

Inpatient case fatality rates improvements in children under 5: Diarrhoeal disease, pneumonia and severe acute malnutrition

L Bamford,¹ FCPaed, DrPH; P Barron,² BCom, FFCH; S Kauchali,^{1,3} FCPaed, MS, MPhil; N Dlamini,¹ MMed (Paeds)

¹ National Department of Health, Pretoria, South Africa

² School of Public Health, University of the Witwatersrand, Johannesburg, South Africa

³ Department of Paediatrics and Child Health, College of Health Sciences, School of Clinical Medicine, University of KwaZulu-Natal, Durban, South Africa

Corresponding author: L Bamford (lesley.bamford@health.gov.za)

Data on the number of admissions and deaths in children aged under 5 years from diarrhoea, pneumonia and severe acute malnutrition are routinely collected through the District Health Information System. These data, and the associated case fatality rates, are available for all public sector hospitals in South Africa (SA), and can be compared over time, as well as across different settings. This article presents these data for the period 2011/12 - 2016/17. It reflects on the remarkable improvements in these case fatality rates, and the likely reasons for their declines across all provinces. The article concludes by identifying the actions that need to be taken to ensure that SA achieves the Sustainable Development Goal aim of ending preventable child deaths by 2030.

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Pneumonia, diarrhoea and malnutrition remain important causes of death in children aged under 5 years, both globally^[1] and in South Africa (SA),^[2] and contribute significantly to the under-5 mortality rate. In 2015, pneumonia and diarrhoea were the leading causes of under-5 deaths (excluding perinatal causes), accounting for 16% and 9%, respectively, of all under-5 deaths worldwide.^[1]

Data from the Second National Burden of Disease Study^[2] show a similar picture in SA, with diarrhoea accounting for 16% and pneumonia for 12.3% of under-5 deaths. An additional 19.5% of deaths were due to HIV, and it is likely that many of these deaths were associated with pneumonia and diarrhoea.

Diarrhoea, pneumonia and malnutrition coexist, with many children suffering from two or more of these conditions simultaneously. Almost half of all under-5 deaths are associated with undernutrition,^[3] and children with severe acute malnutrition (SAM) are 6.3 times as likely to die from diarrhoea, and 8.7 times more likely to die from pneumonia, when compared with children with these diseases who are not malnourished.^[4] Data from child mortality audits show that one-third of children under 5 years of age who died in SA hospitals had SAM, and a further 27% were underweight for their age.^[5]

Pneumonia, diarrhoea and SAM are preventable and treatable causes of child deaths. All three are diseases of poverty, and are closely associated with factors such as poor home environments, poor access to nutritious foods and lack of access to health services. Child survival interventions prevent deaths from these diseases by reducing the number of cases, decreasing their severity and ensuring that they are correctly managed. Key prevention strategies include optimal breastfeeding practices and adequate nutrition, immunisations, handwashing with soap and water and prevention of comorbidities (especially HIV infection). Provision of safe drinking water and basic sanitation is important to prevent diarrhoea, while reduced household air pollution is associated with a reduction in pneumonia.^[6,7]

Effective treatments are also available. Therefore, improving healthcare-seeking behaviour and effective case management at household and health-facility levels are important interventions for reducing deaths from these diseases.^[6] The treatment of pneumonia depends on the child taking an appropriate course of antibiotics, with more severe cases requiring supplemental oxygen. Effective treatment of diarrhoeal disease rests on three key interventions: the administration of oral rehydration salt (ORS) solutions to prevent life-threatening dehydration; continued feeding; and zinc supplementation. Most treatment is thus provided at household and primary healthcare level, although access to hospital care is important in more severe cases, with rehydration usually requiring short-term parenteral infusion of fluids. The management of SAM is slightly more complicated, but correct case management based on nationally adapted World Health Organization guidelines^[8] has been shown to reduce case fatality rates substantially.^[9]

A reduction in the number of deaths from these three diseases indicates improvements in the health and nutrition status of young children, and is an important outcome of child health and nutrition programmes implemented in the public health system at all levels, from community and household interventions through to the national level.

Methods

All public sector hospitals in SA are required to submit data to the District Health Information System (DHIS) on a monthly basis. These include data on the number of children aged under 5 years who are admitted with diarrhoea, pneumonia and SAM, as well as the number of deaths associated with these conditions. Case fatality rates for the three conditions are automatically calculated for each level of the health system (facility, district, provincial and national).

For this study, data were extracted from the DHIS data files, which are stored in the National Department of Health, focusing on the data related to the three indicators of case fatality rates for diarrhoea,

pneumonia and SAM for the financial years 2011/12 to 2016/17. These data were extracted into an Excel (Microsoft, USA) file, disaggregated down to provincial level and compiled into relevant tables and figures. There was no sampling and all the relevant data were used in the analysis.

Results

The number of admissions and deaths of children under 5 years of age due to diarrhoea, pneumonia and SAM for the past 6 financial years in public health facilities are shown in Tables 1 to 3. Despite some minor variation, there is a relatively consistent pattern for all three diseases. Admissions for each disease increased between 2011/12 and 2015/16, and then decreased during 2016/17. In addition, the number of deaths, as well as the case fatality rates, declined consistently over the 6-year period.

The number of admissions due to diarrhoea (Table 1 and Fig. 1) showed a steep rise in 2013/14. This can be attributed to the higher number of cases (and deaths) associated with rotavirus infection which occurred during that year.^[10] The number of reported deaths declined by 43% (from 1 541 in 2011/12, to 873 in 2016/17), while the case fatality rate decreased from 4.5% in 2011/12, to 2% in 2016/17, representing a decline of 55.5%.

DHIS data on admissions, deaths and case fatality rates for pneumonia are shown in Table 2 and Fig. 2. Overall deaths declined by 43% (from 1 769 in 2011/12 to 1 005 in 2016/17) over the 6-year period. The case fatality rate declined by 51.2%, from 4.1% in 2012/13 to 2.0% in 2016/17. Over the same time period, there was a general increase in the number of admissions, from 43 138 in 2011/12 to 50 439 in 2016/17 (although there was an anomaly in 2012/13, as Western Cape Province data for that year are not available).

DHIS data on admissions, deaths and case fatality rates for SAM are shown in Table 3 and Fig. 3. The number of admissions of children with SAM increased consistently between 2011/12 and

2014/15, before declining in the latter 2 years. The number of deaths showed a similar pattern, with the number of deaths increasing

Table 2. Pneumonia admissions, deaths and case fatality rates in children aged under 5 years, 2011/12 - 2016/17

Year	Admissions, N	Deaths, n (CFR, %)
2011/12	43 138	1 769 (4.1)
2012/13*	36 431	1 395 (3.8)
2013/14	43 402	1 524 (3.5)
2014/15	48 365	1 411 (2.9)
2015/16	53 290	1 240 (2.3)
2016/17	50 439	1 005 (2.0)

*Western Cape Province data for 2012/13 are not available.

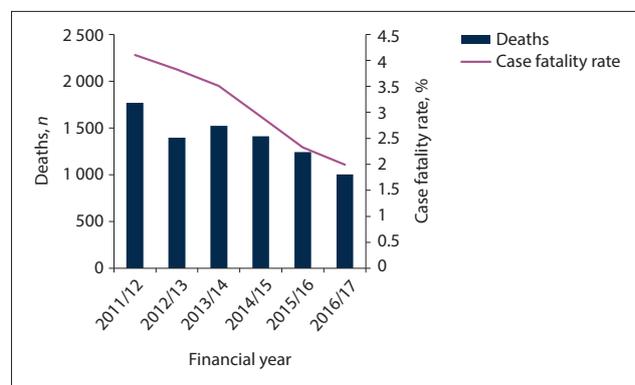


Fig. 2. Pneumonia deaths and case fatality rates in children aged under 5 years, 2011/12 - 2016/17.

Table 3. SAM admissions, deaths and case fatality rates in children aged under 5 years, 2011/12 - 2016/17

Year	Admissions, N	Deaths, n (CFR, %)
2011/12	12 107	1 589 (13.1)
2012/13*	12 904	1 637 (12.7)
2013/14	14 842	1 672 (11.3)
2014/15	15 911	1 851 (11.6)
2015/16	15 515	1 379 (8.9)
2016/17	14 940	1 192 (8.0)

SAM = severe acute malnutrition; CFR = case fatality rate. *Western Cape data for 2012/13 are not available.

Table 1. Diarrhoea admissions, deaths and case fatality rates in children aged under 5 years, 2011/12 - 2016/17

Year	Admissions, N	Deaths, n (CFR, %)
2011/12	34 017	1 541 (4.5)
2012/13	35 666	1 526 (4.3)
2013/14	45 824	1 769 (3.9)
2014/15	45 779	1 513 (3.3)
2015/16	47 640	1 041 (2.2)
2016/17	44 120	873 (2.0)

CFR = case fatality rate

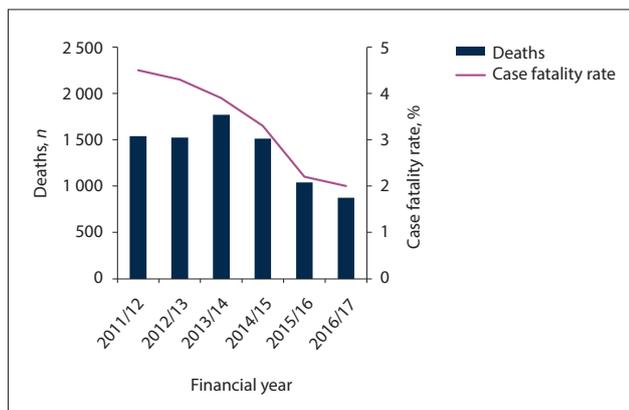


Fig. 1. Diarrhoea deaths and case fatality rates in children aged under 5 years, 2011/12 - 2016/17.

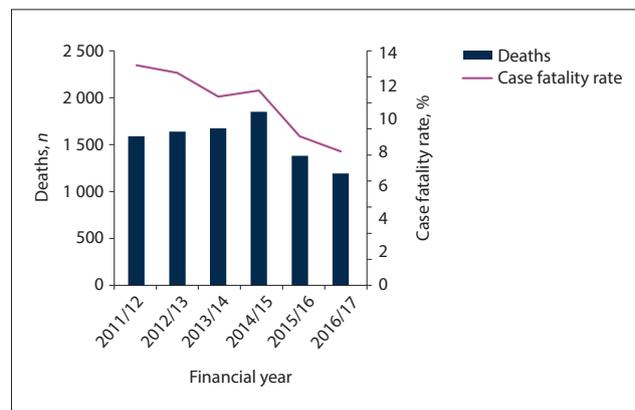


Fig. 3. Severe acute malnutrition deaths and case fatality rates in children aged under 5 years, 2011/12 - 2016/17.

annually to 2014/15, with a rapid decline of 36% occurring in the past 2 years. Apart from a small increase between 2013/14 and 2014/15, the SAM case fatality rate declined consistently, with an overall decline of 38.9% over the 6-year period.

Provincial trends for the three diseases are shown in Figs 4 - 6. Case fatality rates declined in all provinces across all three diseases over the 6 years. The Western Cape has consistently reported case fatality rates far below those in other provinces. Across the board

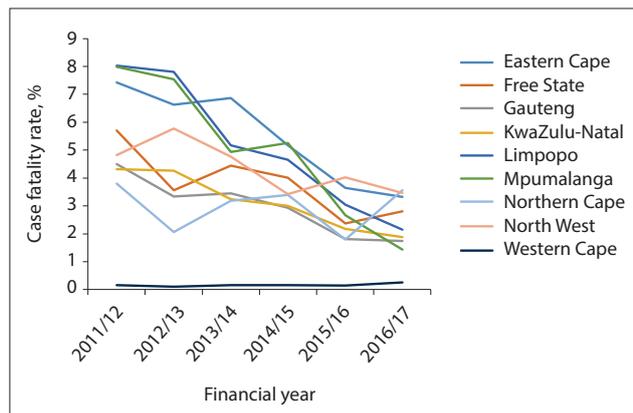


Fig. 4. Diarrhoea case fatality rates in children aged under 5 years per province, 2011/12 - 2016/17.

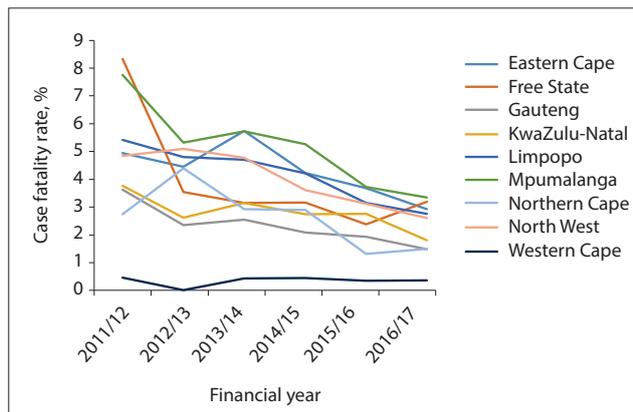


Fig. 5. Pneumonia case fatality rates in children aged under 5 years per province, 2011/12 - 2016/17. Western Cape data for 2012/13 are not available.

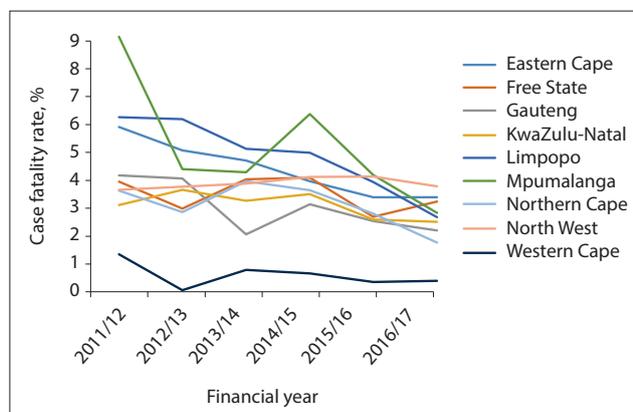


Fig. 6. Severe acute malnutrition (SAM) case fatality rates in children aged under 5 years per province, 2011/12 - 2016/17. Western Cape data for 2012/13 are not available.

these rates are largely the results of a decrease in the numerator, i.e. the number of deaths, rather than a decrease in the denominator, i.e. the number of admissions, which have remained consistently high.

Limitations of DHIS data

While the quality of DHIS data has improved over time, ongoing efforts are required to ensure that data are complete and accurate. DHIS reporting is well-established in most district hospitals, and reporting by secondary, tertiary and central hospitals has also improved substantially in recent years.

It is likely that most deaths from diarrhoea and pneumonia are recorded, as well as deaths associated with clinically apparent SAM. Collecting data on all admissions proved more challenging for some hospitals; thus increases in the number of admissions recorded over time may reflect either a true increase, or better reporting.

Only deaths which occur in health facilities are reported. However, in the absence of reliable reporting of the cause of child deaths through vital registration,^[11] DHIS data provide useful information on child mortality trends.

Discussion

The number of admissions associated with each of the three diseases shows a fairly consistent trend – increasing between 2011/12 through 2015/16 before declining in 2016/17. While this may reflect a real increase in the number of children with these diseases, it is more likely to reflect more complete reporting and/or improved access to inpatient care. Given the increased number of admissions, the decrease in the number of deaths associated with each of the diseases is particularly encouraging.

Case fatality rates have consistently declined year on year for all three diseases (with the exception of SAM in 2014/15) over the 6 years. It should be noted that case fatality rates are not corrected for case mix. The declines are therefore likely to reflect a combination of improved case management of sick children, and a different case mix, with children presenting to public health facilities both earlier in the course of their illness and/or with less severe illness.

As shown in Figs 4 - 6, case fatality rates have declined in all provinces. The consistently low case fatality rates reported by the Western Cape reflect both the high number of admissions and low number of deaths reported by the province's hospitals. There is a need to ensure that all child deaths are reported (especially by central hospitals), and to identify practices and other factors that contribute to the low case fatality rates with a view to (where possible) replicating these factors elsewhere.

The decline in the number of child deaths associated with all three diseases can be attributed to a number of factors, with the relative contribution of the different factors being difficult to quantify. The most obvious reason is the dramatic decline in HIV prevalence in young children as a result of the successful scale-up of the prevention of mother-to-child transmission of HIV, with transmission rates declining from 8% in 2008 to 2.6% at 6 weeks in 2012/13,^[12] with a further estimated decline to 1.5% in 2015.^[13] As a result, fewer children are at risk of developing (and dying from) diarrhoea, pneumonia and SAM.

Increased coverage of other key child survival interventions has also contributed to the reduction in deaths. Immunisation against rotavirus and pneumococcal diseases was introduced into the routine immunisation schedule in 2009, and coverage levels equivalent to those of more traditional vaccines were rapidly achieved.^[14] Case-control studies demonstrated that immunisation with these two vaccines was associated with reductions in hospitalisation for rotavirus-associated

diarrhoea^[15] and presumed bacterial pneumonia,^[16] while invasive pneumococcal disease among children in SA fell substantially.^[17] Rates of exclusive breastfeeding in infants under 6 months of age remain modest (32% in 2016,^[18]) but have increased substantially from the 8% reported in 2003.^[19] Non-breastfed children are 11 times more likely to die of diarrhoeal disease than exclusively breastfed children,^[6] so improvements in the proportion of children who breastfeed can play a significant role in further declines in admissions and case fatality rates for all three diseases.

Fortification of basic foodstuffs and routine supplementation have contributed to a decline in micronutrient deficiencies in children under 5 years of age. Vitamin A deficiency among children under 5 decreased from 63.6% in 2005 to 43.6% in 2012, while anaemia and iron deficiency anaemia in children under 5 decreased by 63.0% and 83.2%, respectively, during the same period.^[20,21]

Care seeking and home management of these diseases have also improved, with 88% of children with symptoms of pneumonia being taken to a health facility or practitioner, and 73% of children with diarrhoea receiving recommended home-made fluids, and 51% fluid made from an ORS packet.^[18]

The quality of case management at health facilities and hospitals is not routinely measured, and the role of improved case management in reducing child deaths is thus difficult to determine. However, the steady decline in case fatality rates suggests that improved case management in health facilities has contributed to the decrease in the number of deaths. Efforts to improve case management of children with diarrhoea, pneumonia and SAM through the implementation of standard treatment guidelines^[8,22,23] are likely to have contributed to the decline in case fatality rates, as have efforts to improve clinical governance through appointment of District Specialist Support Teams.^[24]

The impact of improved access to social support, through the child support grant (CSG), and improved access to basic services, is difficult to measure. There have been across-the-board improvements in children's access to basic services, although access remains far from universal (Table 4). Likewise, receipt of a social grant has been shown to promote positive nutritional, educational and health outcomes, especially in young children.^[25] By 2014, close to 12 million children were receiving a CSG, with a further 470 015 children receiving a foster child grant and 131 040 children receiving a care dependency grant.^[26]

Efforts to improve the quality of data

Current efforts to improve the quality of data are focused on ensuring that all hospitals collect admission and discharge data using standardised tools (including a standardised paediatric ward register), and that there is full alignment between the child mortality audit and DHIS data.

More attention also needs to be paid to correctly identifying all children with SAM; it is likely that many uncomplicated cases are currently missed owing to failure to accurately measure and classify the nutritional status of children admitted with other diseases (especially diarrhoea and pneumonia). Better recognition of children with SAM and earlier appropriate case management should reduce the number of deaths associated with the condition. This, together with recognition of more uncomplicated cases (where mortality is lower), is likely to result in a further decline in the case fatality rate.

Efforts to further reduce deaths

While the reduction in the number of child deaths is encouraging, under-5 mortality rates remain higher in SA than in other upper-middle-income countries such as Brazil, Mexico, Peru and China.^[28] Deaths in the post-neonatal period account for a higher proportion

Table 4. Access to key basic and social services, 2002 v. 2014^[27]

Proportion lacking service	2002	2014
Children living in households where there is reported child hunger	30.6	12.3
Children living in households without basic sanitation	54.8	25.6
Children living in households without water on site	41.2	31.4
Children living in overcrowded households	26.6	18.4
Children living far away from their health facility	37.1	21.5

of deaths than in countries with comparable mortality rates, with diarrhoea and pneumonia accounting for a high proportion of these deaths. This suggests that further improvements can be anticipated, providing that access to the child survival interventions described earlier is fully scaled-up. The Western Cape figures also suggest that most other provinces can still make significant improvements in the reduction of hospital deaths from the three diseases.

While significant progress has been made in reaching children with the package of child survival interventions, many gaps and inequities persist. Further gains are likely to depend on ensuring that these interventions reach all children, especially the most vulnerable groups. This will require:

- Continued improvements in the reduction of mother-to-child transmission of HIV and a reduction in the HIV prevalence of pregnant women, as well as ensuring that all HIV-infected children are identified early, receive antiretroviral therapy and are virally suppressed.
- Improvements in infant and young child feeding, especially increasing rates of exclusive breastfeeding until 6 months old, and improvement in complementary feeding practices in children aged 6 - 24 months.
- Increasing coverage of preventive and promotive services, especially immunisation.
- Earlier access to appropriate healthcare when sick, through improving household care-seeking behaviour and ensuring access to care.
- Improved case management in health facilities, including primary healthcare facilities and hospitals. Early identification and correct management of children with growth faltering and moderate malnutrition is particularly important.
- Addressing the social determinants of health, especially ensuring household food security, increasing access to basic services, particularly water and sanitation, and ensuring that all eligible children receive a child support or other grant.
- Community case management of diarrhoea and pneumonia by community health workers has been shown to reduce under-5 mortality,^[29] and consideration should be given to introducing this in parts of the country with high mortality rates, especially in remote rural areas where access to health services may be difficult.

Conclusion

The sustained decline in the number of deaths among children under 5 years of age in public sector hospitals from diarrhoea, pneumonia and SAM is encouraging. The majority of the remaining deaths associated with these diseases are preventable. Further improvements in coverage of key child health and nutrition interventions, accompanied by improvement in the quality of care children receive in public health facilities, will be required for SA to achieve the Sustainable Development Goal target of ending preventable child deaths by 2030.

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