RAPID MORTALITY SURVEILLANCE REPORT 2014

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Burden of Disease Research Unit
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UCT Centre for Actuarial Research

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

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ACRONYMS AND ABBREVIATIONS

q_0	-	probability of a live birth dying before age 1
$_5q_0$	-	probability of a live birth dying before age 5
$_{45}q_{15}$	-	conditional probability of a 15-year-old person dying before age 60
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
e_0	-	life expectancy at birth
e_{60}	-	life expectancy at age 60
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
MRC	-	Medical Research Council
NMR	-	neonatal mortality rate
NPR	-	National Population Register
NSDA	-	Negotiated Service Delivery Agreement
PRMR	-	pregnancy-related mortality ratio
RMS	-	Rapid Mortality Surveillance
Stats SA	-	Statistics South Africa
U5MR	-	under-5 mortality rate
VR	-	vital registration
WPP	-	World Population Prospects (2012 revision)

EXECUTIVE SUMMARY

This is the fourth report based on the Rapid Mortality Surveillance (RMS) system. Originally set up to monitor the trend in adult deaths recorded on the National Population Register at a time when there was a substantial time lag in the cause-of-death reports produced by Stats SA, the RMS still provides timely empirical estimates of the mortality-based high-level indicators for Outputs 1 and 2 of the health-related targets of the Negotiated Service Delivery Agreement (NSDA) up to 2014. In addition, the RMS data provide a check on consistency of the VR data and for the past couple of years have highlighted an increasingly worrying trend in under-recording by the vital registration system.

Estimates of the neonatal mortality rate (NMR) and the maternal mortality ratio (MMR) cannot, however, be obtained from this source. The NMR up to 2014 is based on adjusted data from the District Health Information System (DHIS) and the MMR on adjusted data from cause-of-death data from Stats SA up to 2013.

The latest estimates show that the **average life expectancy in South Africa has reached nearly 63 years**, an increase of nearly 9 years since the low in 2005. The increase in life expectancy is due to a drop in the levels of child mortality as well as young adult mortality.

In 2013, the mortality of young adults continued to decline, albeit at a reduced level. **All indicators are now below the NSDA targets set for 2014/15.** However, as was the case last year, compared to the levels in 2011, the decline in infant and under-five mortality rates continues to stagnate with rates at 28 and 39 per 1 000 live births, respectively. Similarly, neonatal mortality rates which improved, gradually, since 2009 have remained at 11 per 1 000 live births since 2012. The maternal mortality ratio peaked in 2009 and has declined to 155 per 100 000 live births.

There is still a need to develop a methodology to provide estimates of sub-national trends for the provinces and health districts. The increase in the ratio of the number of deaths from the RMS to the cause-of-death numbers could indicate that deaths are being missed in the cause-of-death data, particularly in the most recent year (2013), and it is important that this issue not be ignored any longer.

KEY MORTALITY INDICATORS, RMS 2009-2014

LIFE EXPECTANCY AND ADULT MORTALITY (OUTPUT 1)							
INDICATOR	**TARGET 2014**	**2009**	**2010**	**2011**	**2012**	**2013[5]**	**2014**
Life expectancy at birth Total	59.1 (Increase of 2 years)	57.1	58.5	60.5	61.3	62.2	62.9
Life expectancy at birth Male	56.6 (Increase of 2 years)	54.6	56.0	57.8	58.5	59.4	60.0
Life expectancy at birth Female	61.7 (Increase of 2 years)	59.7	61.2	63.2	64.0	65.1	65.8
Adult mortality ($_{45}q_{15}$) Total	43% (10% reduction)	46%	43%	40%	38%	36%	34%
Adult mortality ($_{45}q_{15}$) Male	48% (10% reduction)	51%	48%	46%	44%	42%	40%
Adult mortality ($_{45}q_{15}$) Female	37% (10% reduction)	40%	38%	35%	32%	30%	28%
MATERNAL AND CHILD MORTALITY (OUTPUT 2)							
INDICATOR	**TARGET 2014**	**2009**	**2010**	**2011**	**2012**	**2013[5]**	**2014**
Under-5 mortality rate (U5MR) per 1 000 live births	50 (10% reduction)	56	52	40	41	41	39
Infant mortality rate (IMR) per 1 000 live births	35 (10% reduction)	39	35	28	27	29	28
Neonatal mortality rate[2] (<28 days) per 1 000 live births	12 (10% reduction)	14	13	13	11	11	11
INDICATOR	**TARGET 2014**	**2008[4]**	**2009**	**2010**	**2011**	**2012**	**2013**
Maternal mortality ratio[3] (MMR) per 100 000 live births	252 (reverse increasing trend and achieve 10% reduction)	281	302	267	200	166	155

1. DHIS data
2. Stats SA data
3. Baseline for MMR set at 2008 due to lag in availability of data
4. Baseline set to 2008 due to lag in availability of data
5. Based on RMS data rather than VR data because of apparent significant under-recording by the VR data

INTRODUCTION

This is the fourth in the series of annual reports utilising the data from the Rapid Mortality Surveillance (RMS) database described in the first report (Bradshaw, Dorrington and Laubscher, 2012) to track several high-level indicators of mortality a year or two ahead of the release of the vital registration data, after correcting for incompleteness of reporting. These indicators include life expectancy, the adult mortality index ${}_{45}q_{15}$, under-5 mortality rate, infant mortality rate and the neonatal mortality rate. 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 RMS data series has been updated to the end of 2014 and the cause-of-death data to the end of 2013.

As was mentioned in the previous report, the estimates of the population and in particular the number of births each year has been changed to take into account the population estimates from the 2011 Census (Stats SA, 2013a). Although the official mid-year estimates were constructed to match in total the size of the population in 2011, they were not constructed with a series of births and migration (although some effort has been made to improve this in the most recent estimates (Stats SA 2015)) that replicates the age distribution of the population of the Census under age 30. In particular these estimates imply quite a different pattern of births over the years immediately preceding the census. In addition estimates of past mid-year populations change with each new release, which would necessitate re-estimation of the series of indicators each year. It was therefore decided to extend the use of an alternative set of mid-year population estimates, which were derived to be consistent with the 2011 Census population (Dorrington, 2013), by projecting forward to 2014 using unchanging fertility and migration.

As was done previously, adjustments have been made to allow for the under-registration of deaths, after first adjusting the data to account for a proportion of people who are not on the National Population Register. In addition, the same methodology as used previously, was used to estimate the MMR from the cause-of-death data.

DATA SOURCE

The Department of Home Affairs is responsible for civil registration and the maintenance of a computerised National Population Register (NPR). 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 Medical Research Council has obtained monthly information about the deaths registered on the National Population Register and has developed a consolidated data base. 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, in common with deaths from the vital registration system (as reported in the cause-of-death data released by Stats SA) in developing countries, is non-registration of the death.

As the RMS 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 the maternal deaths. The latest available data are for the year 2013 (Stats SA, 2014b). In addition, too few neonatal deaths are recorded in the RMS 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 2009-14 (DHIS) to estimate the number of neonatal deaths that occur in public hospitals to produce a more recent estimate. Because of this, estimates of neonatal mortality for recent past years may need to be modified slightly to account for detailed unit record vital registration data when these are released.

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 (to avoid having to recast the indicators)
- be as consistent with the age distribution of the population of the 2001 and 2011 Censuses and the 2007 Community Survey as is reasonable, allowing, *inter alia*, for possible undercounting of children and age exaggeration at old age.

For the first report the estimates produced by the ASSA2008 AIDS and Demographic projection model 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 have been released and they suggest that not only has fertility been different from that assumed by projection models (including the ASSA model) for the past 10-15 years, but also that immigration has been somewhat higher than assumed by the projection models. Thus, for reports since then, in the absence of a suitable alternative, an alternative set of mid-year population estimates with an age distribution and size consistent with those of the 2001 and 2011 Censuses (Dorrington, 2013) is used.

As for the previous report, the numbers of births for the years 2000-2003 were taken as those estimated by back-projecting the numbers surviving to the 2011 Census. The numbers of births for the years 2004-2010 were taken as the average of the numbers estimated from the registered births by year of birth corrected for estimates of the completeness of registration, and the estimate of the number of births 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)[1]. The numbers of births in the years 2011-2014 were estimated as an average of the preceding two estimates and an estimate of the number of births derived from applying the fertility rates for 2011 to the AltMYE numbers of women of reproductive ages in these years.

ADJUSTMENTS

Evaluation of the RMS data shows that there has been a steady improvement in birth and ID registration, and a consequent reduction in the under-recording of deaths in the population register relative to those captured by Stats SA's cause-of-death processing. From Figure 1 it can be seen that more than 95% of the death notifications of people aged 25 and over, and close to or over 90% 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 births could be registered.

While up to 2010 it appeared that the proportion of registered deaths for adults (15+) on the population register had reached a plateau the proportions increased suddenly in 2011, to the point where there appear to be more deaths aged 25+ on the NPR than are being recorded by the VR cause-of-death data. This trend continued in 2012 and appears to have worsened significantly in 2013. As it should not be possible for a death to be recorded on the population register without there being a death certificate the increase in proportion must indicate that for some reason not all deaths on the population register are being processed by Stats SA. Although some of the discrepancy appears to be due to efforts to accelerate the release of the cause-of-death reports[2], it seems unlikely that this will account for all the deaths missing from the vital registration. This matter needs to be investigated, for as things stand at the moment one cannot rely on estimates of mortality and survival derived from the 2013 data (and possibly to some extent the 2011 and 2012 data). In addition, extrapolation of past trends of the relative completeness of the RMS are no longer as reliable as they were, undermining confidence in the estimates produced using the RMS data.

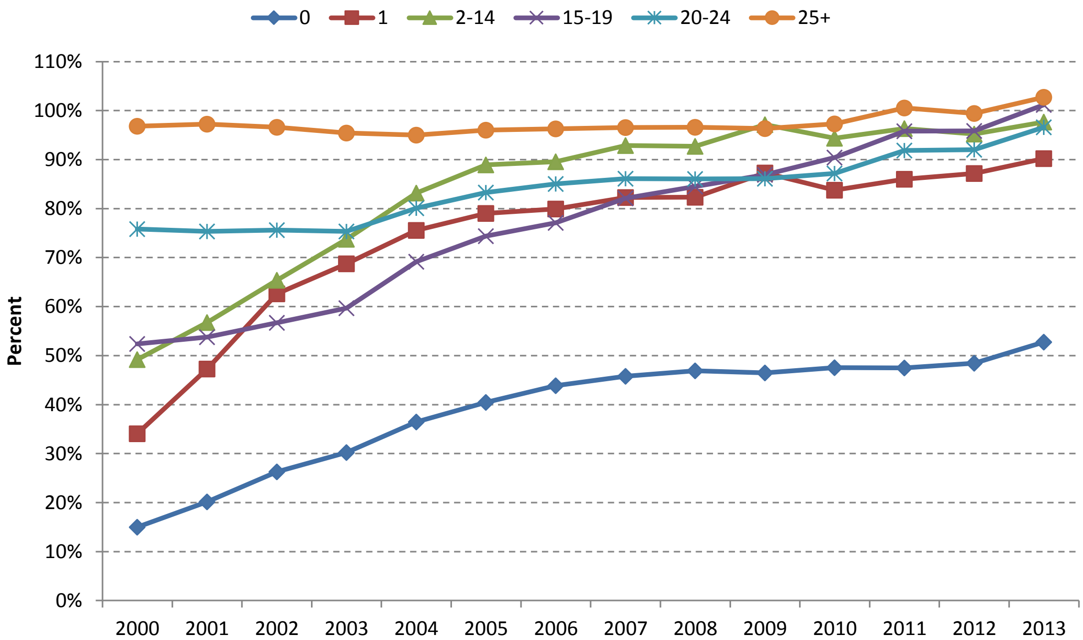


Figure 1: RMS deaths as a proportion of Stats SA deaths by age group, 2000-2013

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

[2] The publication of the Statistical Release on "Mortality and causes of death in South Africa, 2012" suggest that about half of these missing deaths were captured as late registrations in the report on deaths in the following year. However, the same report on deaths registered in 2013 shows only limited further late registrations.

As was done in the previous reports, the RMS 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. The second step is to account for under-notification of deaths. The first adjustment is made by 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. The same factors are then used to produce estimates for 2012 to 2014, for which cause-of-death data are either unreliable or have yet to be processed. Thereafter, the estimated numbers of deaths are adjusted for general under-notification (i.e. deaths with no death certificates). The levels of completeness of the VR data assumed are as follows:

age 0: 85.0%
age 1: 53.8%
ages 2–14: linear trend between the figure for age 1 and figure of 93% for age 15
ages 15+: 93.0%

A brief description of the approach used to estimate the completeness of registration of deaths is given in the appendix.

Aside from adjusting the 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 need 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).

The RMS data cannot be used to estimate neonatal deaths, because in 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 suggests that an increasing proportion of the VR deaths are being captured by the DHIS[3]. 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 is 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 is 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 is 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.

Thus for year t, if $VR(t)$ is the number of neonatal deaths from vital registration and $NND(t)$ is the number of neonatal deaths from DHIS, and $SB(t)$ is the number of stillbirths from the DHIS then the coverage of DHIS to VR in year t was calculated as

$c(t) = NND(t\text{-}1)/VR(t\text{-}1)$ if $VR(t\text{-}1)$ is available, otherwise
$c(t) = c(t\text{-}1) + NND(t)/SB(t) – NND(t\text{-}1)/SB(t\text{-}1)$.

As the number of neonatal deaths recorded by the DHIS is now close to that recorded by the VR it ought to be possible in future to estimate the NMR directly from the DHIS data. Had the rate been estimated directly using the DHIS numbers for 2014 (instead of indirectly as described above) the NMR for 2014 would be 12 per 1 000, not 11 per 1 000.

TRENDS IN RMS DATA

The number of deaths from the National Population Register is shown in Table 1 for 2000-2014 alongside the number of deaths from the Stats SA cause-of-death reports for 2000-2013. 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 458 933 in 2013. The RMS numbers increased from 359 470 in 2000 to a peak of 555 081 in 2006 and declined to 447 732 in 2014. It should be noted that the changes in the numbers of deaths cannot be interpreted without taking into account the general improvement in death registration (except in the most recent years), and in the case of the RMS, improved birth registration, over the period.

The rapid decline in the number of deaths in recent years makes it important to investigate whether there are any indications of system failure. Although subtle changes in completeness of recording are quite difficult to detect, extensive investigations have only identified evidence of some failures in the vital registration in 2013. This will need to be monitored going forward.

[3] To the point that in 2013 the DHIS capture more neonatal deaths than recorded by the VR cause-of-death data.

Table 1: Number of natural (N), unnatural (U) and total (T) deaths in RMS compared with Stats SA data by year

	RAPID MORTALITY SURVEILLANCE*			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			

* RMS numbers updated as of end April the following year

The trends in the number of deaths from the RMS are shown in Figure 2 and show a continuation of the marked decline since 2006 in natural causes in the young adult age group. This decline is mirrored for children <15 years with the exception of a levelling off in the last two years.

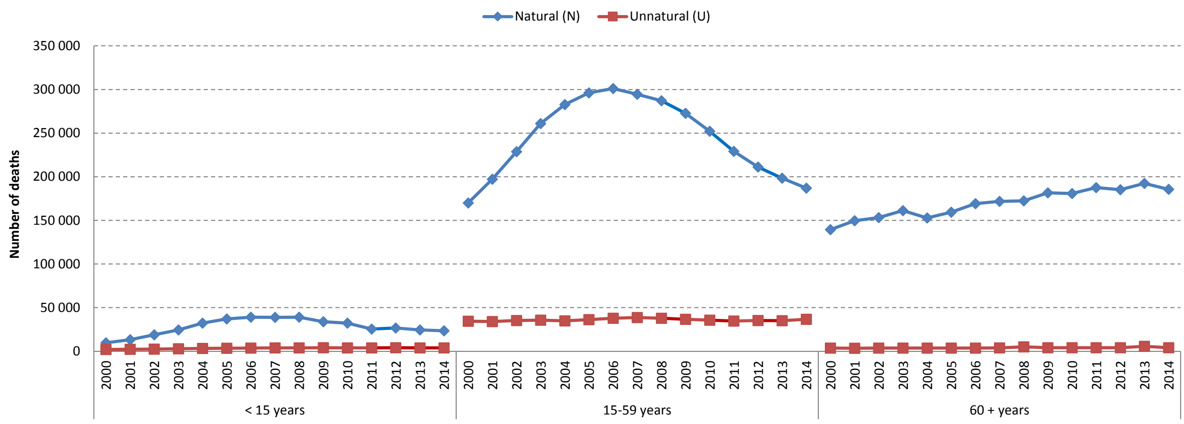


Figure 2: Trend in the number of natural (N), unnatural (U) by broad age group, RMS 2000-2014

The proportion of the VR deaths captured by the RMS increased from 86.3% in 2000 to 98.8% in 2013 (Figure 3). The proportion of unnatural deaths captured by the RMS was at a constant level of approximately 80% until 2004, after which it increased gradually to above 90% for 2010 and then accelerated for 2011, fell back to around 90% in 2012 before accelerating to a record 95%.

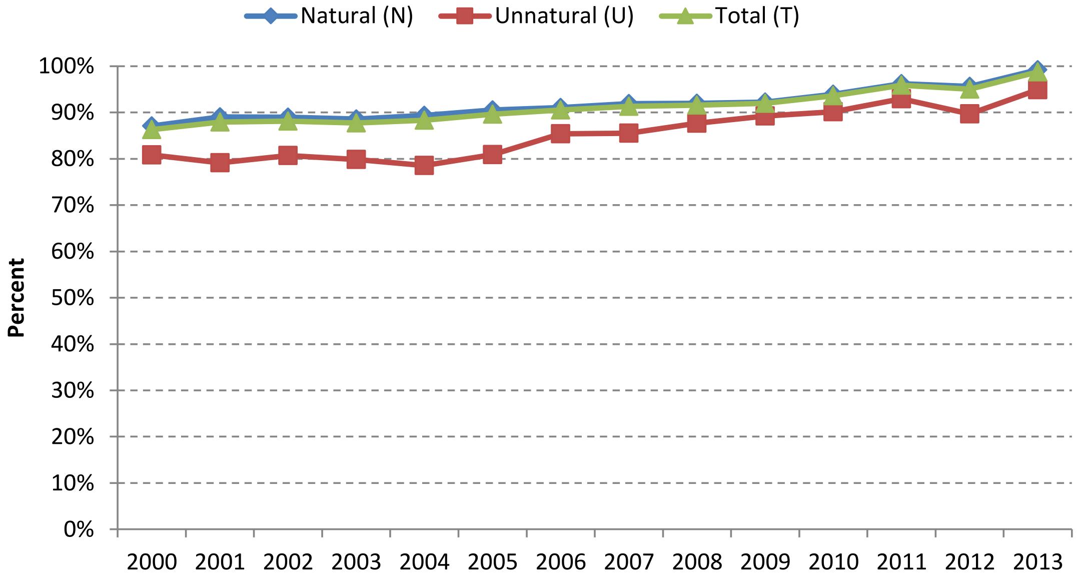


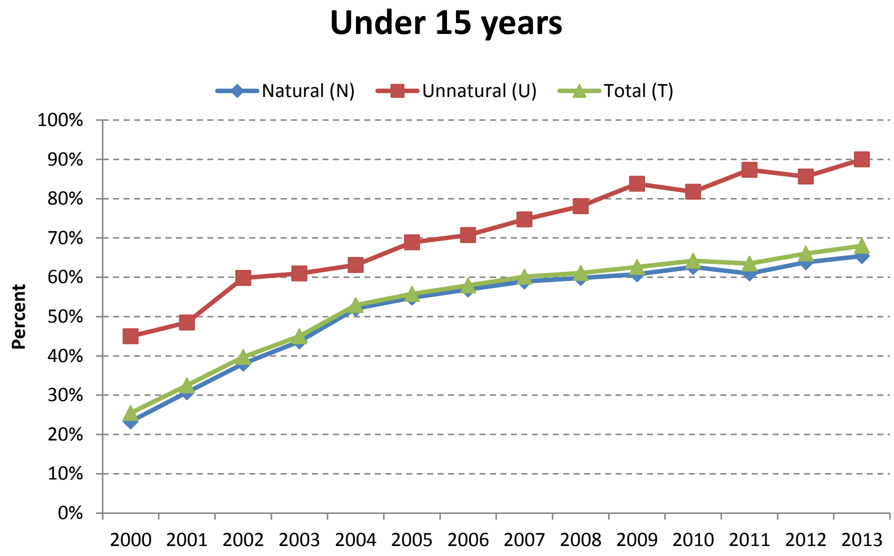
Figure 3: Ratio of RMS to Stats SA data (%) by natural (N), unnatural (U) and total (T) category, 2000-2013

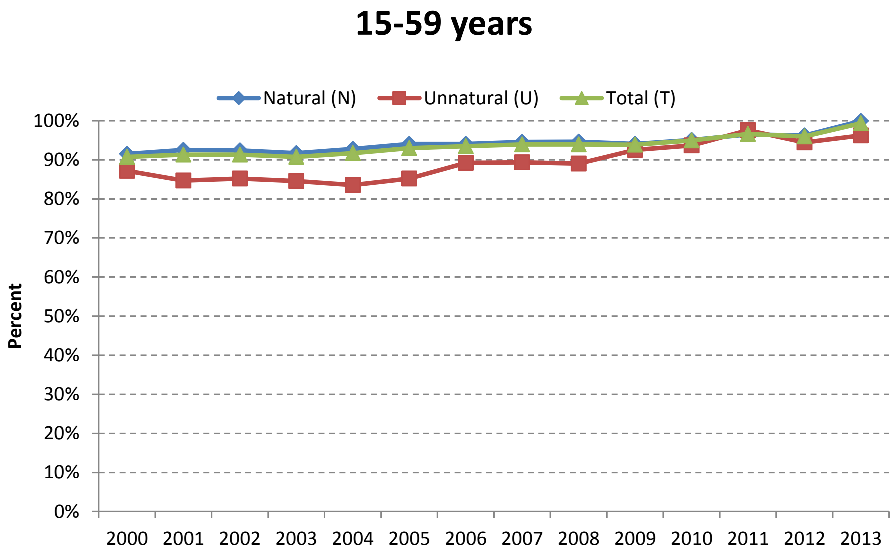
Table 2 shows the numbers in broad age groups, and the proportion of the VR deaths captured by the RMS is shown in Figure 4 for each age group. There has been a considerable increase in the proportion for children <15 years and seems to have been levelling off at about 60% prior to the uptick in 2012 and 2013. In this age group, the proportion of unnatural VR deaths captured by the RMS is higher than the proportion of naturals 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 the older ages. While the proportions in the 15-59 year age group remained fairly level, there has been a noticeable increase for 2011 bringing it over 96% and by 2013 it was close 100%. This trend is also apparent in the proportions in the 60+ year age group, where the proportion is now (inexplicably) over 100% for the natural and total. In the case of unnatural deaths in the 60+ year age group, although the proportion has increased since 2005 and has now reached 75% with the increase in proportions in 2011, it is unclear why it is so low given the near complete match for natural deaths. This and the blips in unnatural deaths in 2008 and 2012, shown in red in the table, suggest problems with categorisation of deaths in the RMS data which require further investigation.

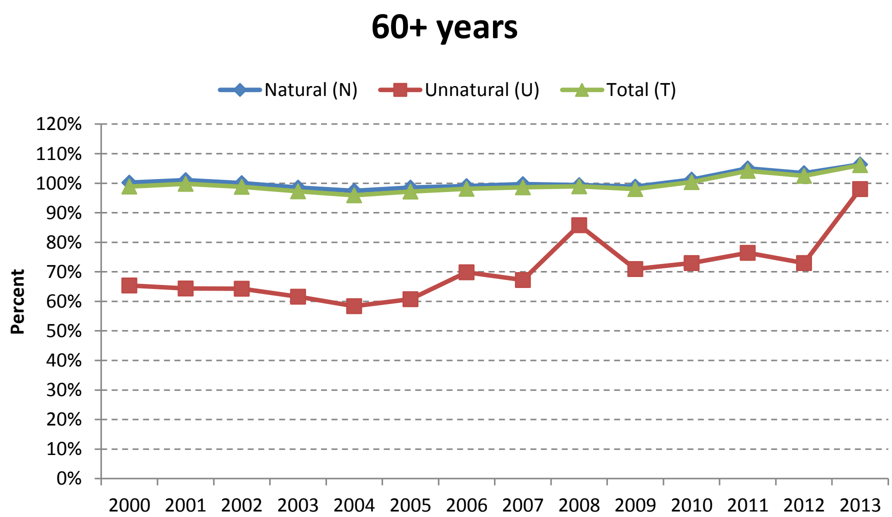
Table 2: Number of natural (N), unnatural (U) and total (T) deaths in RMS in broad age groups compared with Stats SA data by year

	RAPID MORTALITY SURVEILLANCE*			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			
	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			
	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	189348	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			

* RMS numbers updated as of end April the following year







* The disruptions in 2008 and 2013 appear to be the result of errors in the RMS data, highlighted in Table 2.

Figure 4: Ratio of RMS to Stats SA data (%) in broad age groups by natural (N), unnatural (U) and total (T) category, 2000-2013

CORRECTING FOR INCOMPLETENESS

Figure 5 to Figure 10 compare the numbers of deaths, in total and for various age ranges, as reported by Stats SA (VR), from the National Population Register (RMS), together with the VR adjusted for incompleteness of registration (Adj VR), the RMS 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 there was a great deal of consistency between the RMS and VR data until 2010, after this year the VR data appear to be under-recorded relative to the RMS data, sometimes to the point where what should be a subset of VR deaths on the PR is bigger than the total number of VR deaths! This is particularly the case for 2013.

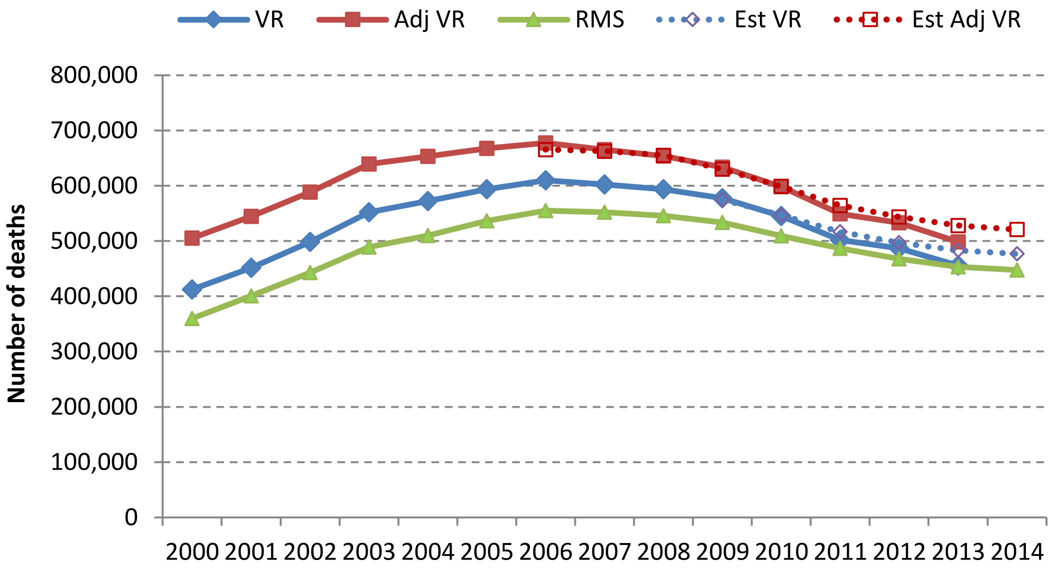


Figure 5: VR, VR adjusted for incompleteness of reporting, RMS, estimated VR, estimated adjusted VR: Total deaths

While there were slight differences for the period 2006-2008 in the other age ranges, in total (Figure 5), and for ages 15-59 (Figure 9), the adjustments to the RMS data appear to work very well up to 2010. However, there is a clear difference in the total number and adult age groups (15+) from 2011. Once again, for some, yet to be investigated, reason the numbers of VR death in these age groups is lower than expected on the basis of the RMS data. Since the only ways for the VR data to be lower than estimated from the RMS 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 is in need of further investigation.

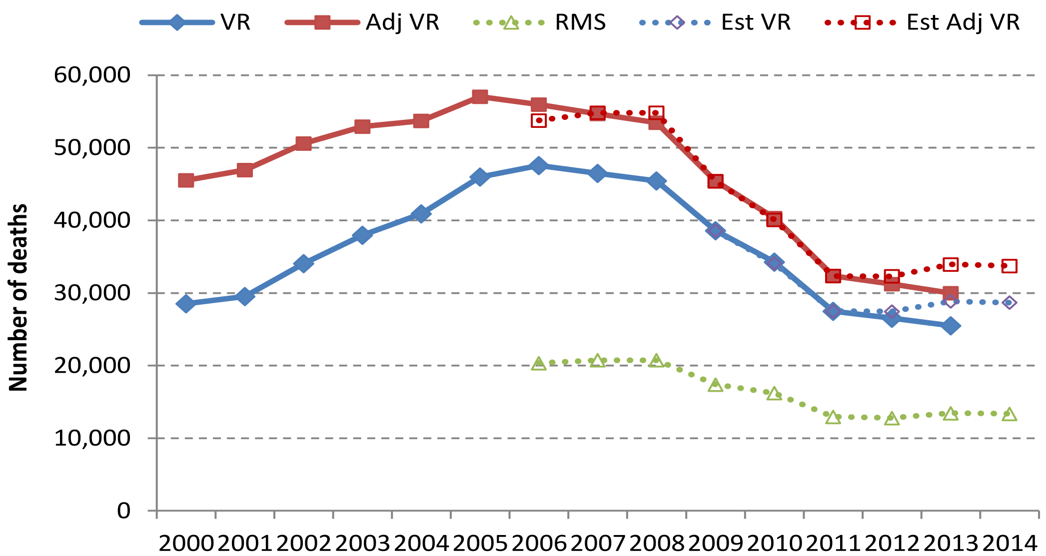


Figure 6: VR, VR adjusted for incompleteness of reporting, RMS, estimated VR, estimated adjusted VR: Deaths < 1

The comparison of the number of deaths under the age of 1 year (Figure 6) 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 RMS appear quite reasonable. Thus according to the RMS data the number of deaths under age 1 year (and ages 1-4 years (Figure 7)) appear to have ceased to decline in 2011. The slight discrepancy for 2006-2008 is the result of small errors in the projection of the ratio of RMS to VR in the early years of the process (VR data up to 2004).

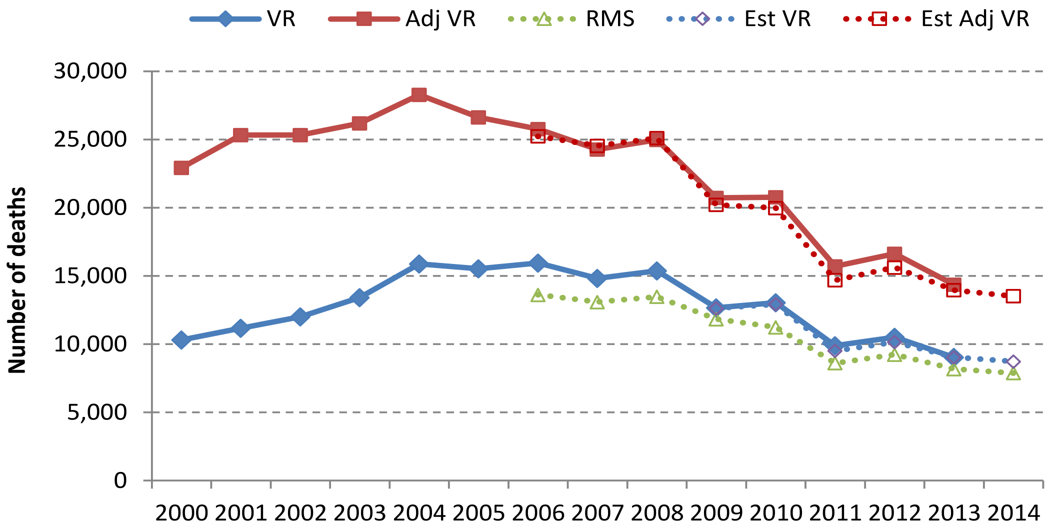


Figure 7: VR, VR adjusted for incompleteness of reporting, RMS, estimated VR, estimated adjusted VR: Deaths 1-4

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 (Figure 6 to Figure 8). 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 2009-2011.

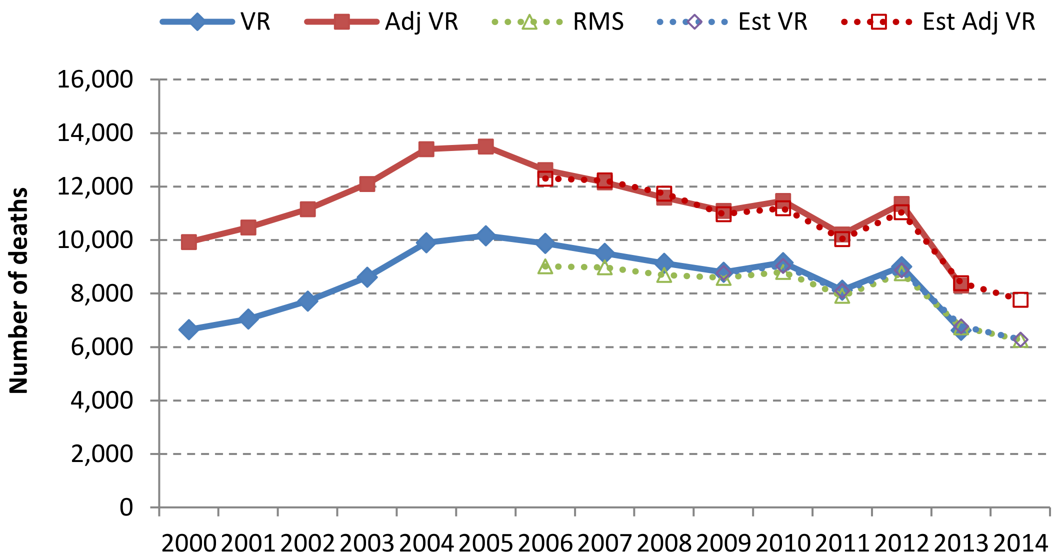


Figure 8: VR, VR adjusted for incompleteness of reporting, RMS, estimated VR, estimated adjusted VR: Deaths 5-14

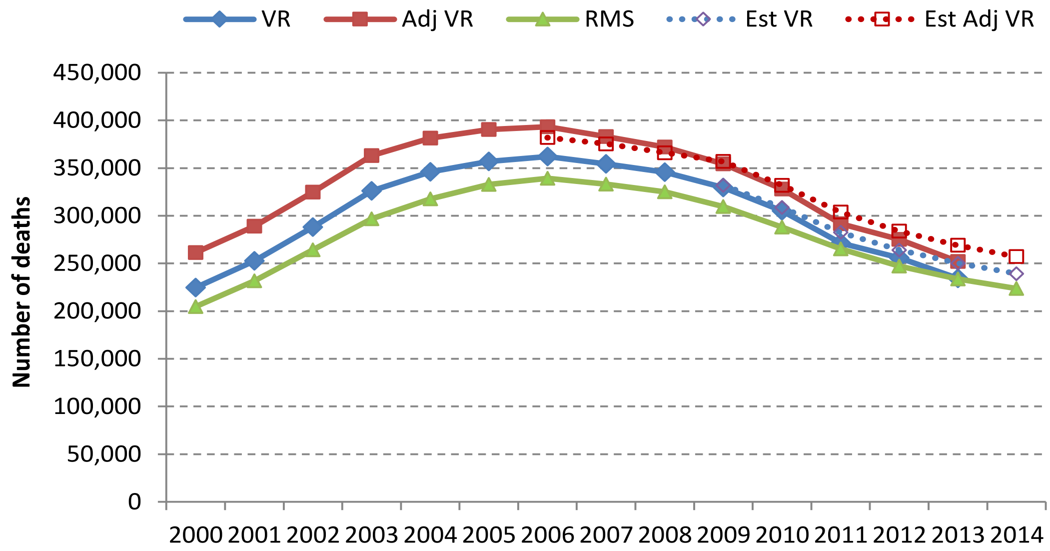


Figure 9: VR, VR adjusted for incompleteness of reporting, RMS, estimated VR, estimated adjusted VR: Deaths 15-59

As shown in Figure 10, it appeared as if up until 2010 the number of deaths captured in the RMS was virtually the same as those ultimately reported by Stats SA, suggesting that virtually everyone from the age of 60 is on the NPR. However, once again, something appears to have changed since 2011, with the RMS capturing significantly more deaths than are reported by Stats SA. However, as Figure 9 confirms, the problem is not confined to the oldest age group.

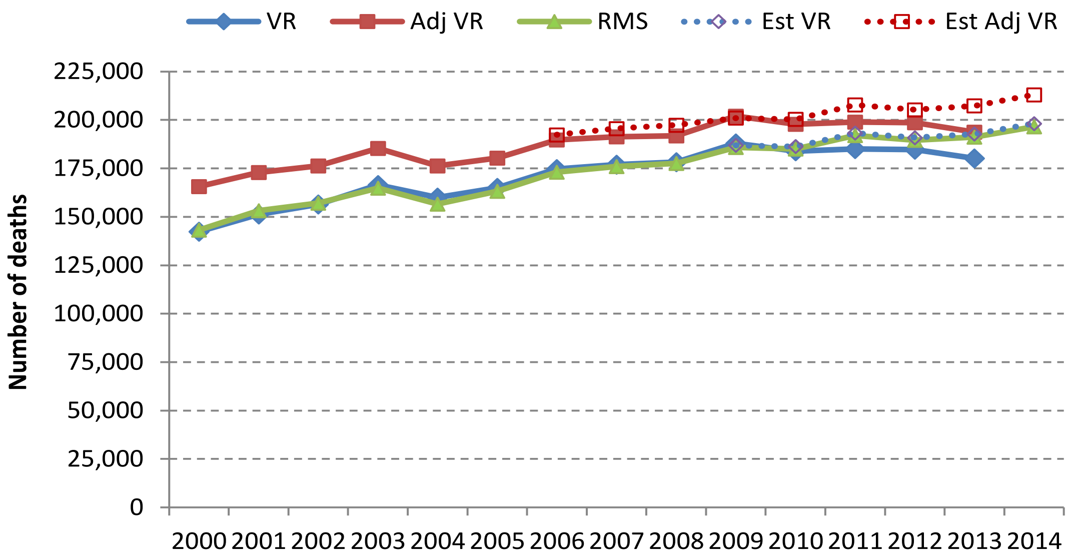


Figure 10: VR, VR adjusted for incompleteness of reporting, RMS, estimated VR, estimated adjusted VR: Deaths 60+

LIFE EXPECTANCY AND ADULT MORTALITY

Key indicators are estimated from mortality rates calculated from the adjusted number of deaths divided by the population estimate at each age. The life expectancy at birth 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 years, are shown in Table 3. They are shown against targets recommended by the HDACC (HDACC 2011) reworked to be consistent with the new base estimates in 2008/9. It can be seen from the table that within three years, the life-expectancy targets had already been exceeded, with particularly good 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, probably as a result of greater than expected roll-out of ARVs. The trends in these indicators since 2000 are shown in Figure 11 and Figure 12. In addition, the trend in older-age mortality is tracked using the index e_{60} (the average life expectancy for people who have survived to age 60), and is shown in Figure 13. As can be seen from Figure 13, the mortality of older adults appears not to have changed much since 2001. The average life expectancy at the age of 60 remains about 15 years for men and 19 years for women.

Estimates of ${}_{45}q_{15}$ for 2011 derived using the VR data are lower and those of e_{60} higher than estimates based on RMS which probably reflects deaths missing from the VR dataset, and thus it is assumed that in these cases the estimates from the RMS data are more accurate.

Table 3: Estimated life expectancy and adult mortality (${}_{45}q_{15}$), RMS 2009-2014

INDICATOR	TARGET 2014	2009	2010	2011	2012	2013[1]	2014
Life expectancy at birth Total	59.1 (Increase of 2 years)	57.1	58.5	60.5	61.3	62.2	62.9
Life expectancy at birth Male	56.6 (Increase of 2 years)	54.6	56.0	57.8	58.5	59.4	60.0
Life expectancy at birth Female	61.7 (Increase of 2 years)	59.7	61.2	63.2	64.0	65.1	65.8
Adult mortality (${}_{45}q_{15}$) Total	43% (10% reduction)	46%	43%	40%	38%	36%	34%
Adult mortality (${}_{45}q_{15}$) Male	48% (10% reduction)	51%	48%	46%	44%	42%	40%
Adult mortality (${}_{45}q_{15}$) Female	37% (10% reduction)	40%	38%	35%	32%	30%	28%

1. Based on RMS rather than VR because of unexplained shortfall in registration

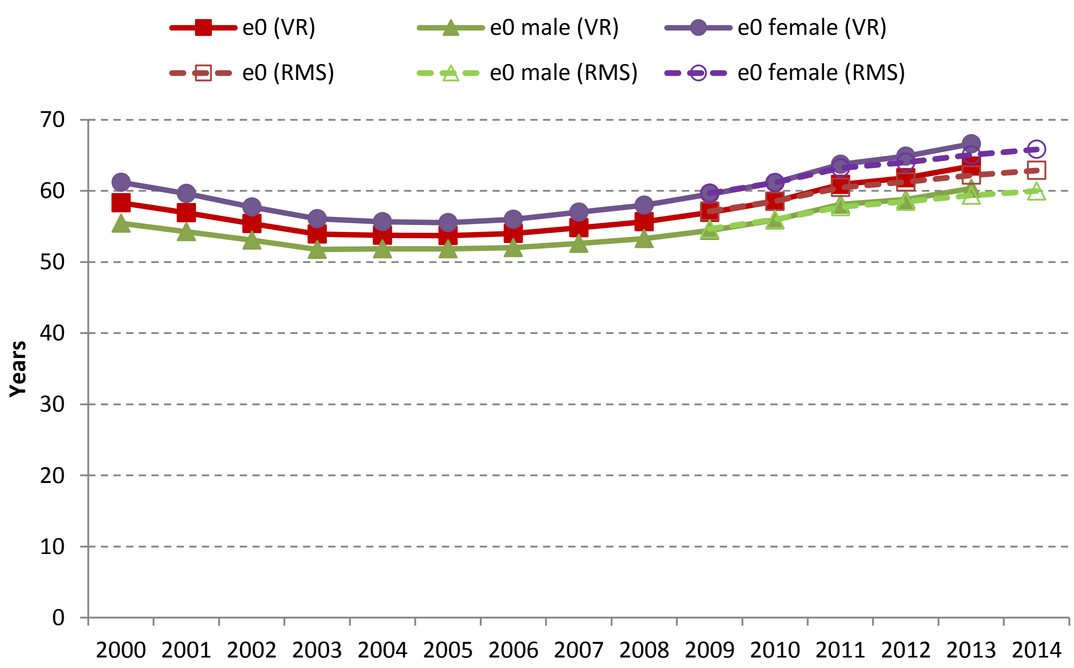


Figure 11: Life expectancy (e_0) from VR and RMS, 2000-2014 (after adjusting for incompleteness)

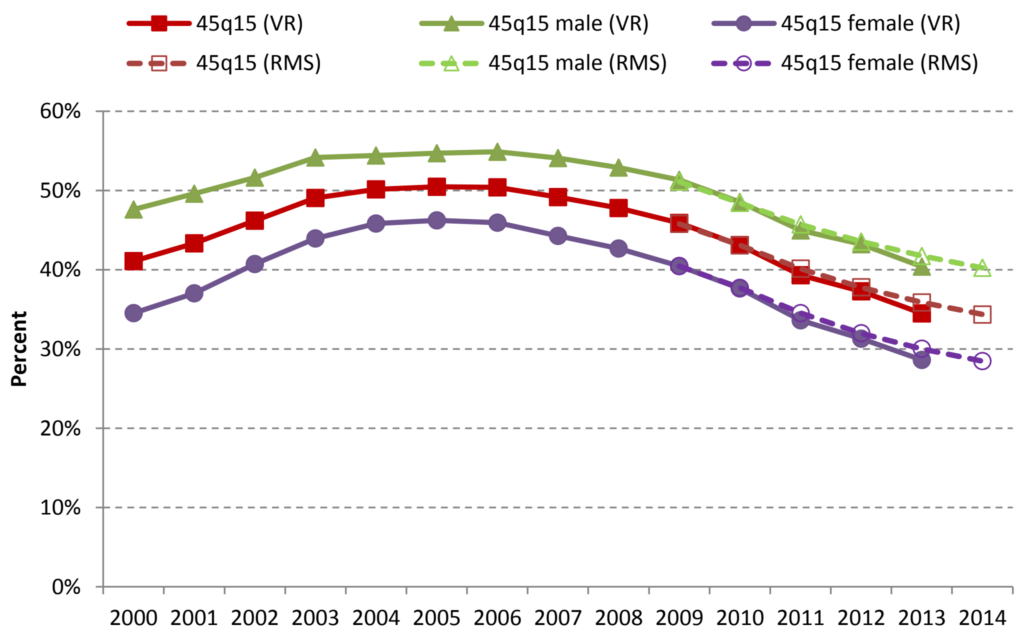


Figure 12: Adult mortality ($_{45}q_{15}$) from VR and RMS, 2000-2014 (after adjusting for incompleteness)

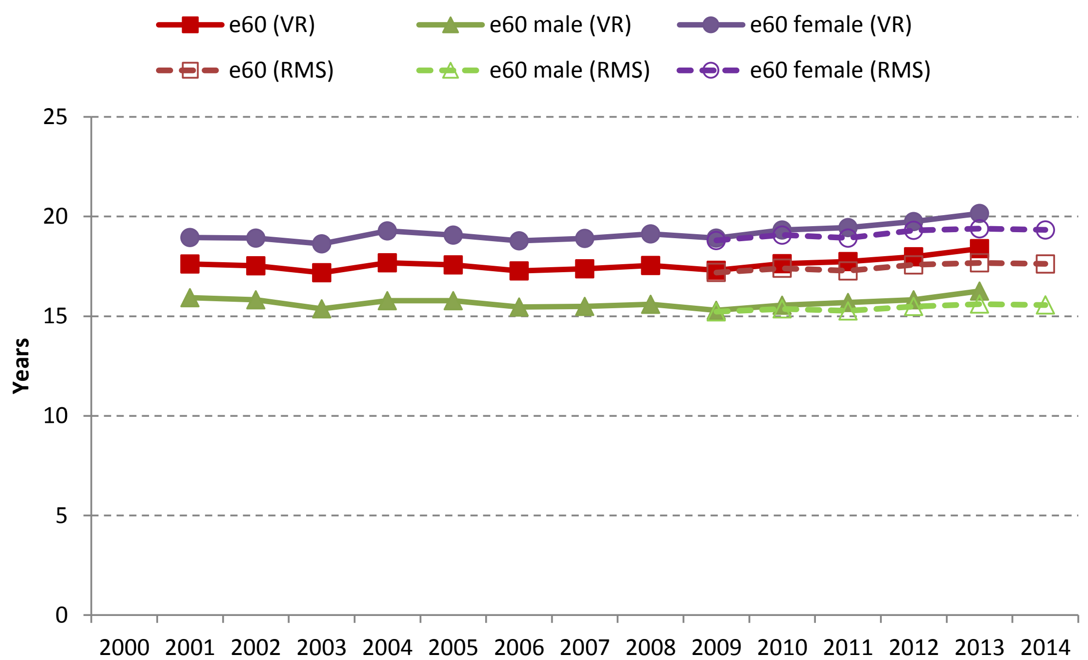


Figure 13: Life expectancy at the age of 60 (e_{60}) from VR and RMS, 2000-2014 (after adjusting for incompleteness)

CHILD MORTALITY (U5MR, IMR, NMR)

The annual number of deaths under 5 years of age in the RMS has declined from 34 006 in 2006 to 21 341 in 2014. The number of deaths by month, compared with the number of deaths reported by Stats SA for 2009-2013, is shown in Figure 14. It can be seen that there is a high degree of correspondence between the two series, with the marked seasonal effect all but disappearing as the numbers decline. There doesn't appear to have been any clear seasonal effect for the past four years according to the data from the population register.

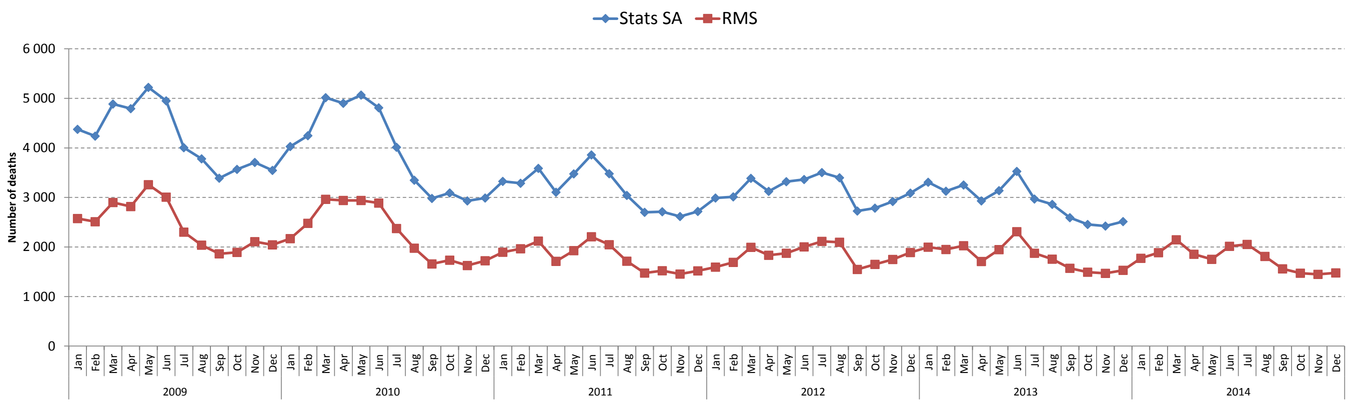


Figure 14: Monthly number of child deaths under 5 years from Stats SA and RMS, 2009-2014

The trends in selected causes in the Stats SA data for 2007-2013 are shown in Figure 15. Although the peaks are much lower in the more recent years, both diarrhoeal deaths (ICD code A09) and pneumonia deaths (ICD code J18) show characteristic seasonal patterns. In 2011, the diarrhoeal deaths peaked in Feb-March and the pneumonia deaths in June. The overall effect was a unimodal peak from March-June. 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 expected, 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 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, perinatal conditions contribute a higher proportion of the deaths.

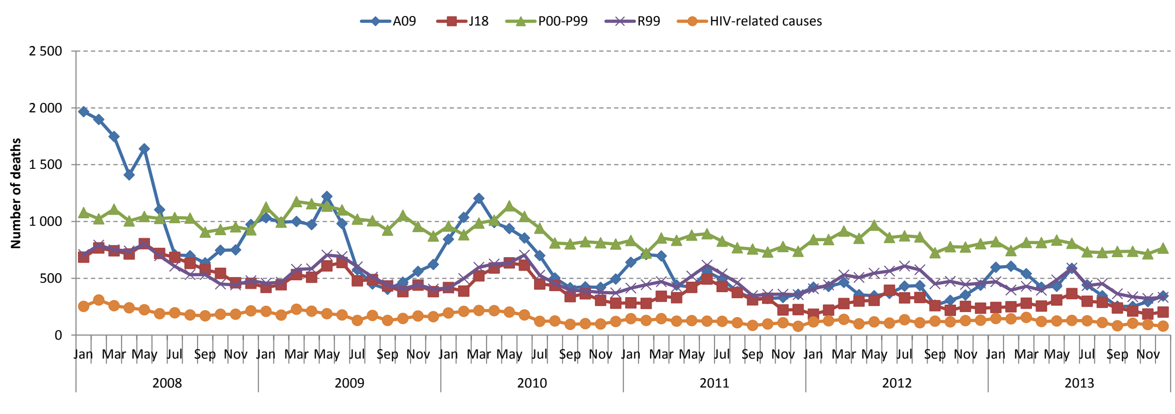


Figure 15: Number of child deaths under 5 years of age by selected cause-of-death, Stats SA 2008-2013

Figure 16 shows the monthly number of deaths from the RMS by year (with the lines becoming darker as the years progress to 2013), indicating the decline in the number of deaths under 5 years accompanied by an attenuation of the seasonal effect particularly between 2010 and 2011. From 2011 there is no clear pattern of deaths by months (with the possible exception of a high point in June and low points in April and September) with little change in the overall level.

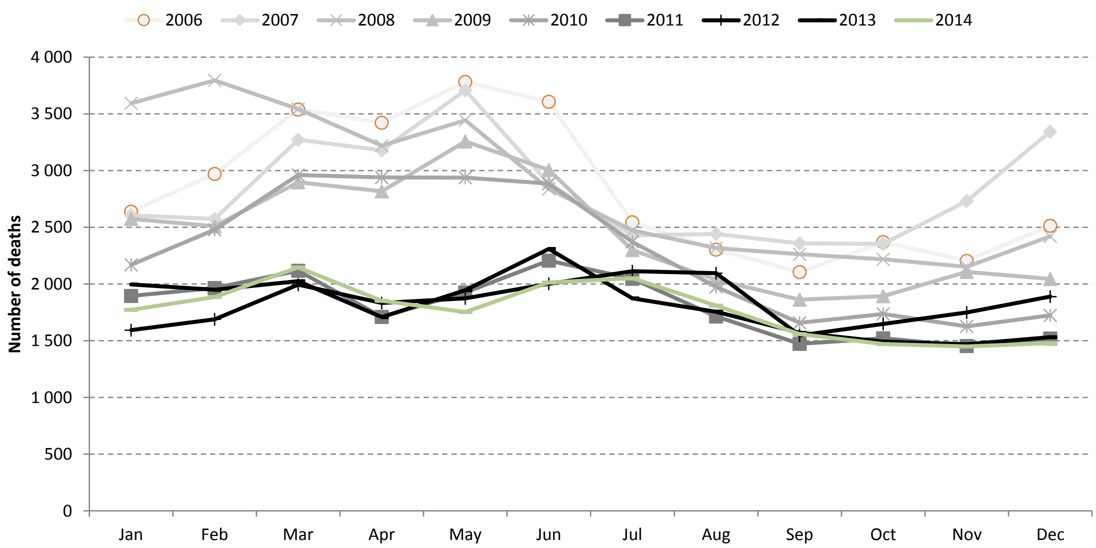


Figure 16: Number of child deaths under 5 years by month, RMS 2006-2014

When compared with the vital registration data from Stats SA, it is found that neonatal deaths in the RMS 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 17 shows the number of neonatal deaths and stillbirths from the DHIS compared to the number of neonatal deaths from the cause-of-death data from vital registration. It can be seen that the neonatal deaths in the VR data were fairly steady from 2006-2009 and have declined slightly since then. The number of neonatal deaths in the DHIS, on the other hand, has increased steadily from 2008-2014. On the other hand the VR data for registered stillbirths shows little change over the period at a level of about 15 000.

In 2008, the DHIS captured 72% of the VR neonatal deaths, 75% in 2009, and 86% in 2010. However, in 2011, the number of neonatal deaths in the DHIS matched the number of the VR neonatal deaths and has risen above it in recent years. The VR neonatal deaths misses deaths that have not been registered. While the DHIS misses the deaths that occur in the private sector or at home.

Since both this proportion and the number of neonatal deaths relative to the number of stillbirths captured by the DHIS increased over this period, it is probable that the increase in number of neonatal deaths from the DHIS is 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 of 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 MMR is less than 10%. As the proportion of VR that are DHIS increases the difference between the estimate of the proportion reduces.

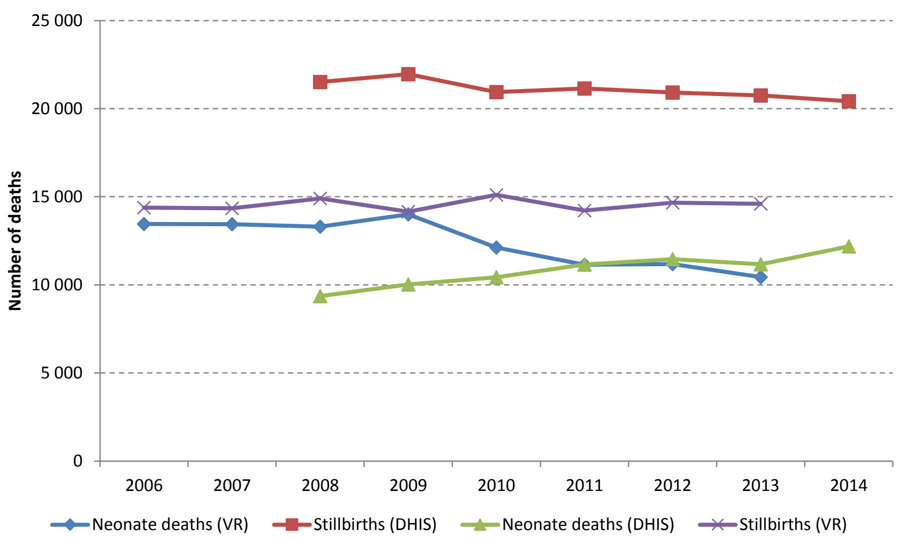


Figure 17: Stillbirths and neonatal deaths from VR and DHIS

Estimates of the key indicators of mortality for children are shown in Table 4 for the period 2009-2014, together with the reworked targets recommended by HDACC. Figure 18 shows the U5MR, IMR and NMR. The U5MR and IMR are calculated from VR for the period 2006-2013 and from the RMS for the period 2009-2014, once the data have been adjusted for under-registration. The NMR is estimated from the registered deaths (adjusted for under-registration) for the period 2006-2013 and the DHIS (adjusted for under-coverage, relative to the registered deaths, and the incompleteness of the vital registration) for the period 2011-2014. From Figure 18, 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 (below the HDACC target) for the period 2009-2014. The IMR and the U5MR declined rapidly since 2008, and by 2011 are well below the targets recommended by HDACC. However, the rapid decline appears to have ended, with no further decline in 2012 or 2014.

Also included on the figure are estimates of 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 using the neonatal deaths from the DHIS. These estimates suggest that it may be possible in future years to produce as accurate estimates of the NMR and IMR from the recorded data directly. This will be monitored over the next few years.

Table 4: Estimated U5MR, IMR and NMR, RMS 2009-2012 and DHIS 2009-2014

INDICATOR	TARGET 2014	2009	2010	2011	2012	2013[1]	2014
Under-5 mortality rate (U5MR)	50 per 1 000 live births (10% reduction)	56 per 1 000 live births	52 per 1 000 live births	40 per 1 000 live births	41 per 1 000 live births	41 per 1 000 live births	39 per 1 000 live births
Infant mortality rate (IMR)	35 per 1 000 live births (10% reduction)	39 per 1 000 live births	35 per 1 000 live births	28 per 1 000 live births	27 per 1 000 live births	29 per 1 000 live births	28 per 1 000 live births
Neonatal mortality rate (<28 days) (NMR)	12 per 1 000 live births (10% reduction)	14 per 1 000 live births	13 per 1 000 live births	13 per 1 000 live births	11 per 1 000 live births	11 per 1 000 live births	11 per 1 000 live births

1. Based on RMS rather than VR because of unexplained shortfall in registration

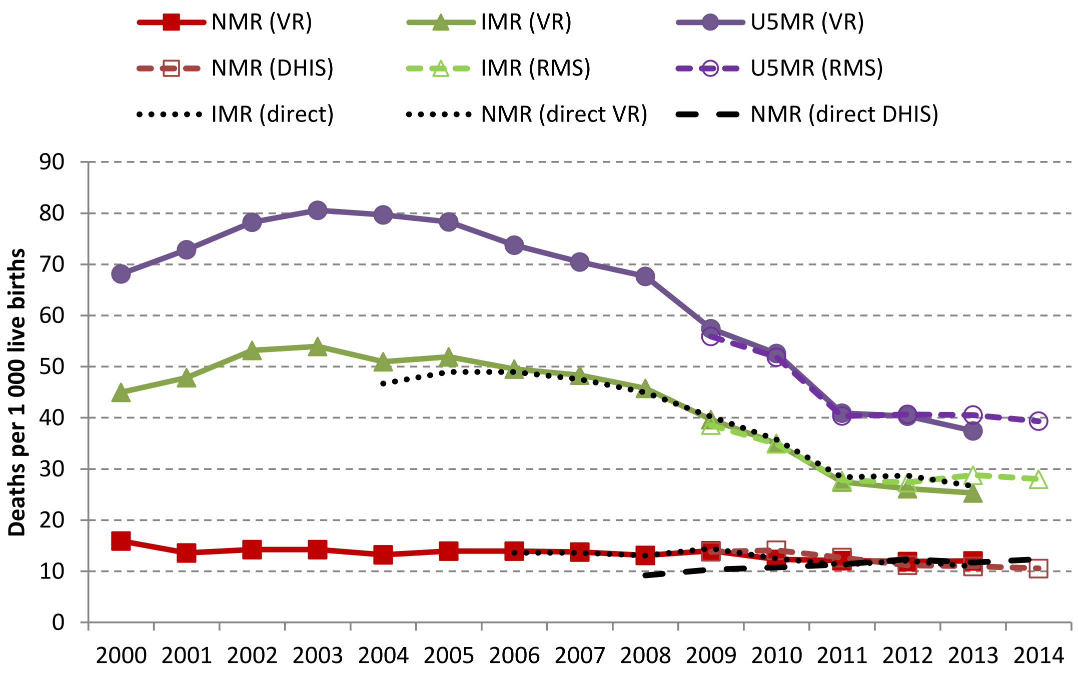


Figure 18: Under-5 mortality rate (U5MR) and infant mortality rate (IMR) from VR/RMS and neonatal mortality rate (NMR) from VR/DHIS, 2000-2014 (after adjusting for incompleteness)

MATERNAL DEATH

The uncertainty about the level of maternal mortality is well recognised (HDACC, 2011; Bradshaw and Dorrington, 2012; Stats SA, 2013c; Dorrington and Bradshaw, 2015). The MMR rose from 281 per 100 000 live births in 2008 to peak at 302 per 100 000 live births in 2009 before dropping significantly to 155 per 100 000 live births in 2013 (Table 5). Even allowing for the possible underestimation of adult deaths the MMR has been below the HDACC target since 2011.

Table 5: Estimated MMR, Stats SA 2008-2013

INDICATOR	TARGET 2014	2008	2009	2010	2011*	2012*	2013*
Maternal mortality ratio (MMR)	252 per 100 000 live births (Reverse increasing trend and achieve 10% reduction)	281 per 100 000 live births	302 per 100 000 live births	267 per 100 000 live births	200 per 100 000 live births	166 per 100 000 live births	155 per 100 000 live births

* These estimates have been adjusted for an increase in under-registration of deaths due, in the main, to late registration which appear to have become significant since 2011

Figure 19 shows the estimates of 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, and provide values that are much lower than the HDACC/MDG estimates until recent years. It is somewhat surprising that the HDACC estimate should be so close to that 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 and it will be important to assess the extent of late registrations once the 2014 report becomes available.

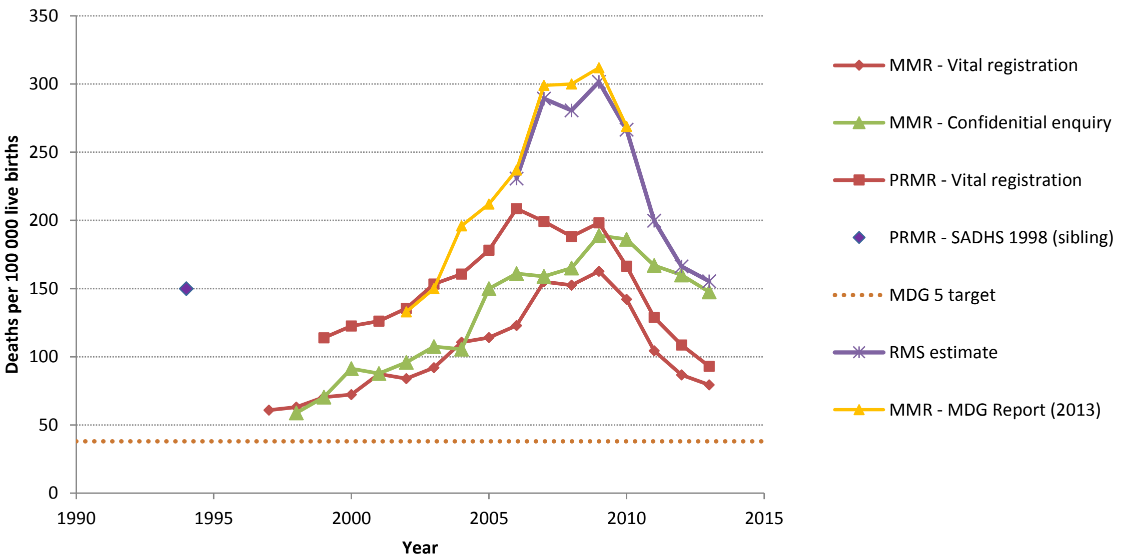


Figure 19: Estimate of MMR from various sources, 1995-2013
Source: Adapted and updated from Bradshaw and Dorrington, 2012

Nonetheless, the HDACC estimates, as well as those reported in the 2013 MDG Country Report (Stats SA, 2013c), and the institutional MMR reported by the National Committee for Confidential Enquiry into Maternal Deaths (Pattinson, Fawcus and Moodley, 2013), 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 20 indicate a marked increase in the number of indirect maternal deaths since 2003. As noted by Bradshaw and Dorrington (2012), 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 20 is the fact that there appears to have been a drop in the number of deaths from every cause since 2009, with a sizeable decline in “Complications from other conditions” for 2011, followed by a further decline in 2012. To what extent the declines in the most recent years are connected to the apparent under-reporting is still unclear

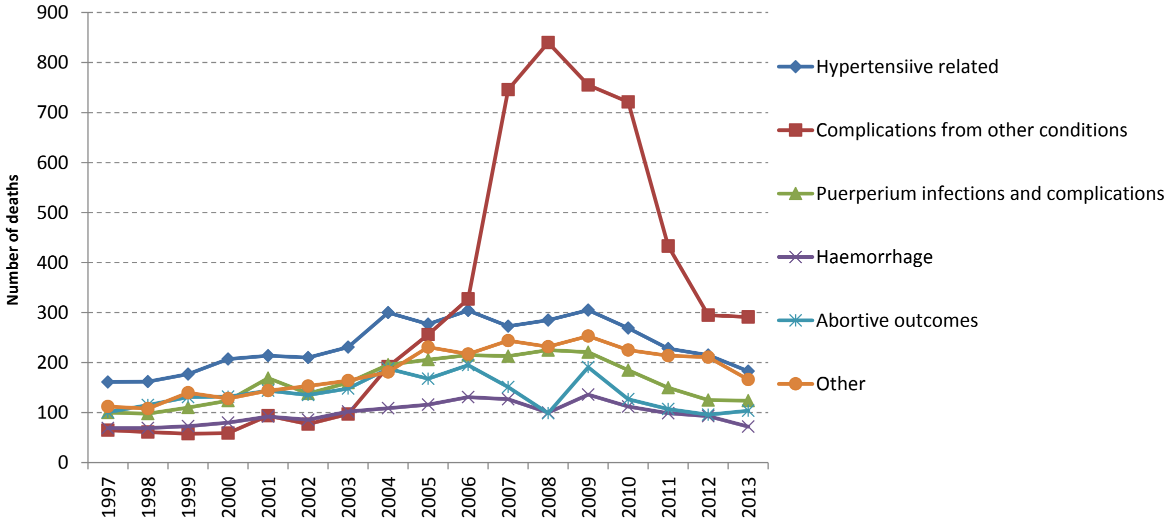


Figure 20: Trend in the number of maternal deaths by cause, Stats SA 1997-2013

COMPARISON WITH ESTIMATES FROM OTHER SOURCES

A natural question to consider is how the estimates derived in this report compare with those presented elsewhere. Where appropriate, the RMS estimates are compared with those from Stats SA (from the MDG country report[4] or the official mid-year population estimates), 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.

Figure 21 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 2015) over most of the period, those of the World Population Prospects (WPP), 2015 revision, (UN Population Division 2015) in the first half of the period, and the MDG from 2007-2010. While the estimates from the official mid-year population projection are little different from those in the WPP (which underlie the Spectrum model used by Stats SA to produce the mid-year estimates), the IHME (Wang et al 2014) remain higher than any of the other estimates for years prior to 2010 and are surely too high as a result. There is good agreement with estimates from the MDG report from 2007 onwards, although prior to this the MDG estimates are implausibly. Although both the IHME and IGME now take the RMS estimates into account when producing their estimates, neither is able to incorporate into their modelling the apparent stagnation in rates from 2011, each handling the trend differently.

The picture is similar for IMR (not presented), with the exception that relative to the U5MR, the IHME assume higher IMR (over 72% of U5MR) than do the other sources (averages 69%) when the U5MRs are around 80, which results in the estimates of IMR being even higher relative to those of the RMS. The RMS and IGME estimates are similar for 2002-2010, after which the RMS estimate a greater decline to 2011 and then little change to 2014, whereas the IGME rates decline slowly after 2010.

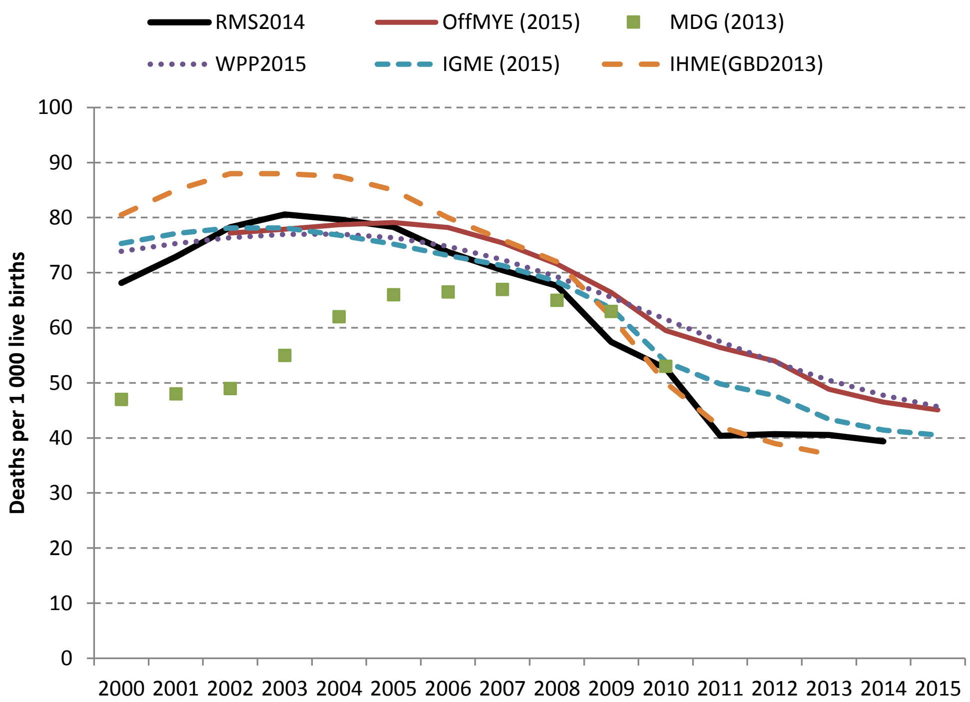


Figure 21: Comparison of estimates of the under-5 mortality rate (U5MR), 2000-2015

Figure 22 compares the life expectancy at birth with those from other sources, showing 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, with the RMS estimate some two years higher than the IHME estimate (Naghavi et al 2015) and five year higher than the WPP estimate in 2013. About two years of the difference in the level from the WPP life expectancies is due to higher adult mortality, the rest of the difference between the RMS and other life expectancies is mainly due to differences in under-five mortality. The trend in life expectancy underlying the 2015 series of mid-year estimates (Stats SA 2015), while at

[4] According to the MDG report (Stats SA, 2013c), the MDG estimates are from the 2013 mid-year estimates (Stats SA, 2013b), which have been derived using the Spectrum model. However, the MDG estimates do not seem to have corrected for the fact that the estimates are not for the regular calendar year but for the year starting six months earlier, while the mid-year estimates appear to have been corrected.

broadly similar levels to the RMS is decidedly odd and points to a problem either in the model used or the parameterisation of that model.

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 declining to a minimum in 2005 (not presented). However, while according to the RMS the difference declined from 5.75 years in 2000 to 3.7 years in 2005 before rising to 5.4 years in 2014, the comparable figures for IHME were a similar 6.4 years, 4 years and 5.3 years, and for WPP a much narrower, 4.3 years, 2.6 years and 4 years.

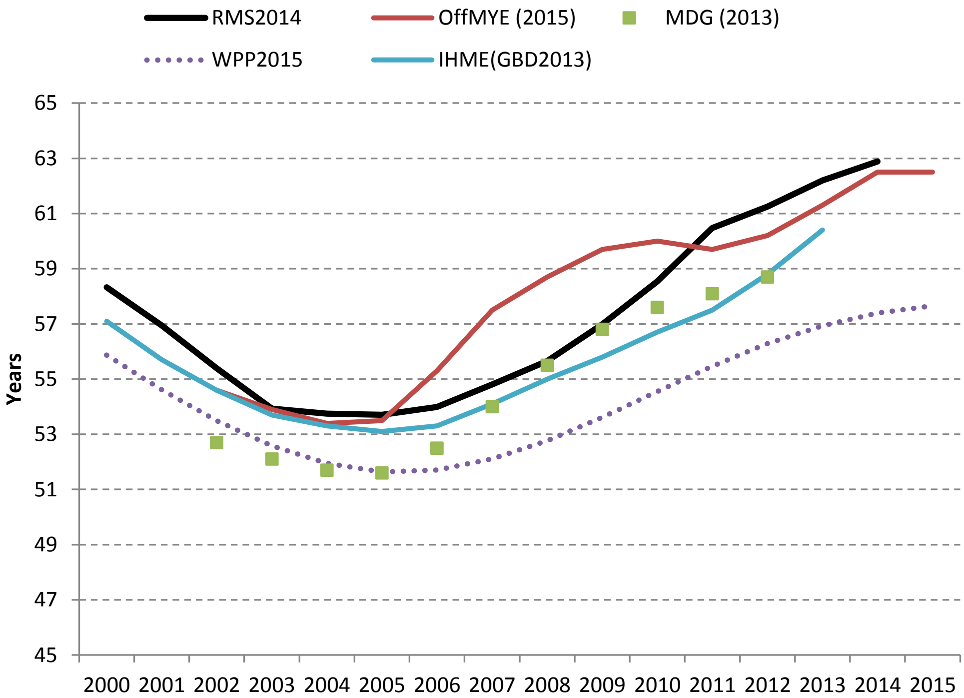


Figure 22: Comparison of estimates of life expectancy at birth (e_0), 2000-2015

Although there is consistency between the RMS and MDG estimates of MMR (Figure 23), this is mainly because the same method and similar data were used for both 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 produced by IHME[5] (Hogan et al 2010, Lozano et al 2011 and Kassebaum et al 2014) and the two quite different estimates produced by MMEIG, one year apart (WHO et al 2014). However, the fact that the HDACC estimates lie comfortably in the cloud of uncertainty suggests that they are at least as reliable as any of the other estimates, and surely 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.

[5] Although usually one would simply accept the most recent set of estimates from an institution, in the case of IHME, the estimates available via their website tool are still the older estimates, and for both the IHME and MMEIG, the sizeable difference between recent estimates gives a good indication of the uncertainty about the estimates.

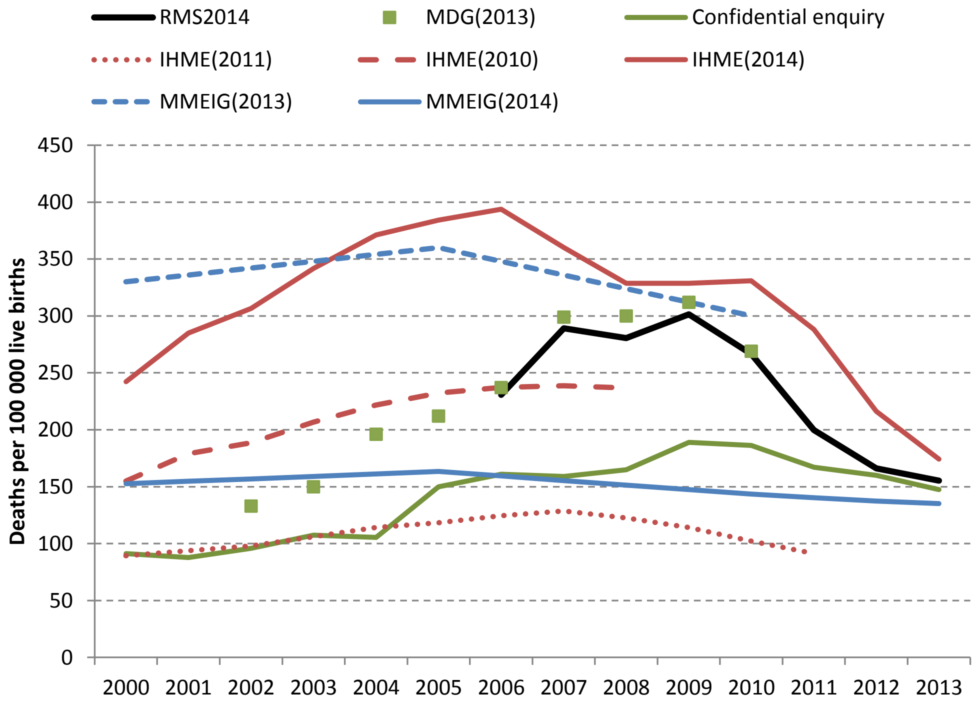


Figure 23: Comparison of estimates of maternal mortality ratio (MMR), 2000-2015

As far as adult mortality is concerned (Figure 24), the RMS estimates lie between the WPP and IHME estimates until 2008. After this, while there is some consistency in trend between the RMS and WPP estimates, the trend in the IHME estimates is quite different, accounting for most of the slower increase in life expectancy after 2008. Given the extensive provision of ARVs in this period it seems implausible that adult mortality would show no decline between 2008 and 2011, as suggested by the IHME estimates.

As indicated above, the WPP mortality leads to estimates of life expectancy that are lower than other estimates, and thus the WPP adult mortality appear to be on the high side – increasingly so after 2012.

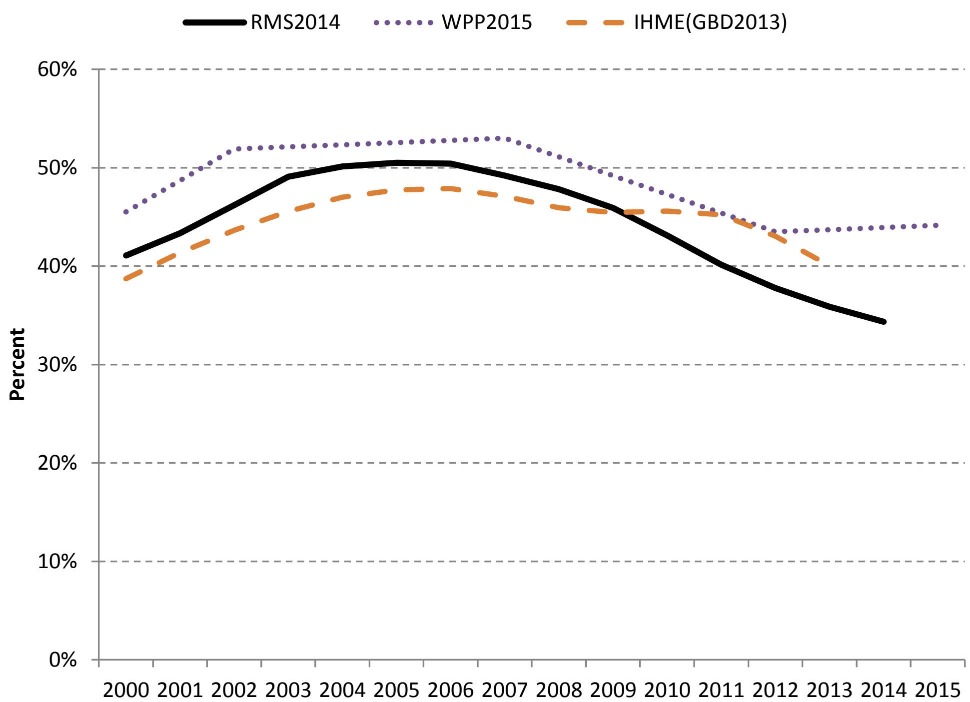


Figure 24: Comparison of estimates of adult mortality ($_{45}q_{15}$) for males and females combined, 2000-2015

Although it is difficult to assert that the neonatal mortality in South Africa is as low as that estimated by the RMS (Figure 25), it is important to point out that the IHME estimates (IHME 2015) imply implausibly high completeness of reporting of post-neonatal deaths in 2010. IGME rates match so closely that it is probable that they are merely a smoothed version of the RMS rates.

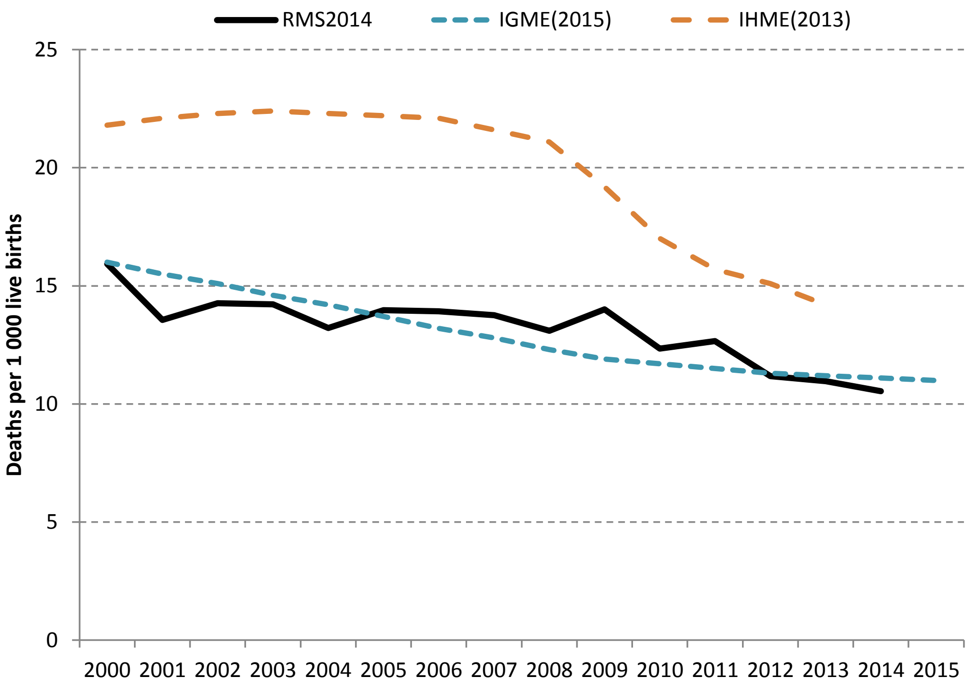


Figure 25: Comparison of estimates of neonatal mortality rates (NMR), 2000-2015

CONCLUSIONS

The estimates of mortality clearly show that South Africa is making progress in improving the health status of the nation and that all of the NSDA targets for 2014 tracked by this report have already been exceeded. The empirical data indicates that life expectancy has increased by nine years from 2005, reaching a level of 63 years in 2014. Most of the improvement has been due to the sustained improvements in mortality of young adults and child mortality, largely due to the roll-out of ARV treatment and prevention of mother-to-child transmission of HIV.

The rapid decline in the childhood mortality rates appears to have stopped abruptly in 2011, suggesting that future improvements will have to come from improvement in non-HIV causes of death. However, as these estimates are based on the assumption of no further increase in the completeness of registration of deaths, there is some uncertainty. It is possible that the child mortality rates actually declined if registration of childhood deaths had improved from 2011 to 2014, although this seems unlikely given other evidence suggesting that opposite might be the case. Furthermore, the scope for such improvement is limited by the fact that completeness of registration is assumed already to be quite high. There is an urgent need for a good quality national survey to benchmark the child mortality rates. The South African Demographic and Health Survey planned for 2016 will provide essential information to benchmark the child mortality estimates.

By comparison, the neonatal mortality rates have shown a modest decline in the last few years and have now also exceeded the NSDA target. However, if one were to assume that the excess of deaths recorded in the DHIS data over those in the VR data was the result of declining completeness of reporting, then the NMR could be 12 rather than 11 per 1 000. Further declines in child mortality will require improvements to health care services, particularly for the newborns, as well as addressing environmental and social factors associated with poor infant and child health.

The maternal mortality ratio, which remains challenging to measure precisely, has declined dramatically since 2010 and is now well below the NSDA target. South Africa has some way to go to reach the MDG target of 50 per 100 000 live births. Comparison with estimates from other sources suggest that the estimates from the RMS are either supported by these estimates, or where there are differences, these could be due either to the implausibility of the estimates of others or covered by the extreme uncertainty of the estimates. It is important for South Africa to use a consistent method for tracking change. Both the confidential enquiry and the RMS estimate indicate improvement in reducing maternal mortality.

The reduced lag in reporting the cause-of-death data that has been achieved by Stats SA is to be commended. The 2013 and 2014 deaths[6] have been reported 11 months after the year end, compared to 20 months for 2012 deaths and 26 months for the 2011 deaths (Stats SA 2014b; Stats SA, 2014c; Stats SA, 2015). Users of these data need to be aware that this acceleration in reporting has inevitably led to a drop in the number of death being reported for the year in question, owing to an increase in late registration. However, the number of deaths on the RMS should never exceed the number processed by Stats SA. However, even taking into account the additional 2011 deaths included in the reports on 2012 and 2013 deaths, comparison of the adult deaths for 2011 suggests an inexplicable shortage in 2011 VR deaths. In addition some of the shortfall in 2013 appears to be specific to a particular districts or two, rather than general late registration data, suggesting that the acceleration to release may be responsible for other problems. These matters need further investigation. Finally, as the release of the unit record cause-of-death data for a particular report is usually delayed by several months after the release of the report, it would be helpful if, in future Stats SA could report the cause-of-death details for maternal deaths so that the MMR can be estimated upon release of the report. In addition, it would be useful if the unit record data released following each report include late registrations of deaths which occurred in the previous years so that further analysis can be done on the full data.

It is interesting to note that the comparison of estimates of IMR and NMR produced directly by dividing the number of registered deaths (or in the case of the neonatal deaths, those captured by the DHIS) by the number of births registered up to one year after the year of birth without correcting for incompleteness of registration. This suggests that the direct estimates are close enough to those produced using data corrected for under-reporting as to be a suitable alternative for tracking these indicators. It will be useful to investigate the possibility of using direct estimates to provide sub-national trends.

Finally, we had hoped to expand the analysis to provincial data in this report but encountered a mismatch of provincial boundaries used by the two data sources with the NPR data currently being recorded according to 2001 boundaries and the VR data being recorded according to the boundaries applicable at the time of death. Hopefully these data will be recast before the next report.

[6] Released as this report went to print.

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APPENDIX: 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 (15+) mortality and finally the completeness of reporting of deaths aged 5-14. The process of estimating completeness of reporting deaths, particularly infant and child deaths was quite intricate and is described in broad terms. A more detailed description is scheduled to appear in the technical report on the second South African National Burden of Disease methods to be published early 2015.

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 number of births by calendar year was estimated as the number required to result in the number of surviving children at each age at the time of the 2011 Census.

The completeness in individual years between the years of the point estimates of the expected number of deaths was estimated, in general,[7] 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.

Adults (15+ 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.

Children 5-14 years

Completeness of reporting by single years of age for ages 5-14 were derived on the assumption that the average of completeness for ages 1-4 was equal to that estimated for the age group 1-4 in total, and that completeness changes linearly with age between ages 1 and 15.

[7] 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.