimate of ${}_{45}q_{15}$ in 2015 and 2016 for males derived using the VR data is lower and those of e_{60} for females in 2016 slightly higher, than estimates based on NPR data, which probably reflects deaths missing (possibly due to late registration) from the VR dataset, and thus it is assumed that in these cases the estimates from the NPR data are the more accurate. These show a definite levelling off in trend in recent years.

Table 3: Estimated life expectancy at birth (e_0) and adult mortality (${}_{45}q_{15}$), RMS 2012-2018

INDICATOR	2012	2013	2014	2015	2016	2017	2018
Life expectancy at birth Total	61.4	62.1	62.7	63.3	63.9	64.6	64.8
Life expectancy at birth Male	58.4	59.1	59.5	60.1	60.9	61.6	61.9
Life expectancy at birth Female	64.4	65.2	65.9	66.6	66.9	67.6	67.9
Adult mortality (${}_{45}q_{15}$) Total	38%	36%	35%	34%	33%	32%	31%
Adult mortality (${}_{45}q_{15}$) Male	44%	42%	41%	40%	39%	38%	37%
Adult mortality (${}_{45}q_{15}$) Female	32%	30%	29%	28%	27%	26%	25%

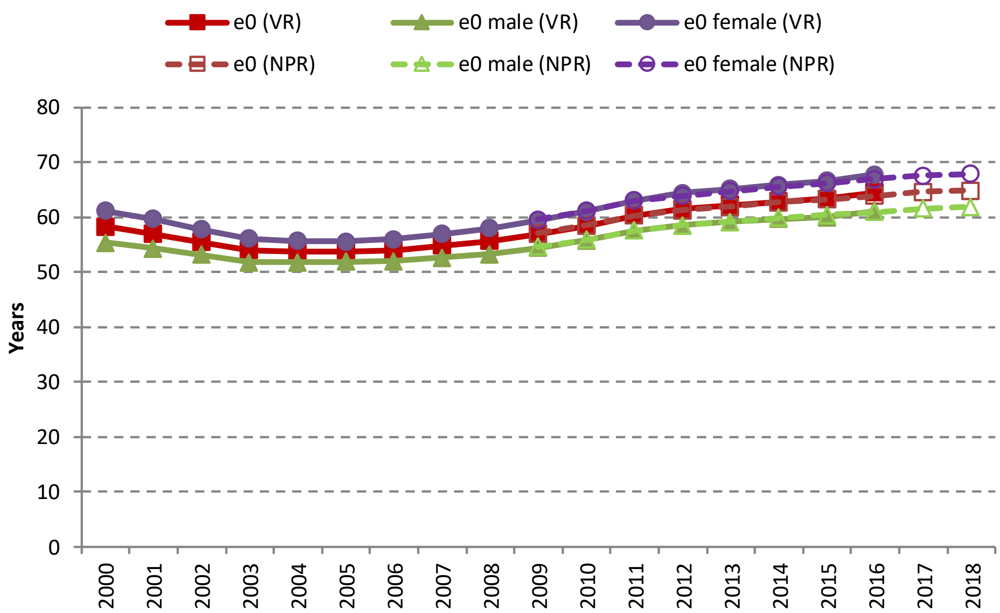


Figure 13: Life expectancy at birth (e_0) from VR and RMS, 2000-2018 (after adjusting for incompleteness)

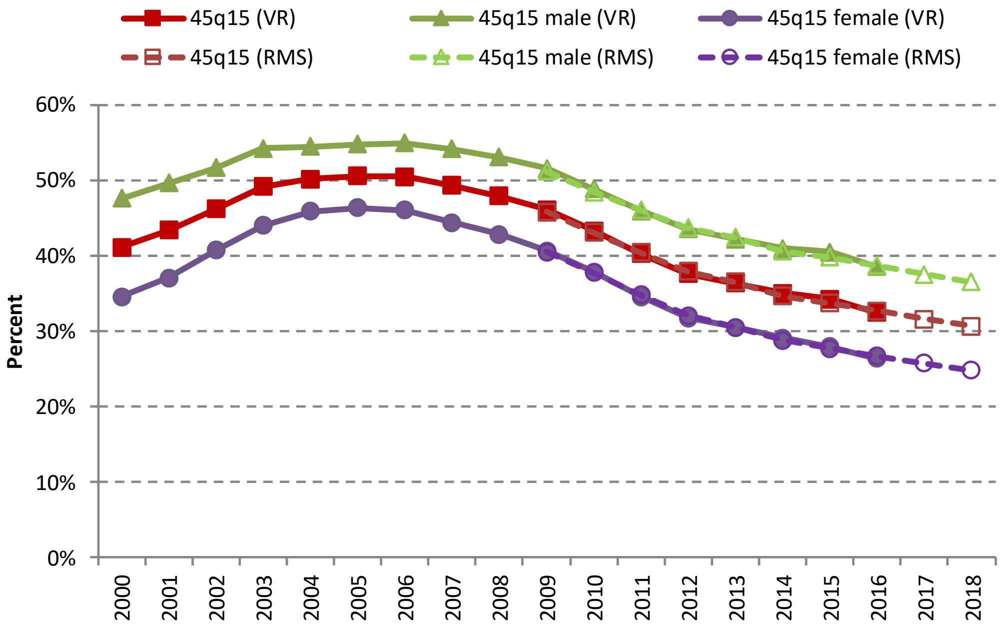


Figure 14: Adult mortality ($_{45}q_{15}$) from VR and RMS, 2000-2018 (after adjusting for incompleteness)

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 15. As can be seen from this figure, the mortality of older adults appears not to have changed much since 2004. The average life expectancy at the age of 60 remains about 15.5 years for men and 19 years for women.

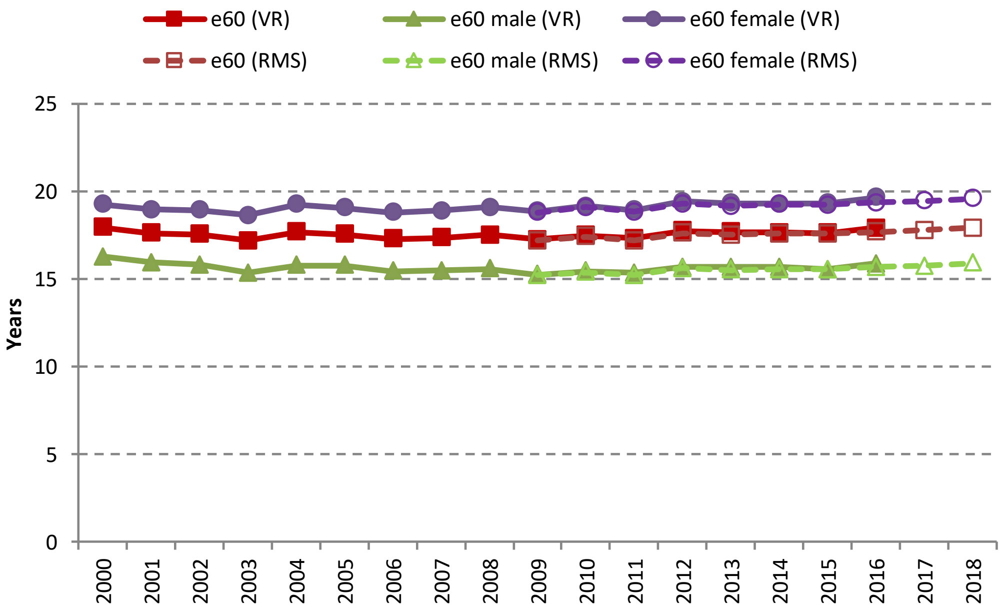


Figure 15: Life expectancy at the age of 60 (e_{60}) from VR and RMS, 2000-2018 (after adjusting for incompleteness)

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 15 965 in 2017 and increased to 16 981 in 2018. The numbers of deaths by month, compared with the numbers of deaths reported by Stats SA for 2013-2016, is shown in Figure 16. There is a high degree of correspondence between the two series, with the marked seasonal effect all but disappearing in 2017 but returning in 2018, with deaths higher over the winter months from May-August. What is unusual about the numbers from the causes of death data for 2016 is the sharp fall-off in numbers, relative to the NPR data, in the last two months, suggesting that many deaths in December, particularly, failed to have been captured by Stats SA by release of the data in 2018.

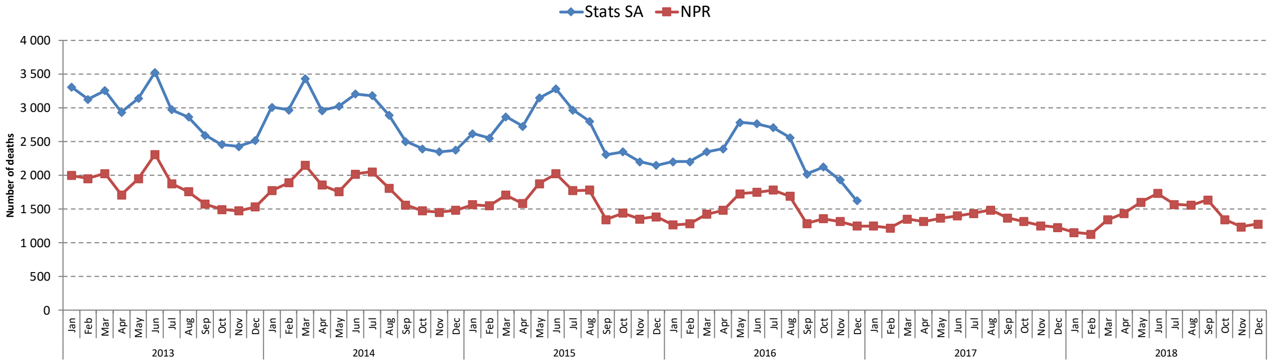


Figure 16: Monthly number of child deaths under 5 years from Stats SA and NPR, 2013-2018

The trends in the numbers of deaths by selected causes in the Stats SA data for 2011-2016 are shown in Figure 17. Both diarrhoeal deaths (ICD code A09) and pneumonia deaths (ICD code J18) have characteristic seasonal patterns which have attenuated over time. A summer peak in Feb-March for diarrhoeal deaths (ICD code A09) has almost disappeared. A winter peak in the pneumonia deaths (ICD code J18) as well as the diarrhoea (ICD code A09) persist. The deaths from causes originating in the perinatal period (ICD codes P00-P99) 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. The HIV deaths (ICD codes B20-B24), including pseudonyms (ICD codes B33 and D84), are much lower than one would expect given the severity of the epidemic, reflecting the tendency of not disclosing HIV on death notifications. The trend in the HIV deaths indicates a very mild seasonal effect. Deaths from diarrhoeal diseases showed a considerable decline between 2008 and 2009, with a substantial drop in the summer peak and a smaller drop in the May peak. It remains a challenge to know what contribution the reductions in HIV infection, the introduction of new vaccines, and improved access to water and sanitation have made to the decrease. However, generally, as the U5MR decreases, deaths due to perinatal conditions, which have remained quite stable, contribute a higher proportion of the deaths. The 2016 data suggests that deaths in the last two months, particularly in deaths from causes in the perinatal period, were not captured by Stats SA at the time of release of the data.

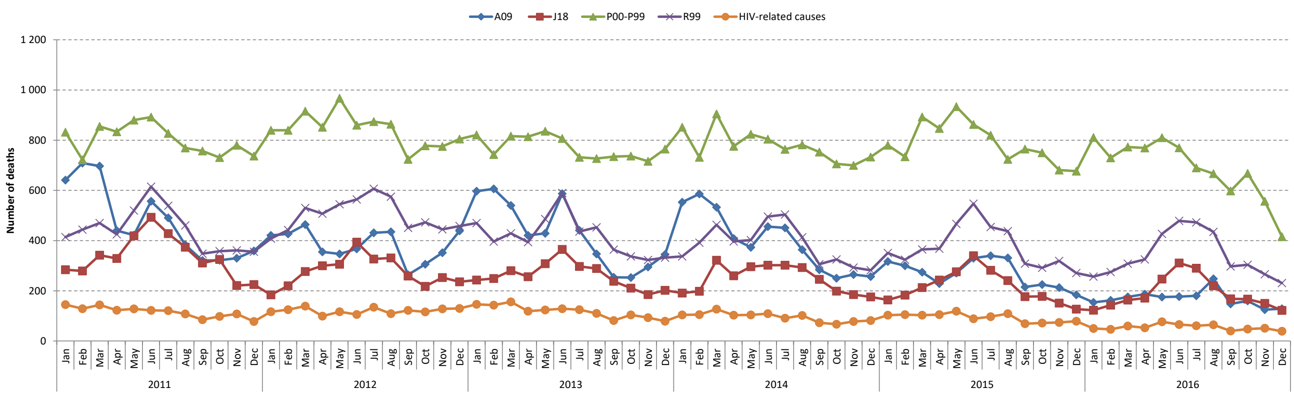


Figure 17: Number of child deaths under 5 years of age by selected cause-of-death, Stats SA 2011-2016
Note: Unchanged from previous RMS report

Figure 18 shows the monthly number of deaths from the NPR by year (with the lines becoming darker as the years progress to 2018). From 2011, there is no clear pattern of deaths by months (with the possible exception of a high point in May to August and low points in September to April) with little change in the overall level. The May to August ‘hump’ is missing from the deaths in 2017 but has returned in 2018. The reason for this is, at this stage, unclear.

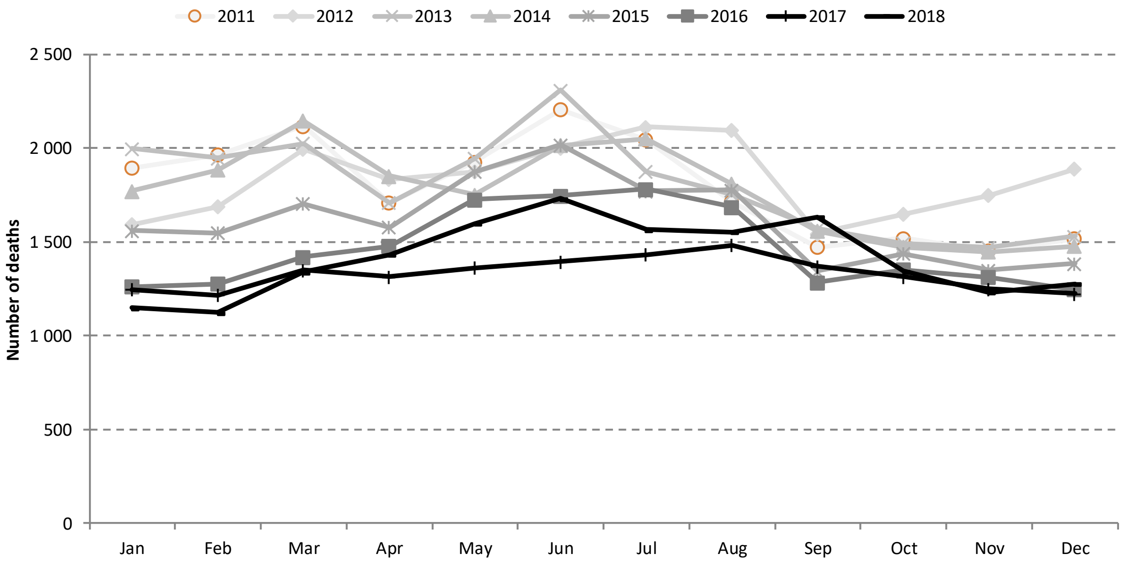


Figure 18: Number of child deaths under 5 years by month, NPR 2011-2018

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 addition, this proportion is not stable over time. For these reasons, it is necessary to consider an alternative data source to monitor the level of NMR. Figure 19 shows the number of neonatal deaths and stillbirths from the DHIS compared to the corresponding deaths from the cause-of-death vital registration (VR). Neonatal deaths from the VR data 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, on the other hand, has increased steadily from 2008-2014, overtaking the VR deaths in 2012. While at the same time the VR data of registered stillbirths shows little change over the period at a level of about 15 000, followed by a decline from 2015-2016, whereas the stillbirths captured by the DHIS has declined steadily over the whole period, particularly from 2015 to 2016, before increasing from 2016 to 2017 and 2018. The decline from 2015 to 2016 is a similar decline in the neonatal VR deaths.

The VR system misses neonatal deaths that have not been registered, while the DHIS misses the deaths that occur in the private sector or at home. In 2008, the DHIS captured 72% 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.

Since both the proportion of VR neonatal deaths that are captured by the DHIS and the number of neonatal deaths relative to the number of stillbirths captured by the DHIS increased over this period, it is probable that, certainly up to 2012, the increase in number of neonatal deaths from the DHIS was mainly due to an increase in coverage. To allow for this increase in coverage, the completeness of the DHIS relative to the VR neonatal deaths for 2010-2012 was estimated as the completeness for the previous year plus any increase in the ratio of neonatal deaths to stillbirths over the previous year from the DHIS data. As a check on the reasonableness of the method, the estimate of DHIS as a proportion of VR data for 2009 is 73% vs the true estimate of 72%, while that for 2010 was 76% vs the true estimate of 86%. Although the difference in 2010 is unsatisfactory, the resulting error in the estimate of NMR is less than 10%. As the proportion of VR that are captured by the DHIS increases the difference between the estimates of the proportion reduces. However, since the number of neonatal deaths recorded by the DHIS has exceeded those recorded by the VR since 2012 (significantly so for after 2013) it seems more appropriate to assume that part, if not all, the decline in VR neonatal deaths in this period is due to a decline in completeness of registration commented on in previous reports. Thus, from 2016 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.

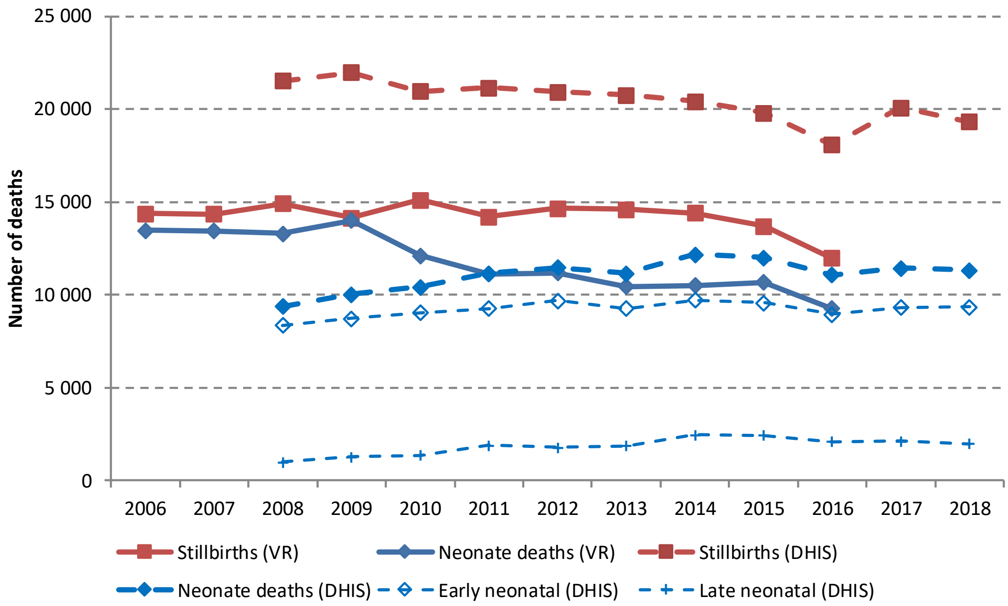


Figure 19: Stillbirths and neonatal deaths from VR and DHIS 2006-2018

Estimates of the key indicators of mortality for children are shown in Table 4 for the period 2012-2018, together with the reworked targets recommended by HDACC. Figure 20 shows the U5MR, IMR and NMR. The U5MR and IMR are calculated from VR data for the period 2006-2016 and from the NPR data for the period 2009-2018, once the data have been adjusted for under-registration. 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 2006-2016 and the DHIS (adjusted for under-coverage, relative to the registered deaths, and the incompleteness of the vital registration) for the period 2011-2018. From Figure 20, 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 2015 and has dropped to 11 per 1 000 in 2017. The IMR and the U5MR declined rapidly since 2008 and by 2017 are approaching the 2019 targets, after stagnating for 2012-2014. However, there was a slight increase in the IMR and U5MR in 2018, reaching 25 and 34 per 1 000 live births respectively.

Also included on the figure 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 2016, the NMR is being estimated from the DHIS deaths and births directly.

Table 4: Estimated U5MR, IMR and NMR, RMS 2012-2018 and DHIS 2012-2018

INDICATOR	TARGET 2019	BASELINE 2012	2013	2014	2015	2016	2017	2018
Under-5 mortality rate (U5MR)	33* (20% reduction)	42 per 1 000 live births	43 per 1 000 live births	42 per 1 000 live births	39 per 1 000 live births	36 per 1 000 live births	33 per 1 000 live births	34 per 1 000 live births
Infant mortality rate (IMR)	23	28 per 1 000 live births	29 per 1 000 live births	29 per 1 000 live births	28 per 1 000 live births	26 per 1 000 live births	23 per 1 000 live births	25 per 1 000 live births
Neonatal mortality rate (<28 days) (NMR)	8	12 per 1 000 live births	11 per 1 000 live births**	12 per 1 000 live births**	12 per 1 000 live births**	12 per 1 000 live births**	12 per 1 000 live births**	11 per 1 000 live births**

* Assumed published figure of 23 was typographical error

** Changed method to derive directly from DHIS neonatal deaths and live births rather than VR deaths and births from 2013

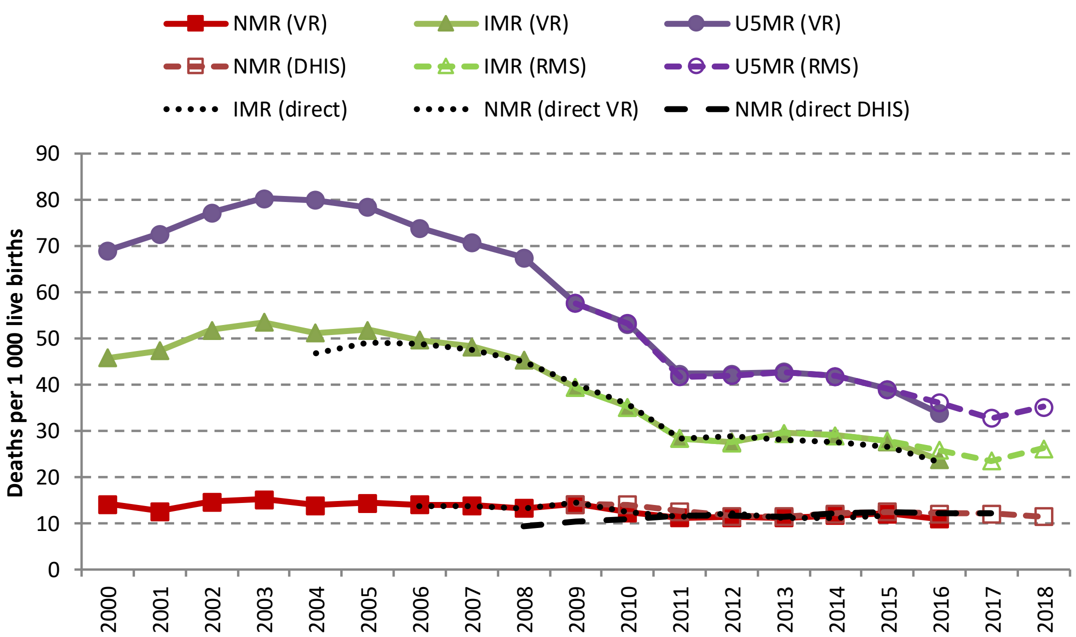


Figure 20: Under-5 mortality rate (U5MR) and infant mortality rate (IMR) from VR/RMS and neonatal mortality rate (NMR) from VR/DHIS, 2000-2018 (after adjusting for incompleteness)

OLDER CHILDREN, ADOLESCENT AND YOUTH MORTALITY

This indicator is not part of the Medium-Term Strategic Framework (MTSF) and is being included in this report for the second time because there has been a 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 5 and Figures 21 and 22 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 peak in 2012 (and slight peak in 2010) seen in the mortality of older children and young adolescents (${}_{10}q_5$) seen in Figure 21 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. In June 2016, the government launched the "She Conquers" campaign[7] that seeks to reduce HIV infections, improve overall health outcomes, and expand opportunities for adolescent girls and young women (AGYW). The mortality of older adolescent and youth (${}_{10}q_{15}$) among females is an essential impact indicator related to this campaign. The rapid decline since 2004 coincides with the provision of ARTs to pregnant women. However, the rate of decline has slowed down since 2014 despite the introduction of the campaign. The mortality rate among males age 15-24 has remained constant since 2011 at 25 per 1 000. Complimentary efforts to reduce injury related mortality will be required for adolescent boys and young men.

Table 5: Estimated mortality rates of older children & young adolescents and older adolescents & youth 2012-2018

INDICATOR	TARGET 2019	2012	2013	2014	2015	2016	2017	2018
Older children & young adolescents (${}_{10}q_5$ per 1000)								
Total	None	10.9	8.0	7.3	7.0	6.5	6.0	6.2
Male	None	11.7	8.7	8.2	7.8	7.4	7.0	7.0
Female	None	10.1	7.3	6.5	6.2	5.6	5.1	5.3
Older adolescents & youth (${}_{10}q_{15}$ per 1000)								
Total	None	24.5	23.5	22.6	22.3	21.7	21.4	20.8
Male	None	25.7	26.0	25.8	26.3	25.8	26.0	25.2
Female	None	23.2	21.1	19.5	18.4	17.5	16.9	16.4

[7] National Department of Health. She Conquers. Available: http://sheconquerssa.co.za. Accessed: 10 January 2020.

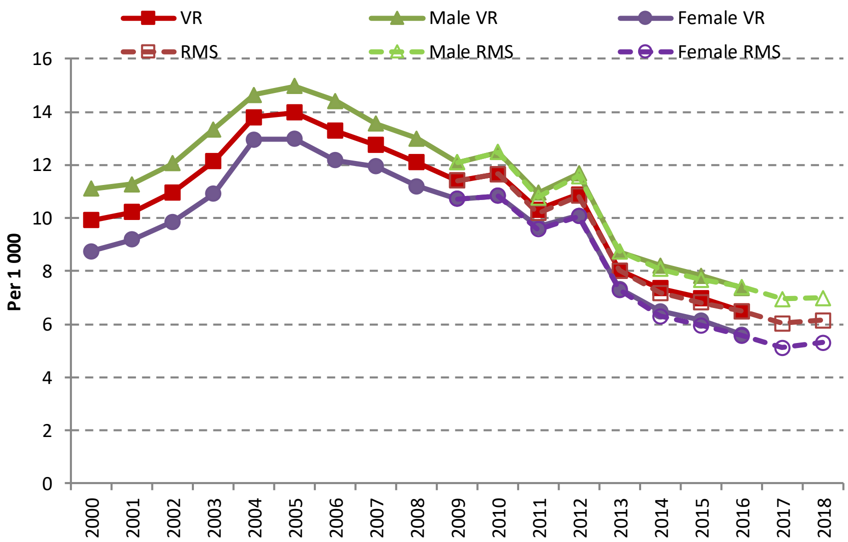


Figure 21: Estimate of $_{10}q_{5}$, the probability of five-year old dying before age 15, for males, females and both, 2000-2018

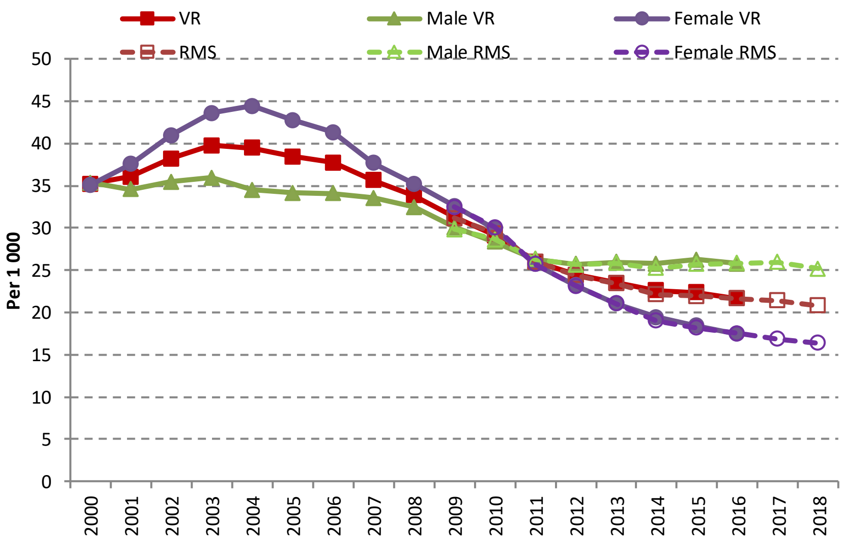


Figure 22: Estimate of $_{10}q_{15}$, the probability of 15-year old dying before age 25, for males, females and both, 2000-2018

MATERNAL DEATH

In common with other indicators based on the cause-of-death data, this indicator has not been updated from last year's report, except for some marginal changes because of the change to estimation of the births and population. The uncertainty about the level of maternal mortality is well recognised (HDACC, 2011; Bradshaw and Dorrington, 2013; Stats SA, 2013b; Dorrington and Bradshaw, 2016). The estimated MMR rose from 232 per 100 000 live births in 2006 to peak at 302 per 100 000 live births in 2009 before dropping substantially to 134 per 100 000 live births in 2016 (Table 6).

Table 6: Estimated MMR, Stats SA 2011-2016

INDICATOR	TARGET 2019	2011*	2012	2013	2014	2015	2016
Maternal mortality ratio (MMR)	Downward trend below 100	198 per 100 000 live births	164 per 100 000 live births	153 per 100 000 live births	166 per 100 000 live births	153 per 100 000 live births	134 per 100 000 live births

* Baseline for MMR set at 2011 due to lag in availability of data
Note: Table is unchanged from previous RMS report

Figure 23 shows the estimates of the maternal mortality ratios (MMRs) and pregnancy-related mortality ratios (PRMRs) produced from different data sources. (By definition, the MMR includes direct and indirect maternal causes of death, while the PRMR also includes incidental deaths during the pregnancy risk period.) The values from vital registration and the confidential enquiry increase to a peak at the same time and appear to match up to 2008 after which the confidential enquiry estimates are about 30% higher than those estimated from VR data. After the peak they both decline to values that are much lower than the RMS/MDG estimates until recent years when the estimates are very similar. It is somewhat surprising that the RMS estimates should now be so close to those of the confidential enquiry. This would suggest that maternal deaths that occur outside state facilities at about the same rate as those that occur within these facilities, which seems a little implausible. It raises concerns about the VR data for 2013-16. Although late registrations of deaths may increase the estimates slightly, judging by the change in estimate for 2013 from last year due to late registrations, the impact is limited.

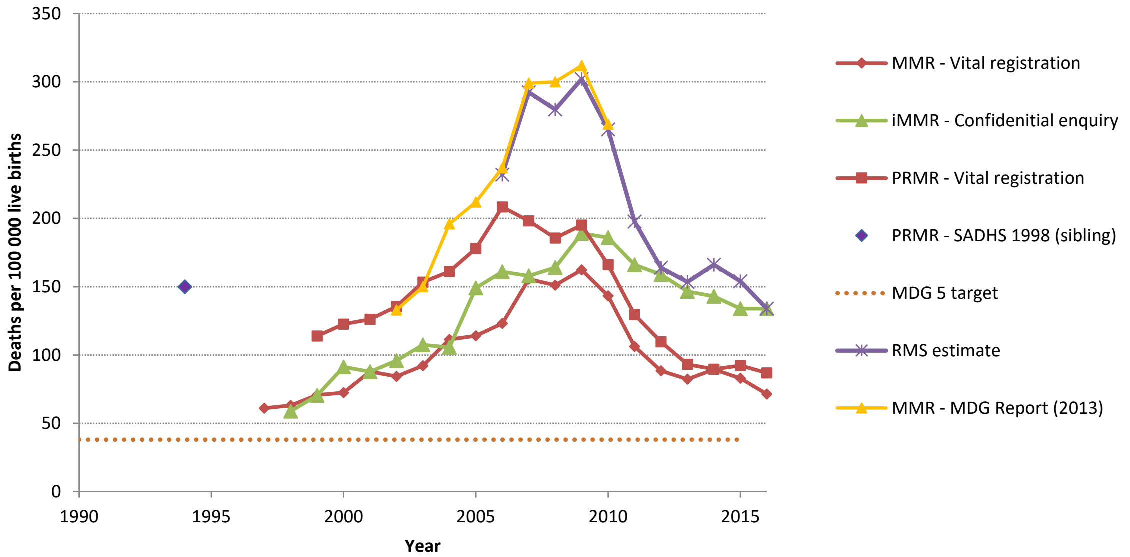


Figure 23: Estimate of MMR from various sources, 1995-2016
Note: Unchanged from previous RMS report

Nonetheless, the RMS estimates, as well as those reported in the 2013 and 2015 MDG Country Reports (Stats SA, 2013b; Stats SA, 2015a) and the institutional MMR reported by the National Committee for Confidential Enquiry into Maternal Deaths (NCCEMD 2018), indicate that maternal mortality may have peaked in 2009. The decline 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. Interestingly although the maternal mortality ratio from VR also peaks in 2009, the ratio based on pregnancy-related deaths as reported in the VR data peaks three years earlier.

The numbers of registered deaths from maternal causes shown in Figure 24 indicate a marked increase in the number of indirect maternal deaths since 2003. As noted by Bradshaw and Dorrington (2013), the timing of the increase in indirect maternal deaths is possibly surprising given that the rapid increase in the mortality of women aged 15-49 due to HIV started some 7-8 years ago and peaked some 2-3 years before 2008. Longer exposures to HIV infection, adverse effects of antiretroviral therapy or changed death certification practice are possible reasons for the delayed increase but deciding which would require further investigation. However, what is of interest from Figure 24 is the fact that there appears to have been a drop in the numbers of deaths from every cause since 2009, with a sizeable decline in "Complications from other conditions" from 2011 to 2012. To what extent the declines in the most recent years are connected to the apparent under-reporting is still unclear. However, it is also of interest to note that there was no decline in "Complications from other conditions" for 2012-2014 and yet deaths from these causes are three times the level they were in 2003. The decline in numbers due to other causes appear also to be limited since 2013 with the exception of "Complications from other conditions", which dropped sharply from 2014 to 2016, but is still double the number in 2003.

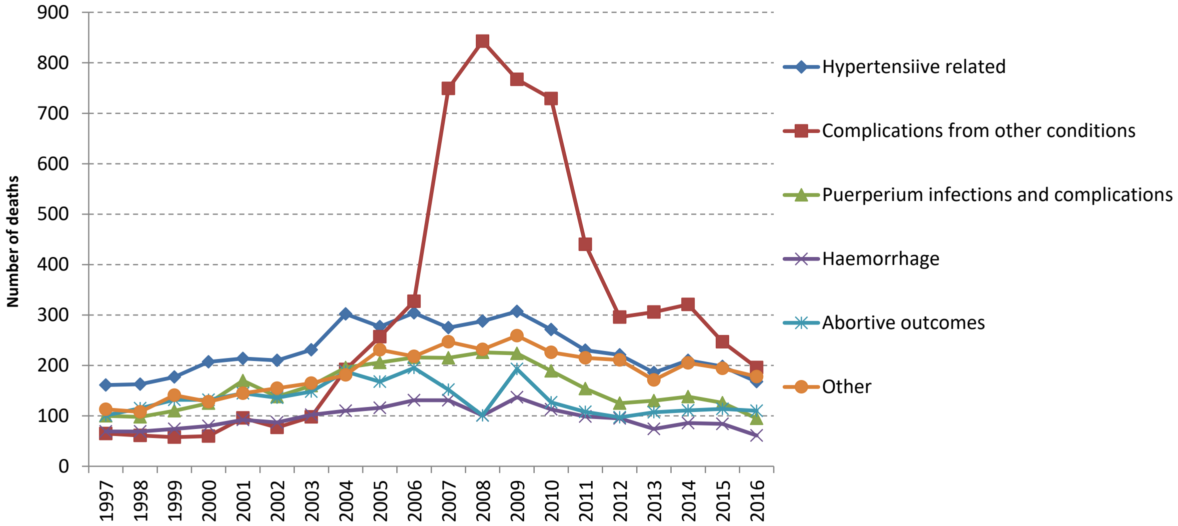


Figure 24: Trend in the number of maternal deaths by cause, Stats SA 1997-2016
Note: Unchanged from previous RMS report

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

Another new addition last year was the introduction of an indicator for tracking mortality due to non-communicable diseases (NCDs). 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 COO-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). The results presented below are the same (apart from small changes due to the changes in the method of projecting the population) as last year since no new causes-of-death data were released this year by Stats SA.

The overall NCD $_{40}q_{30}$ is shown in Table 7 as well as the component for each disease category. With the exception of a small decline in premature mortality from cardiovascular diseases for both men and women, and chronic respiratory disease for women, there has been very little evidence of a change in rates of NCD mortality in the period 2011-2016. 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) uses a more complex methodology to adjust for additional forms of mis-classification of causes of death and is likely to generate slightly different estimates for these indicators.

Table 7: Estimated mortality rates (NCD $_{40}q_{30}$) due to non-communicable diseases (NCD), Stats SA 2011-2016

INDICATOR	TARGET	2011*	2012	2013	2014	2015	2016
NCD $_{40}q_{30}$ Total	None	29%	29%	29%	30%	30%	29%
NCD $_{40}q_{30}$ Male	None	34%	34%	34%	35%	35%	34%
NCD $_{40}q_{30}$ Female	None	25%	24%	24%	24%	24%	24%
INDICATOR	**TARGET**	**2011***	**2012**	**2013**	**2014**	**2015**	**2016**
Cardiov. disease $_{40}q_{30}$ Total	None	15%	14%	14%	14%	14%	14%
Cardiov. disease $_{40}q_{30}$ Male	None	18%	18%	17%	18%	18%	17%
Cardiov. disease $_{40}q_{30}$ Female	None	12%	12%	11%	11%	11%	11%
Cancer $_{40}q_{30}$ Total	None	9%	9%	9%	9%	9%	9%
Cancer $_{40}q_{30}$ Male	None	10%	10%	11%	11%	11%	10%
Cancer $_{40}q_{30}$ Female	None	7%	7%	7%	8%	8%	8%
Diabetes $_{40}q_{30}$ Total	None	5%	5%	5%	5%	5%	5%
Diabetes $_{40}q_{30}$ Male	None	5%	5%	5%	6%	6%	5%
Diabetes $_{40}q_{30}$ Female	None	5%	5%	5%	5%	5%	5%
Chronic resp. disease $_{40}q_{30}$ Total	None	4%	4%	4%	4%	4%	4%
Chronic resp. disease $_{40}q_{30}$ Male	None	6%	6%	6%	6%	6%	6%
Chronic resp. disease $_{40}q_{30}$ Female	None	3%	3%	2%	2%	2%	2%

* Baseline set at 2011 due to lag in availability of data
Note: Table unchanged from previous RMS report

Figure 25 shows the estimates of $_{40}q_{30}$, the probability of 30-year old dying before age 70, due to non-communicable diseases, for males, females and both for 2000-2016. 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.

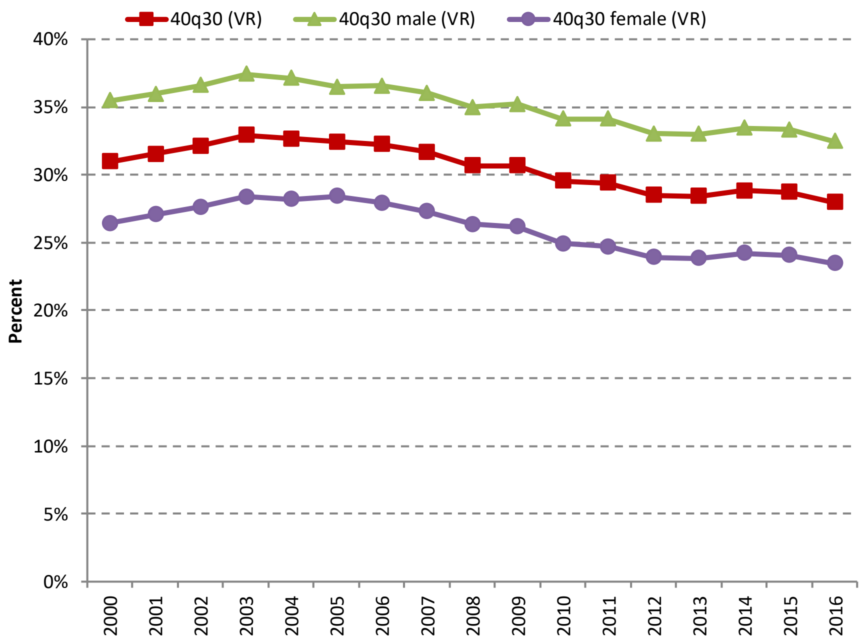


Figure 25: Estimate of $_{40}q_{30}$, the probability of 30-year old dying before age 70, due to non-communicable diseases, for males, females and both, 2000-2016

Note: Unchanged from previous RMS report

Figure 26 presents the mortality rates ($_{40}q_{30}$) by major NCD causes for males and females separately. The trends for each cause differ over time, with CVD clearly declining from a peak in 2003, CRD from a peak in 2005 and Diabetes pretty level over the whole period. Premature mortality from Cancer has been more stable over the period. The gender differences also differ by cause. The Cancer mortality rates for women are about 70% of those for men over the whole period. For CVD, the female to male ratio falls from 75% in 2000 to 64% in 2016 while for CRD, the ratio rises from 46% in 2000 to above 50% in 2005/6 then falls to 40% by 2016. In the case of Diabetes, the 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 100% by 2016.

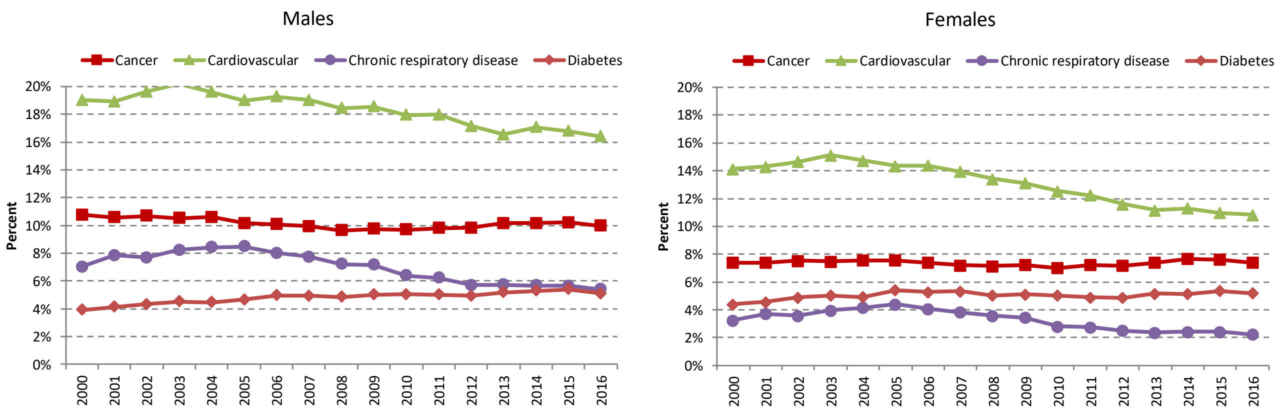


Figure 26: Trend in cause-specific $_{40}q_{30}$, the probability of 30-year old dying before age 70, due to non-communicable diseases, for males and females, 2000-2016

Note: Unchanged from previous RMS report

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 and 2016 Global Burden of Disease (GBD) reports (not shown), and the GBD 2017 report). In addition, estimates of the under-five and neonatal mortality from the 2016 South African Demographic and Health Survey (NDoH, Stats SA, SAMRC & ICF, 2017) are included.

Figure 27 compares the estimates of under-five mortality. There is broad agreement between the RMS estimates and those of IGME (United Nations Interagency Group on Child Mortality Estimation 2019) and those of the World Population Prospects (WPP), 2019 revision, (UN Population Division 2019) over much of the period, and the SDG (Stats SA 2017b) estimates for 2010 and 2011, and for the first time, the most recent estimates, GBD 2017, from IHME (2018) for much of the period. In contrast to their 2018 estimates, which were higher than all other estimates from 2010 onwards, the estimates from this year's official mid-year population projection (Stats SA, 2019b) fall below most of the other estimates from 2013 onwards. 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-five mortality. Although the similarity of RMS to UN IGME estimates is probably because UN 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 SADHS 2002-2006, which is undoubtedly due to the bias in the SADHS estimates due to the fact that women infected with HIV 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 past 10 years, suggesting that the recent estimates from other sources are probably on the high side. The picture is similar for IMR (not presented) with the exception that the SADHS estimate of IMR for last five years is much higher than the RMS estimates and thus more consistent with the other recent estimates, which could suggest that the RMS estimates of IMR may be too low in recent years. However, further investigation suggest that it is possible that the SADHS misclassified stillbirths as neonatal deaths nationally. In addition, the SADHS underestimated the under-five 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.

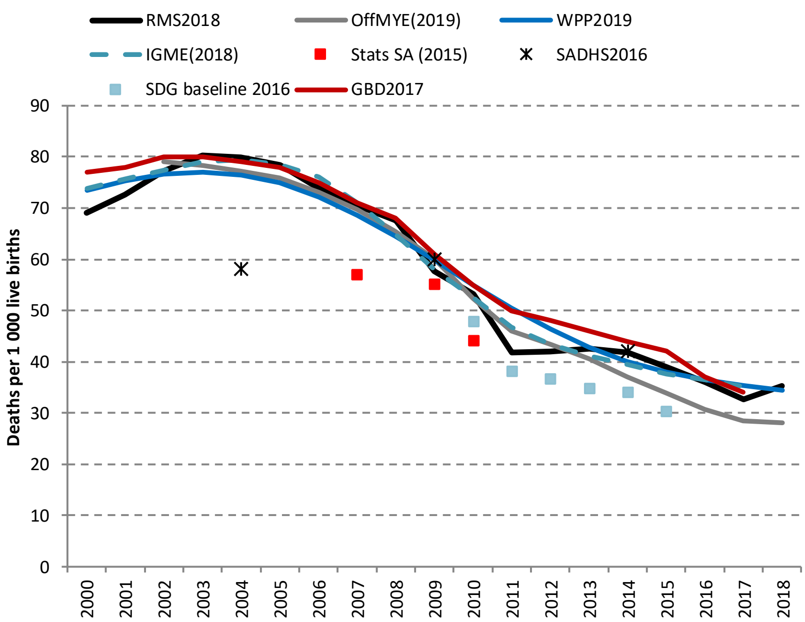


Figure 27: Comparison of estimates of the under-5 mortality rate (U5MR), 2000-2018

Figure 28 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 estimates of the level differ for the GBD 2017, with the RMS estimates being two years higher than the GBD 2017 estimates until 2015, after which the GBD 2017 estimates increase rapidly to overtake the RMS estimates by 2016. After this, the GBD 2017 estimates continue to increase, somewhat implausibly by 2 years from 2016 to 2017. Although the WPP estimates are similar to the RMS estimates at the minimum they are about 1 year lower outside this period mainly due to higher WPP adult mortality. The rest of the difference between the RMS and other life expectancies is mainly due to differences in under-five mortality. The official mid-year estimates (Stats SA, 2019b) are almost entirely consistent with the RMS estimates in recent years (despite noticeable difference in the mortality under age five), which implies that Stats SA's adult mortality must be somewhat higher than that of the RMS in recent years.

In all cases, the life expectancy of females is higher than that of males throughout the period with the difference higher in 2000 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 3.7 years in 2005 before rising to 5.2 years in 2010 and 6.4 in 2015, the comparable figures for GBD 2017 (IHME 2018) were 5.4 years, 2.4 years, 2.6 years and 4.9 years, somewhat different from those for WPP, namely, 6.0 years, 4.8 years, 5.7 years and 6.8 years respectively.

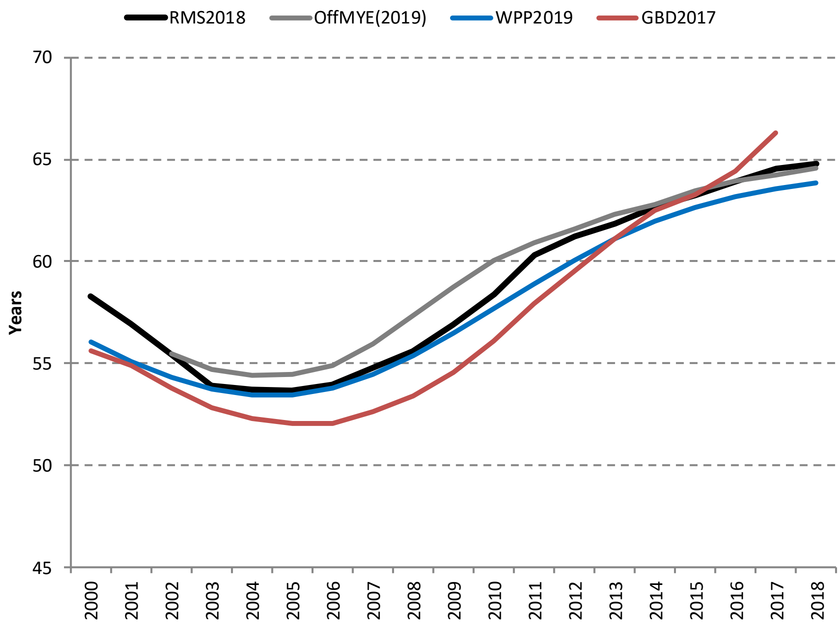


Figure 28: Comparison of estimates of life expectancy at birth (e_0), 2000-2018

Although there is consistency between the RMS and SDG estimates of MMR (Figure 29), 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 three quite different estimates (not shown) produced by IHME (Hogan et al 2010, Lozano et al 2011 and Kassebaum et al 2014, IHME 2015) prior to the latest, and different yet again, GBD 2017 (IHME 2018) estimate and the quite different estimates produced by MMEIG (WHO et al 2012 & 2014) (not shown) and the most recent estimate (MMEIG 2016). The latest, GBD 2017 estimates from IHME (2018) peak earlier than the RMS estimates and then fall to be implausibly[8] low after 2011. However, the fact that the RMS estimates lie comfortably in the cloud of uncertainty suggests that they are at least as reliable as any of the estimates shown in Figure 29. Surely, they are more sensible than estimates that suggest that HIV/AIDS had no impact on maternal mortality or estimates that suggest the ratio peaked several years before adult mortality rates peaked because of HIV/AIDS.

[8] Implausible because they imply negative MMR for births outside the public facilities.

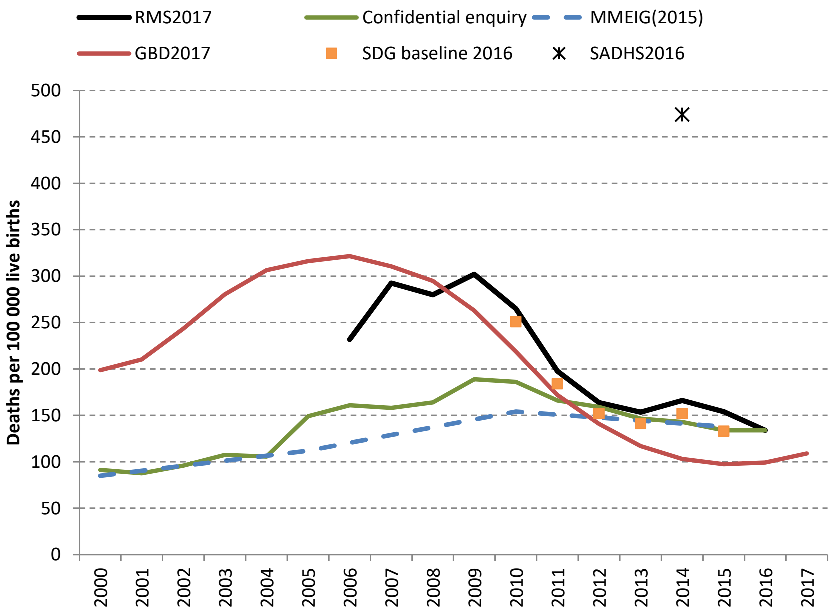


Figure 29: Comparison of estimates of maternal mortality ratio (MMR), 2000-2017
Note: Unchanged from previous RMS report

As far as adult mortality is concerned (Figure 30), the RMS estimates lie below the IHME estimates but are very close to the WPP estimates.

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 drop in rates from 2016 to 2017 (Figure 30).

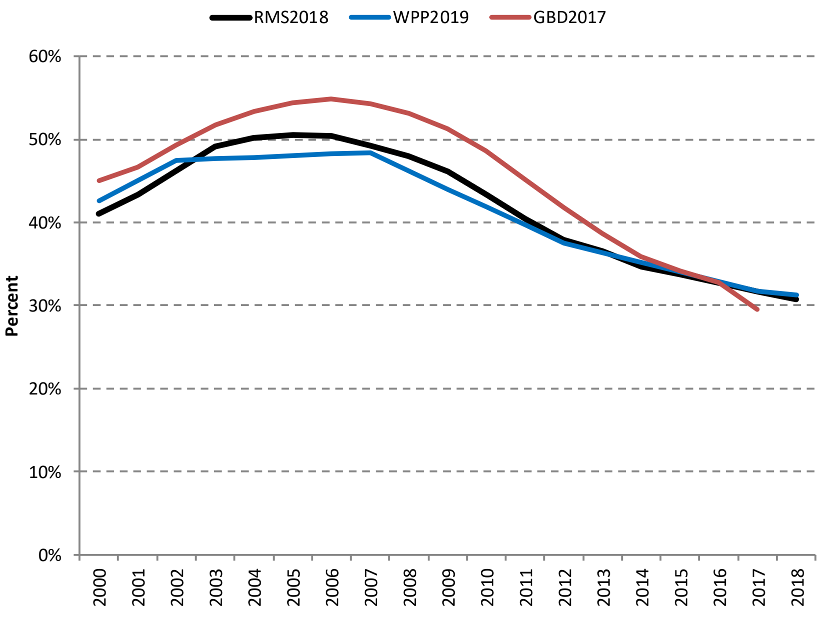


Figure 30: Comparison of estimates of adult mortality ($_{45}q_{15}$) for males and females combined, 2000-2018

Although it is difficult to be sure that the neonatal mortality in South Africa is as low throughout the period as that estimated by the RMS (Figure 31), it is important to point out that the GBD 2017 estimates (IHME 2018) imply an implausible trend in completeness of registration of neonatal deaths over the period rising from an improbable under 40% in 2000 to a more reasonable 80% by late 2000s. Unfortunately, the “3.8 billion” GBD 2017 estimates do not include stillbirths, but comparison of the estimates of stillbirths from GBD 2016 and SADHS with estimates from DHIS data suggest IHME may have underestimated by about 7 per 1,000, which might be connected to their overestimate of neonatal mortality.

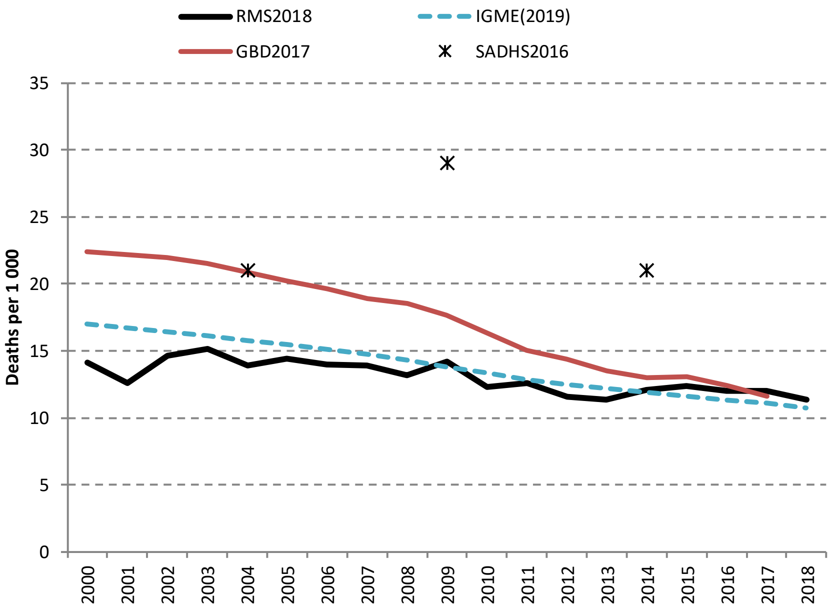
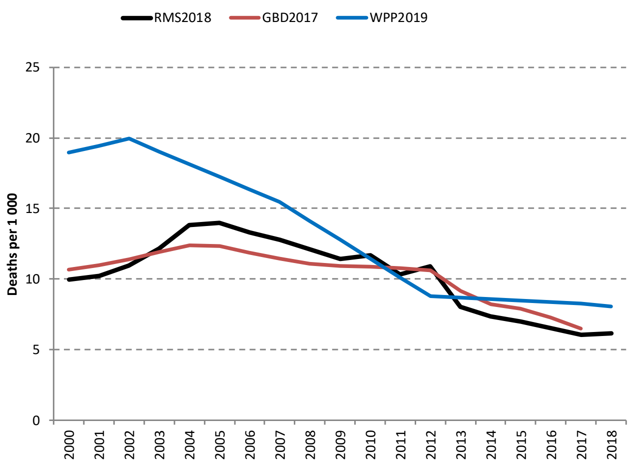


Figure 31: Comparison of estimates of neonatal mortality rates (NMR), 2000-2018

Finally, the RMS estimates of the 10q5 and 10q15 are reasonably consistent with estimates from GBD 2017 (but this is not the case with previous GBD estimates (not shown)) but less so with the WPP 2019 estimates (Figure 32).



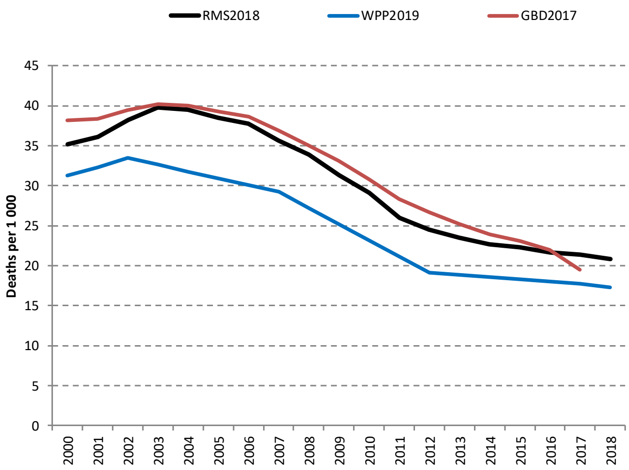


Figure 32: Comparison of estimates of older children & young adolescent and older adolescent & youth mortality rates ($_{10}q_5$ and $_{10}q_{15}$), 2000-2018

CONCLUSIONS

The 2018 mortality estimates show that South Africa is continuing to make progress in extending life expectancy and reducing mortality, although with a slight increase observed in the infant mortality and the under-5 mortality rates from 2017 to 2018. Estimates derived from empirical data indicates that life expectancy has increased by more than ten years from the low of 53.7 years in 2005, reaching a level of 64.8 years in 2018.

Childhood mortality has been declining since 2003. However, levels of mortality stagnated between 2011 and 2014, after which both the infant and under-5 mortality rates continued declining between 2015 and 2017 reaching new national lows of 23 and 34 per 1 000 live births respectively. Of concern is the slight increase observed in both these indicators in 2018. In contrast, the neonatal mortality rate that had shown little change since 2010 and was 11 deaths per 1 000 in 2018, very slightly lower than in 2017. Examination of the data show that the low infant and under-5 morality rates in 2017 were associated with an unusually low winter peak in deaths, particularly among infants 1-11 months old. It is not clear whether this was possibly a result of health system success (e.g. community out-reach) or milder than usual conditions.

The data suggest that the 2019 MTSF target for the U5MR could be met but it is unlikely that the target of 6 per 1 000 live births for the NMR and of 18 per 1 000 live births for the IMR will be met. 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 entail 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).

There is no new estimate of the maternal mortality ratio. As reported previously, South Africa has some way to go to reach the SDG target of 70 per 100 000 live births by 2030. In 2016, the MMR was estimated at 134 per 100 000 live births, having stagnated between 150 and 165 deaths per 100 000 live births for several years.

An indicator of the mortality of older children and young adolescents aged 5-14 years (${}_{10}q_5$) was introduced in the previous report. Global estimates have highlighted concerns that although mortality is low, most of these deaths are preventable and the need for the public health community not to lose sight of the fact that decades of growth and development in the transition to adulthood also involve complex processes and crucial ages or age-intervals or periods in the life cycle that are sensitive to intervention (Bundy et al, 2018). There has been a general improvement in mortality in this age group globally since 1990 (UN IGME, 2018; Patten et al 2015) although variations, associated with socio-economic conditions, have been observed between countries as well as a consistent gender differential with rates for males being higher than for females (Global Burden of Disease Child and Adolescent Health Collaboration, 2015). Although the mortality rates have declined, and South Africa is keeping more children alive, 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 3rd Disease Control Priorities project has identified two cost-effective and scalable health interventions during older childhood years (5–9 years) and adolescence (10–19 years) to provide phase-specific support across the life cycle (Bundy et al, 2018). Their work demonstrates the importance of securing the gains of investment in the first 1 000 days, enabling substantial catch-up from early growth failure, and leveraging improved learning from concomitant education investments. It also highlights that interventions are required in the middle of childhood growth and consolidation phase (5–9 years), when infection and malnutrition constrain growth, and mortality is higher than previously recognised; the adolescent growth spurt (10–14 years), when substantial changes place commensurate demands on good diet and health; and the adolescent phase of growth and consolidation (15–19 years), when new responses are needed to support brain maturation.

Life expectancy at age 60 is a useful summary of the mortality experienced by older South Africans. As reported previously, the mortality rates in older ages have shown little change despite considerable change in the life expectancy at birth. The life expectancy at age 60 has been about 15 years for men and 19 years for women since 2000. The average life expectancy at age 60 years was 17.9 years in 2018. This is lower than the estimate of global average life expectancy at age 60 years of 20.7 years for the period 2015-2020 (UN, 2019). A study of trends in life expectancy in high income countries found that improvements in these countries mostly arose through improvements in mortality over the age of 65 years (Ho and Hendi, 2018). As South Africa grapples with achieving universal health coverage and the implementation of the National Health Insurance, this will be an important indicator to monitor.

There is no new estimate of premature mortality from preventable NCDs. As reported previously, there has been no improvement in NCD mortality over the period 2011-2016. The risk of a 30-year old dying before age 70 from the selected NCDs considered to be preventable is 35% for males and 24% 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), 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 SAHNAHES, 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 2013-17 (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.

Although the 2017 RMS report was extended to include additional mortality indicators required to monitor health, further work is needed to expand the analysis to provincial data in this report and explain differences that have been observed between data sources.

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APPENDIX 1: ESTIMATION OF COMPLETENESS OF REPORTING OF DEATHS

Completeness of reporting of deaths is estimated in three processes for three different age ranges: infant and child mortality, adult (20+) mortality and finally the completeness of reporting of deaths aged 5-19. The process of estimating completeness of reporting deaths, particularly infant and child deaths was quite intricate and is described only in broad terms. A more detailed description appears in the technical report on the second South African National Burden of Disease methods (Pillay-van Wyk et al, 2014).

Infants and children under 5 years

The numbers of registered deaths, under the ages of one and five in particular, 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 for under one 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 in 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 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,[9] 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[10].

Adults (25+ years)

Completeness of reporting of adult deaths was estimated by first estimating it for the following intercensal periods using death distribution methods: 1996-2001, 2001-2007 and 2001-2011. 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 5-24 years

Completeness of reporting by single years of age for ages 5-24 were derived from Beers interpolation from completeness for ages 2, 7, 12, 17, 22 & 27+ (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.

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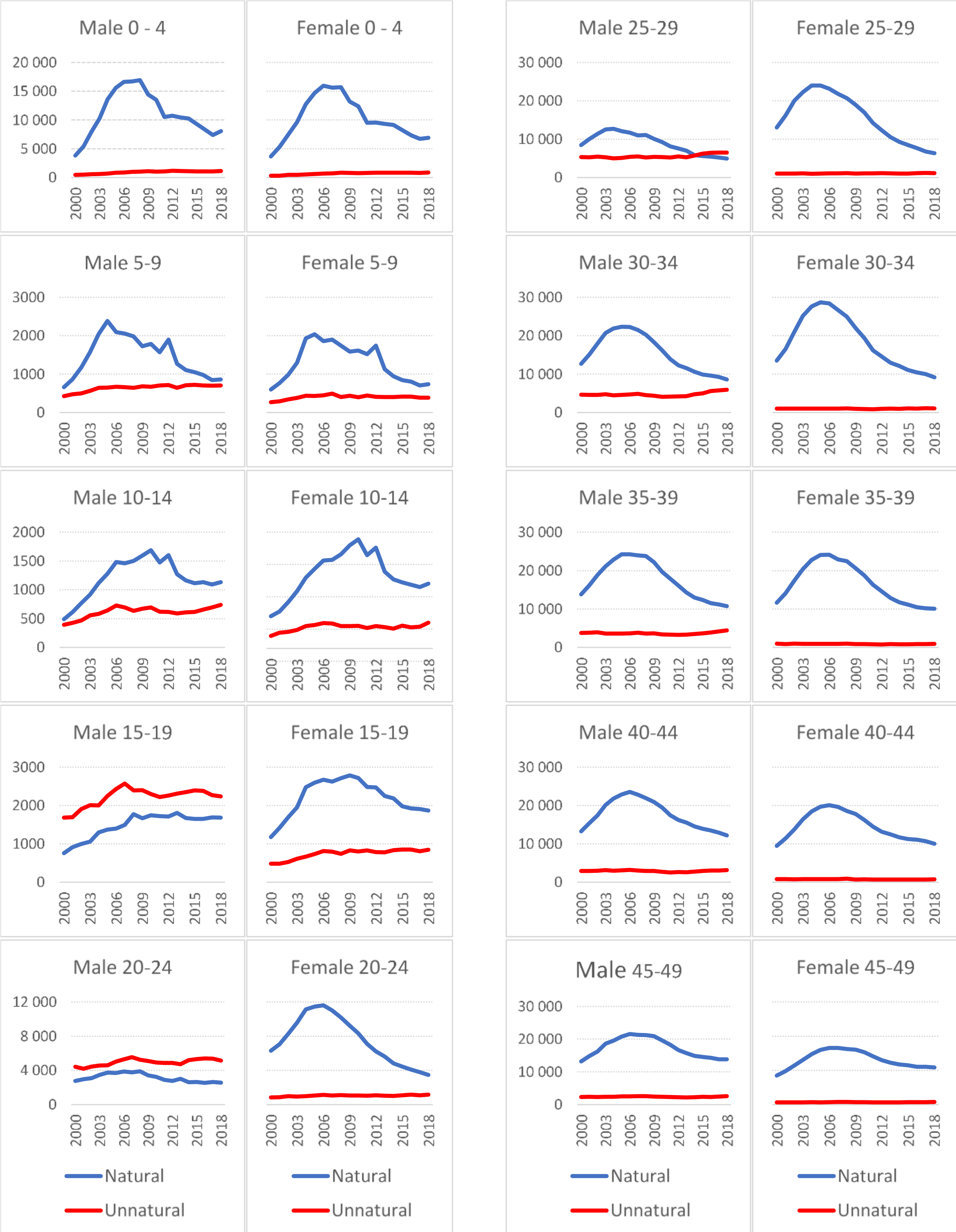
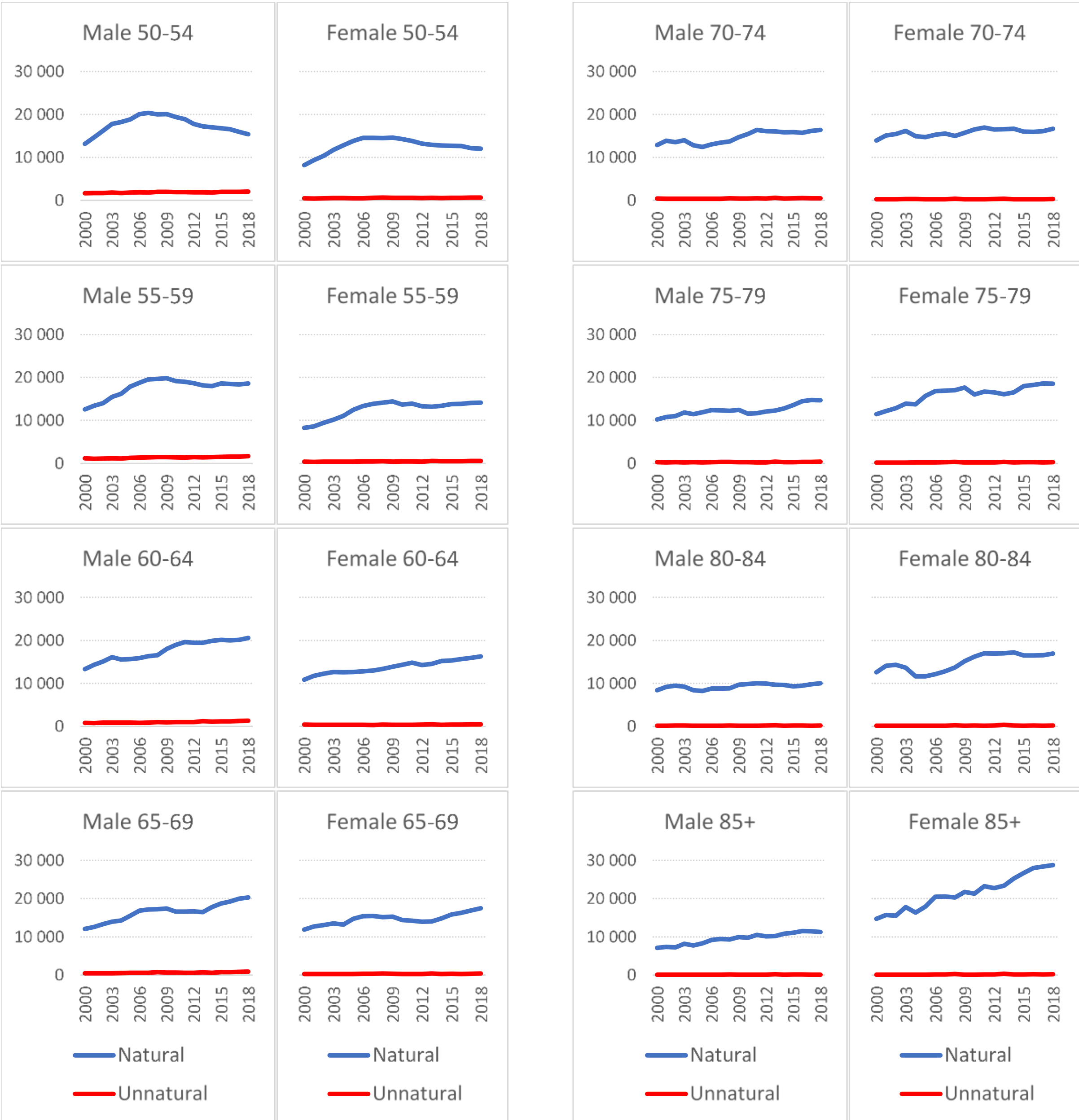
[9] There were one or two years where this assumption implied implausible change in rates between one year and the next, in which case the drastic change in the reported number of deaths was assumed to be due to a change in completeness rather than rate of mortality.

[10] 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.

APPENDIX 2: TREND IN THE NUMBER OF NATURAL AND UNNATURAL DEATHS BY AGE AND SEX, NPR 2000-2018



3


Male 50-54
Female 50-54
Male 70-74
Female 70-74
Male 55-59
Female 55-59
Male 75-79
Female 75-79
Male 60-64
Female 60-64
Male 80-84
Female 80-84
Male 65-69
Female 65-69
Male 85+
Female 85+
30 000
20 000
10 000
0
2000
2003
2006
2009
2012
2015
2018
Natural
Unnatural

BURDEN OF DISEASE RESEARCH UNIT
SOUTH AFRICAN MEDICAL RESEARCH COUNCIL