

Malawi and Millennium Development Goal 4: a Countdown to 2015 country case study



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Summary

Background Several years in advance of the 2015 endpoint for the Millennium Development Goals (MDGs), Malawi was already thought to be one of the few countries in sub-Saharan Africa likely to meet the MDG 4 target of reducing under-5 mortality by two-thirds between 1990 and 2015. Countdown to 2015 therefore selected the Malawi National Statistical Office to lead an in-depth country case study, aimed mainly at explaining the country's success in improving child survival.

Methods We estimated child and neonatal mortality for the years 2000–14 using five district-representative household surveys. The study included recalculation of coverage indicators for that period, and used the Lives Saved Tool (LiST) to attribute the child lives saved in the years from 2000 to 2013 to various interventions. We documented the adoption and implementation of policies and programmes affecting the health of women and children, and developed estimates of financing.

Findings The estimated mortality rate in children younger than 5 years declined substantially in the study period, from 247 deaths (90% CI 234–262) per 1000 livebirths in 1990 to 71 deaths (58–83) in 2013, with an annual rate of decline of 5·4%. The most rapid mortality decline occurred in the 1–59 months age group; neonatal mortality declined more slowly (from 50 to 23 deaths per 1000 livebirths), representing an annual rate of decline of 3·3%. Nearly half of the coverage indicators have increased by more than 20 percentage points between 2000 and 2014. Results from the LiST analysis show that about 280 000 children's lives were saved between 2000 and 2013, attributable to interventions including treatment for diarrhoea, pneumonia, and malaria (23%), insecticide-treated bednets (20%), vaccines (17%), reductions in wasting (11%) and stunting (9%), facility birth care (7%), and prevention and treatment of HIV (7%). The amount of funding allocated to the health sector has increased substantially, particularly to child health and HIV and from external sources, but remains below internationally agreed targets. Key policies to address the major causes of child mortality and deliver high-impact interventions at scale throughout Malawi began in the late 1990s and intensified in the latter half of the 2000s and into the 2010s, backed by health-sector-wide policies to improve women's and children's health.

Interpretation This case study confirmed that Malawi had achieved MDG 4 for child survival by 2013. Our findings suggest that this was achieved mainly through the scale-up of interventions that are effective against the major causes of child deaths (malaria, pneumonia, and diarrhoea), programmes to reduce child undernutrition and mother-to-child transmission of HIV, and some improvements in the quality of care provided around birth. The Government of Malawi was among the first in sub-Saharan Africa to adopt evidence-based policies and implement programmes at scale to prevent unnecessary child deaths. Much remains to be done, building on this success and extending it to higher proportions of the population and targeting continued high neonatal mortality rates.

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Introduction

The world is at the finish line for the Millennium Development Goals (MDGs), madly counting and publicising how many countries have met their goals and how many have not.¹ But the important questions

are not how many, but why, how, and to what extent some countries have achieved the goals and others have not. Answering these questions needs in-depth, historical analysis of the decisions made by governments, partners, and families over the course of

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Research in context

Evidence before this study

This is the first in-depth multidisciplinary analysis of how Malawi has achieved MDG 4. We searched PubMed with no language restrictions with the search terms (“Child”[Mesh] OR (“child”[MeSH Terms] OR “child”[All Fields] OR “children”[All Fields]) OR (“pediatrics”[MeSH Terms] OR “pediatrics”[All Fields] OR “paediatric”[All Fields]) OR (“pediatrics”[MeSH Terms] OR “pediatrics”[All Fields] OR “pediatric”[All Fields])) AND (“Malawi”[MeSH Terms] OR “Malawi”[All Fields]) AND (“mortality”[MeSH Terms] OR “mortality”[All fields] OR “death”[MeSH Terms] OR “death”[All fields]) AND (“Malawi”[MeSH Terms] OR “Malawi”[All Fields]) between Sept 1, 2000 and Jan 4, 2016 (the date of the last search). We found 435 studies, none of which had investigated Malawi’s achievement of MDG 4 in as much depth as our study.

Added value of this study

This study is the first to pool nationally representative household survey datasets to produce trends in under-5 and neonatal mortality by district, region, and the whole of

Malawi. We also examined trends in coverage of key interventions, equity of intervention coverage and mortality, and present a thorough analysis estimating the lives saved by each of the main interventions between 2000 and 2013 using the Lives Saved Tool. This analysis explains 80% of the observed reduction in under-5 mortality. This is also the first study to synthesise publicly available information, relevant published articles, policy documents, and information gained from interviewing key programme and finance staff at district and national levels to investigate Malawi’s success in child survival.

Implications of all the available evidence

This study should inform further efforts to reduce under-5 (especially newborn) mortality as well as maternal mortality in Malawi, and contribute to planning for achievement of the Sustainable Development Goal targets of ending preventable mortality by 2030. Other countries in sub-Saharan Africa should also learn from Malawi’s relative success via this in-depth case study.

25 years, drawing on imperfect data from widely varying sources and analytical approaches from many disciplines that rely on plausibility rather than probability inferences.² The need for answers is urgent, because the MDG finish line is also the starting point for the next set of global and country goals—goals that build on the strengths of the MDGs, but take into account the new understanding regarding the inter-relatedness of health and development, of contextual constraints, and of the challenges of producing timely measurements of progress that can guide mid-course corrections in policies and programmes.^{3,4}

Countdown to 2015 for Maternal, Newborn and Child Survival (Countdown) is a suprainstitutional movement established in 2003 to set and maintain standards for accountability for improving the health of women and children.⁵ Countdown tracks progress and equity in population coverage of health interventions (ie, the proportion of individuals who need an intervention who actually receive it) and the health system and financial determinants related to population coverage in the 75 countries with the highest burdens of maternal and child mortality worldwide.⁴ Frustrated with the failure to explain country progress in achieving high and equitable coverage levels through the use of statistical approaches comparing progress across countries,⁶ Countdown established a programme of in-depth country case studies led by country institutions, bringing together multidisciplinary teams to explore how and why individual countries were able to make progress towards the achievement of MDG 4 and MDG 5, addressing child and maternal survival, respectively. Case studies have

been completed in Bangladesh,⁷ Niger,⁸ Peru (Huicho L, et al, Universidad Peruana Cayetano Heredia, Universidad Nacional Mayor de San Marcos, and Instituto Nacional de Salud del Niño, Lima, Peru, personal communication), and Tanzania,⁹ and this report presents the results for Malawi. Work is continuing in Afghanistan, China, Ethiopia, Kenya, and Pakistan. This case study was led by the Malawi National Statistical Office, with contributions from the Malawian Government, non-governmental organisations, WHO, other UN agencies, and a range of academic institutions both within and outside the country.

The global community has been watching Malawi in recent years, despite its small population of about 16·7 million people (as of 2014).¹⁰ At the start of the monitoring period for the MDGs in 1990, Malawi’s under-5 mortality rate was 247 (90% CI 234–262) per 1000 livebirths (at the national level, we have used estimates from the UN Interagency Group on Mortality Estimation [IGME], because these are the official estimates of the UN agencies).¹¹ By 2013, Malawi was on a trajectory towards success in child survival. The under-5 mortality rate had declined at an average annual rate of 5·4%, to 71 (90% CI 58–83) per 1000 livebirths. In this study, we used a recently completed national survey to determine whether Malawi achieved MDG 4.

Malawi’s progress was notable in part because it ran counter to expectations based on the usual predictors of rapid advances in development. It is a landlocked country with few natural resources, and in 2013 ranked 174th of 187 countries on the Human Development Index.¹² Based on purchasing-power-parity (PPP) estimates and international US dollars, the gross

domestic product per person was \$350 in 1990 and had doubled to \$780 in 2013.¹³ 72·2% of the population was estimated to live in severe poverty in 2010.¹⁴ 85% of the population resides in rural areas, with subsistence farming as the primary source of income. The country has high rates of child undernutrition, exacerbated by food shortages in 2001 and 2002 and by severe foreign exchange and fuel crises during 2009–12.

Countdown invited Malawi to do a case study to understand factors contributing to its progress in achieving MDG 4. The case study objectives were to explain how Malawi achieved MDG 4 at the national level; examine the roles of other programmes (such as immunisation, Integrated Management of Childhood Illness [IMCI], nutrition, reproductive, maternal, and newborn health, and prevention and control of malaria and HIV), equity, and contextual factors in this achievement; describe variations in district progress; and share lessons learned to guide future policies and programmes in Malawi and similar countries.

Methods

Study design and implementation

Our conceptual framework for the case study adapted the impact model used widely in maternal, newborn, and child health research and Countdown, moving from programme processes through immediate outputs and intermediate outcomes to impacts on child health and

nutrition.¹⁵ Additionally, however, we incorporated a systems approach, exploring the mechanisms through which national policies and strategies were operationalised and implemented, and the potential effects of a broad range of contextual factors. We examined trends in equity as an integral part of the case study, including geographical equity as shown by differences in districts as well as differentials in coverage and impact according to household wealth and mothers' education.

Figure 1 summarises the organisation of the case study work relative to the conceptual framework. We defined 1990–2014 as the temporal scope of our analysis, and combined national-level analyses with more focused attention to subsets of districts when data permitted. The entire Case Study Working Group met for the first time in November, 2013, reconvened in March and November, 2014, and met for the final time at a highly publicised launch chaired by the Ministry of Health in July, 2015. Each of the six primary teams (responsible for documentation, financing, coverage, the Lives Saved Tool [LiST] analyses, mortality, and nutrition), as well as crosscutting teams focusing on contextual factors and equity, worked together in the interim periods, coordinating with other teams as needed.

Data sources and analysis

Figure 1 also summarises the sources of data and analytical approaches used by each team (appendix

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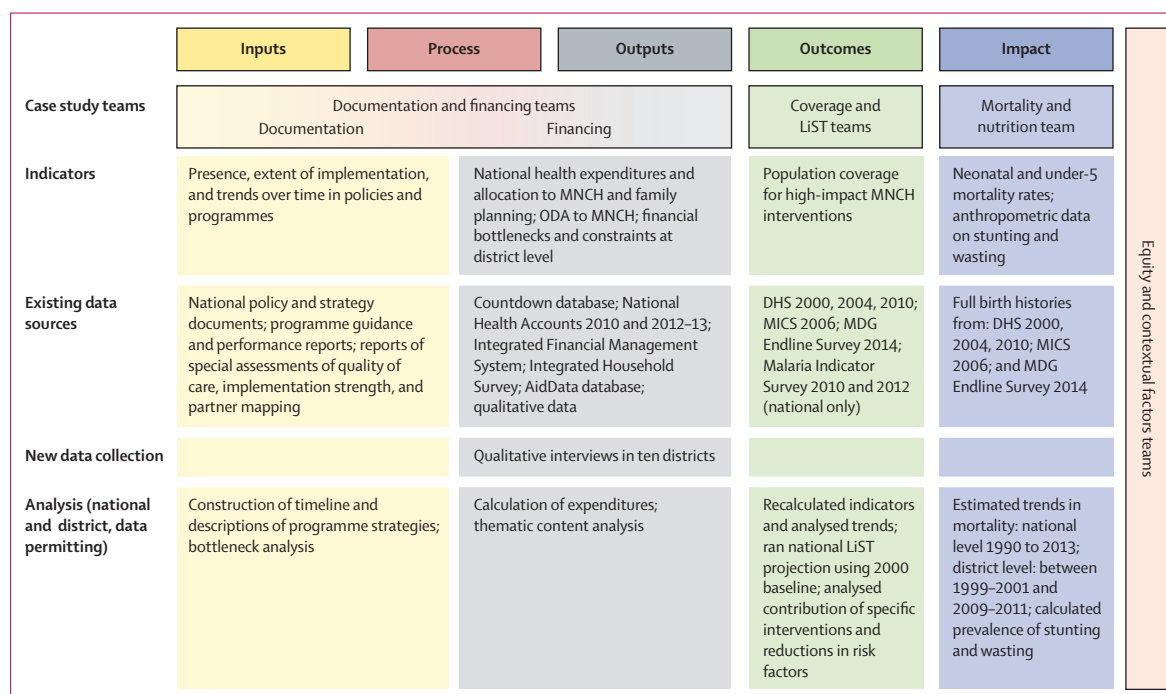


Figure 1: Conceptual model for the case study and overview of methods

DHS=Demographic and Health Surveys. LiST=Lives Saved Tool. MDG=Millennium Development Goal. MICS=Multiple Indicator Cluster Surveys. MNCH=maternal, newborn, and child health. ODA=official development assistance.

pp 2–8). We analysed mortality trends at the national level using the methods developed by the UN IGME to fit trends of neonatal and under-5 mortality to all the nationally representative survey data for Malawi.¹¹ We produced estimates of child mortality indicators (specifically, the neonatal mortality rate, the mortality rate between the ages of 1 month and 59 months, and the under-5 mortality rate) for each of the 26 districts in the analysis. We pooled data from the five nationally representative full birth history surveys done since 2000^{16–20} (figure 1), created consistent coding of districts (as in the 2006 Multiple Indicator Cluster Surveys [MICS]; appendix p 2), and calculated child mortality indicators with standard errors (SEs) for each district for the years 1999–2001 and 2009–11. We estimated SEs using the Jack-knife repeated replications method.²¹ We incorporated the results from the 2014 MDG Endline Survey²⁰ for three 5-year periods before the 2014 MDG Endline Survey took place into a provisional revision of IGME's estimates of trends in the under-5 mortality rate since 1990. We also assessed trends in biodemographic factors related to risk of death in children younger than 5 years. These factors include the proportions of first births or births of order five or higher, births to women younger than 18 years and 35 years or older, and births with a preceding birth interval of less than 18 months. We assessed trends by comparing these indicators between 1999–2001 and 2009–11 using pooled full birth history datasets from the Demographic and Health Surveys (DHS),^{16–18} MICS,¹⁹ and MDG Endline Survey.²⁰ We used estimates of the distribution of deaths in children younger than 5 years by cause developed by the Child Health Epidemiology Reference Group (CHERG) for the year 2000 in Malawi as baselines in our LiST applications, and also report the most recent available CHERG estimates of time trends in the causes of death from 2000 to 2013.²²

We examined trends in moderate and severe stunting (inadequate length and height for age) and wasting

(inadequate weight for height) by recalculating data from the nationally representative household surveys (figure 1). We use stunting and wasting as proxy measures for coverage of nutrition interventions because data for coverage of these interventions is scarce, with the exception of trends in breastfeeding.

We reanalysed trends in coverage at the national level and for each district for all interventions tracked by Countdown and used in LiST²³ for which data were available, using the original datasets from the five national household surveys (figure 1). We used the standard Countdown indicator definitions supplemented by the definitions used for additional proven interventions included in LiST (appendix pp 9–10).

We applied LiST to help attribute reductions in mortality to specific reproductive maternal, newborn, and child health (RMNCH) interventions, changes in stunting and wasting rates, and behaviours. LiST is a widely used software that estimates the impact of scaling up one or several interventions on overall and cause-specific mortality in children (appendix pp 11–17).^{6,24,25} We created a national projection for Malawi using the year 2000 as the baseline, with the most recent estimates of mortality rates and cause of death structure,²² and then applied changes in intervention coverage and nutritional status over time to determine lives saved up until 2013 (appendix pp 18–21).^{11,22,26} For LiST analyses in Machinga and Salima districts, we used the same basic approach but with some adjustments (appendix pp 18–21).

We documented the presence, extent of implementation, and trends over time for relevant programmes and policies by collating information from documents and interviews. We organised the information by health system area (eg, availability of medicines, skills building, skills reinforcement and supervision, and levels of service delivery) and year. The resulting timeline and description of programme strategies were developed and reviewed with the Ministry of Health and major development partners who had supported implementation during this period. We considered a policy as implemented only when it had moved beyond the pilot phase and the Ministry of Health believed that interventions were being provided to most women and children who needed them in most districts in the country. We also did a bottleneck analysis, based on the WHO health system building blocks framework.²⁷ Further details on documentation methods are available in the appendix, pp 22–27.

We analysed financial data at both national and district levels. At the national level, we used data from the Malawi National Health Accounts to analyse health expenditure and its allocation to maternal, newborn, and child health and family planning. Data were extracted from two National Health Accounts reports,^{28,29} covering annual expenditure data for 2006–11. We analysed data by source of expenditure: government, donors, and out-of-pocket expenditures. We estimated government

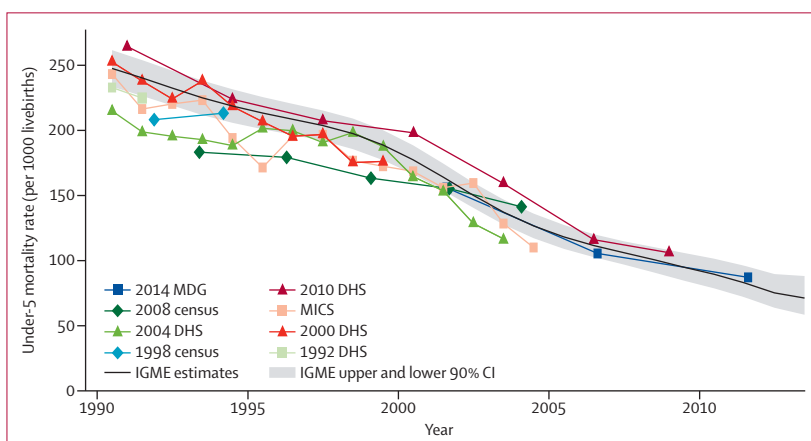


Figure 2: National trends in under-5 mortality rate in Malawi from 1990 to 2013, as estimated in 2014
DHS=Demographic and Health Surveys. IGME=Interagency Group on Mortality Estimation. MDG=Millennium Development Goal Endline Survey. MICS=Multiple Indicator Cluster Surveys.

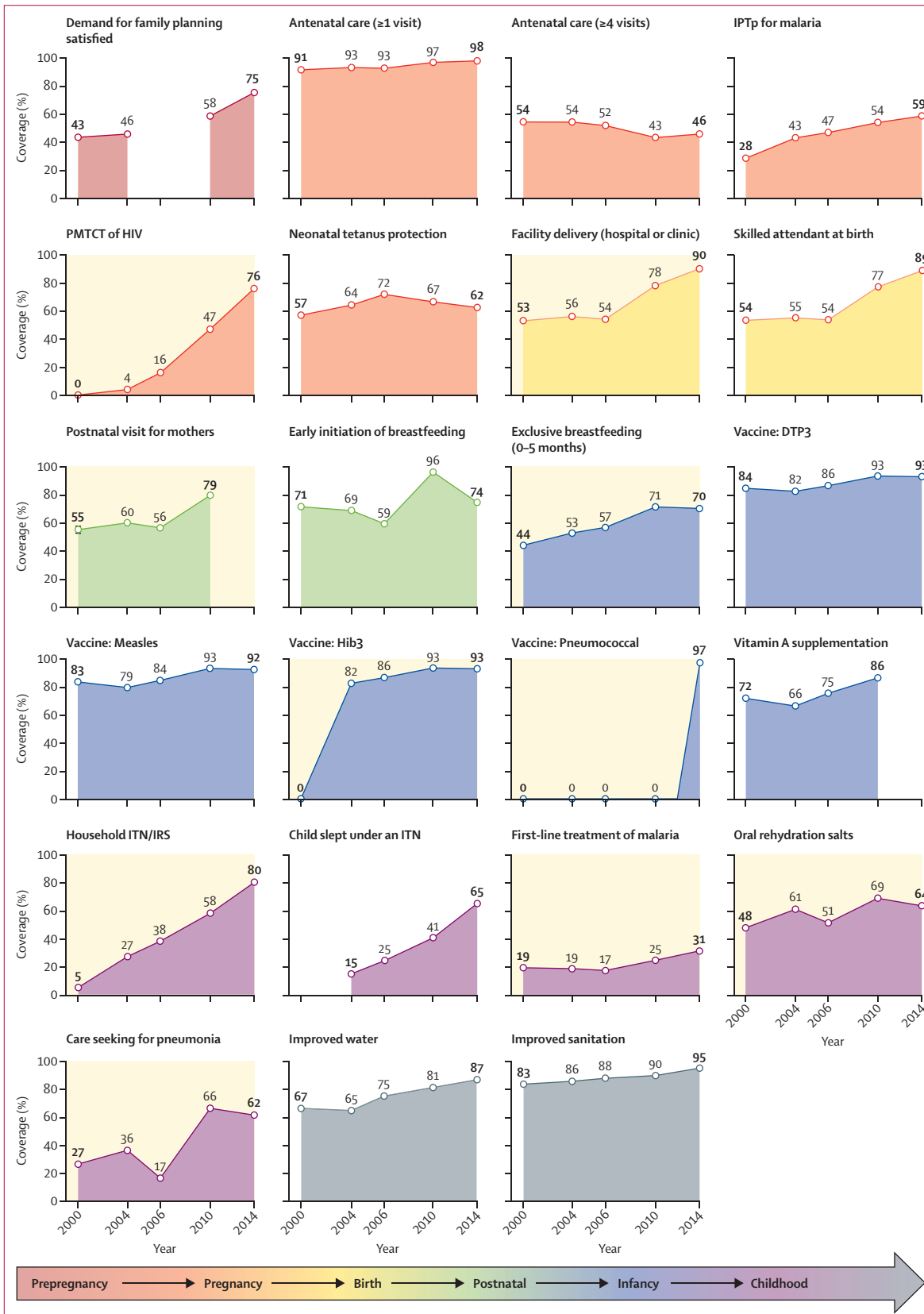


Figure 3: National trends in coverage (%) for priority indicators along the continuum of care, 2000-14
 The ten interventions with the greatest impact on under-5 mortality in Malawi, as estimated by the Lives Saved Tool, are highlighted in yellow boxes. 95% CIs for baseline (2000) and endline (2014) estimates are available in the appendix, p 36.
 DTP3=diphtheria-tetanus-pertussis. IPTp=intermittent preventive treatment in pregnancy. IRS=insecticide-treated bednets. PMTCT=prevention of mother-to-child transmission. ITN=insecticide-treated bednets. PMTCT=prevention of mother-to-child transmission. Hib3=Haemophilus influenzae type B, third dose.

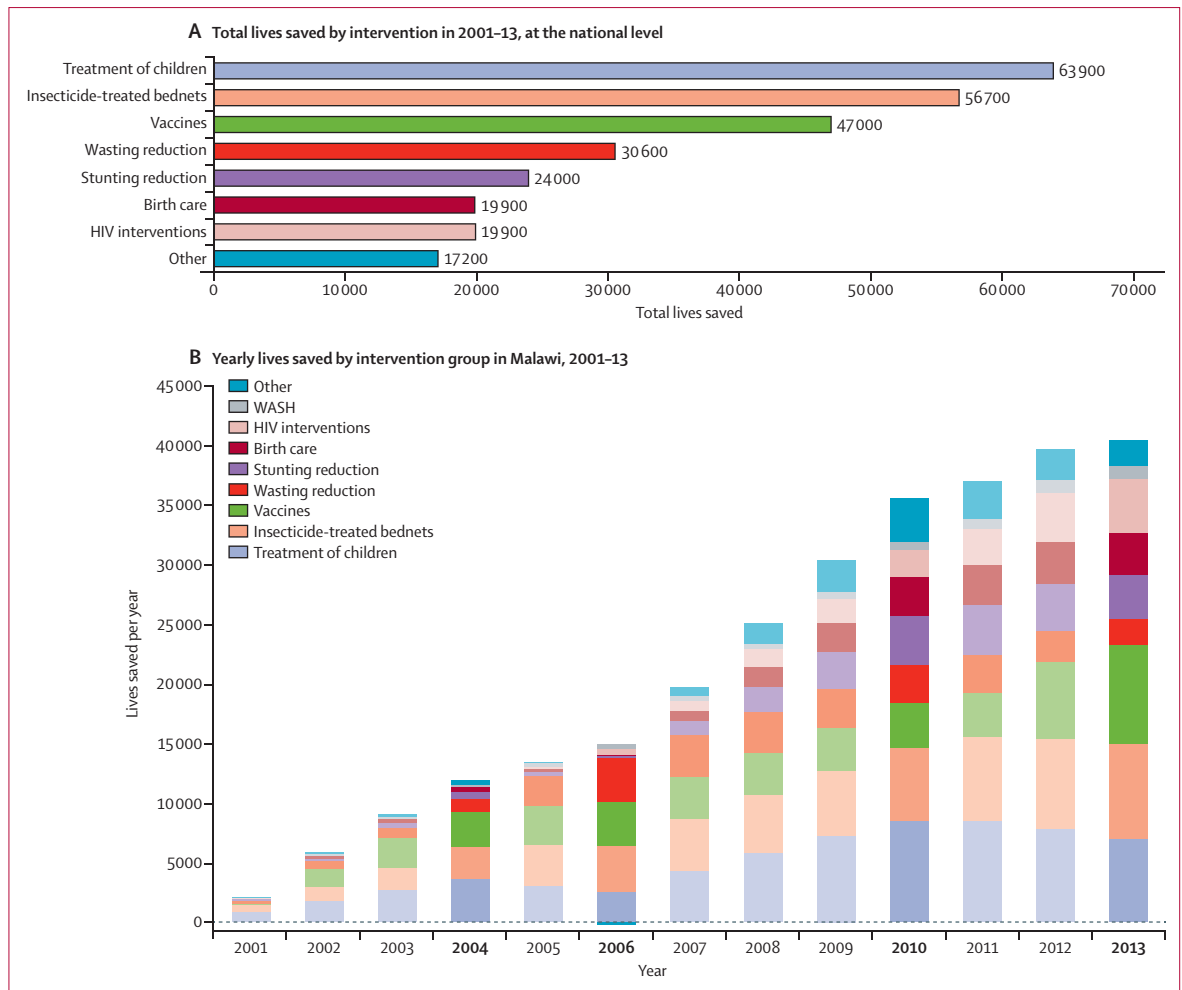


Figure 4: Lives saved according to intervention group during 2001-13 as estimated by the Lives Saved Tool
 (A) Total lives saved according to intervention group between 2001 and 2013 at the national level in Malawi, as estimated by the Lives Saved Tool. (B) Yearly lives saved according to intervention group in Malawi between 2001 and 2013, as estimated by the Lives Saved Tool. The darker bars indicate the years in which intervention coverage was measured (2004, 2006, 2010, and 2013). In 2006 the “other” lives saved per year was actually a negative value (denoted by the blue bar just protruding below the x-axis) and represents missed opportunities to save lives. WASH=water, sanitation, and hygiene.

expenditure on health as a share of total government expenditure compared with the Abuja target of 15%. Official development assistance to maternal, newborn, and child health was obtained from the Countdown database for the period 2003–12. Health expenditure data were converted to Malawian kwacha (when in US dollars) and inflated to 2013 prices.

We also considered contextual variables that we believed could have affected trends in under-5 mortality. All quantitative data for contextual factors were taken from open access sources.

We analysed inequities by drawing on variables available in the DHS, MICS, and MDG Endline Survey. We examined differentials in under-5 mortality by place of residence (urban vs rural) and mother’s education for 1999–2001 and 2009–11, using pooled DHS, MICS, and MDG Endline Survey full birth history datasets. We also assessed changes in the distribution of births by mother’s

education level, and differentials in intervention coverage by household wealth, using standard methods.³⁰

The findings reported here are syntheses of the entire Working Group. We focus on national-level findings and present limited district-level results relevant to equity analyses.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

We present the results based on the conceptual framework (figure 1) moving from right to left, closing with the results on equity and contextual factors. Figure 2 shows

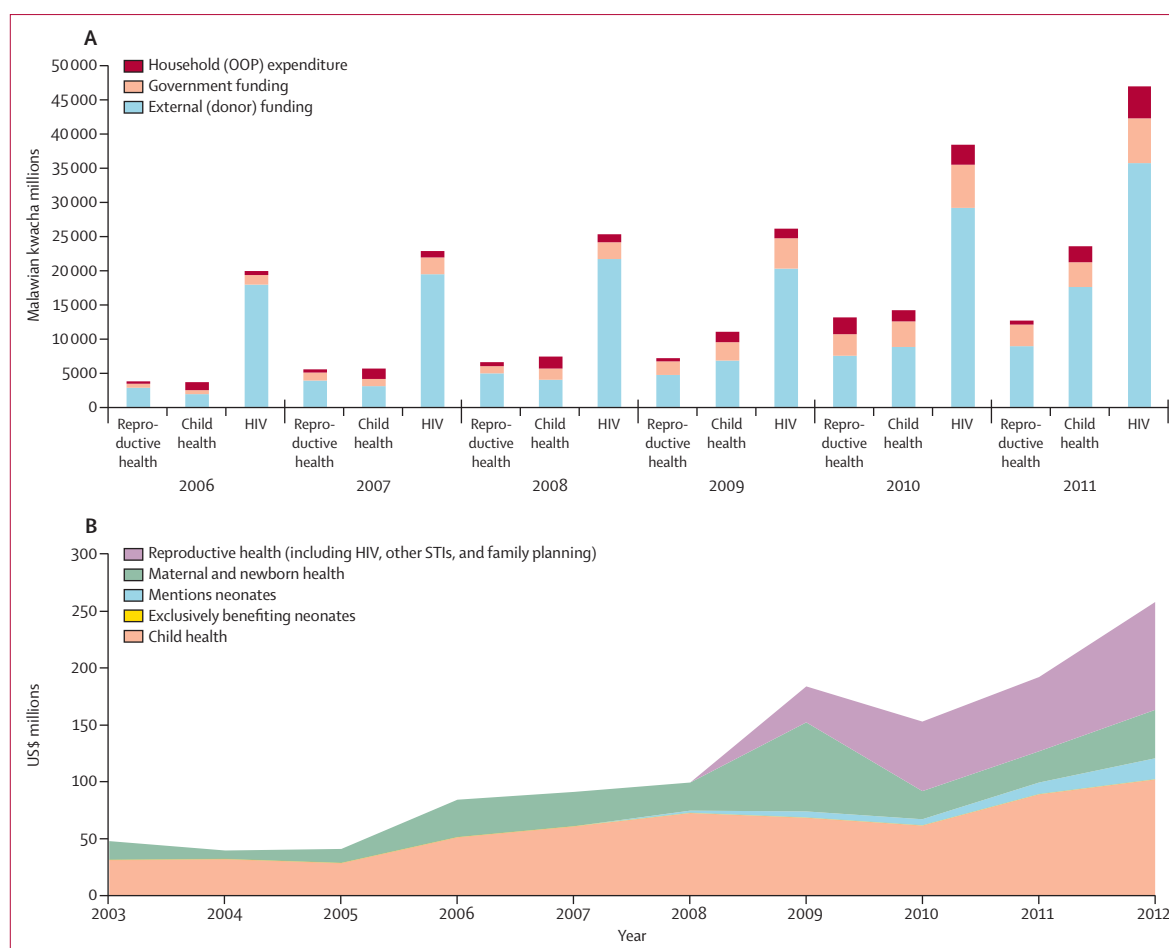


Figure 5: Assessment of health financing trends in Malawi

(A) Health subsector expenditure (in 2013 Malawian kwacha millions) between 2006 and 2011 (data are from Malawian National Health Accounts^{28,29}). (B) Trends in official development assistance for reproductive, maternal, newborn, and child health between 2003 and 2012 (data are from the Countdown official development assistance database). Financing that exclusively benefits neonates is so low that it is not visible on this figure. STIs=sexually transmitted infections. OOP=out-of-pocket.

the results of incorporating the 2014 MDG Endline Survey data into a revision of IGME estimates of trends in under-5 mortality since 1990. The 2014 MDG Endline Survey results fit closely with estimates from earlier periods, confirming that the data are of similar quality to those from earlier surveys. We estimate that under-5 mortality in Malawi declined at an annual rate of 5.4% from 1990 to 2013, and that Malawi had already achieved the 2015 MDG 4 goal reduction by 2013. In absolute terms, the decline is also remarkable—the under-5 mortality rate per 1000 livebirths fell from 247 (90% CI 234–262) in 1990 to 71 (58–83) in 2013. The most rapid mortality decline occurred in the 1–59 months age group. Neonatal mortality declined more slowly (from 50 to 23 deaths per 1000 livebirths, representing an annual rate of decline of 3.3%), although this result is still impressive compared with those of neighbouring countries.^{31,32}

District-level estimates of neonatal and under-5 mortality rates for 1999–2001 and 2009–11, proportionate declines in the neonatal and 1–59-month mortality rate,

and sampling errors are available in the appendix, pp 28–35. All districts show declines in the under-5 mortality rate of 20% or more, but vary substantially. Five districts show a decline of 30% or more in neonatal mortality, and five different districts—with no overlap—show a decline of 60% or more in mortality in children aged 1–59 months. Median district declines also show starkly different rates of progress between 2000 and 2010, with neonatal mortality declining by 12% and mortality in children aged 1–59 months declining by 54%. The district results should be interpreted with caution because of the large sampling errors, although the strong patterns across districts are still informative.

The major causes of child deaths in Malawi changed between 2000 and 2013.²² In 2000, malaria was the single greatest threat to child survival, accounting for about 20% of all deaths in children younger than 5 years in that year, followed by pneumonia (14%), diarrhoea (13%), and AIDS (13%); 23% of deaths occurred in the neonatal period. By 2013, the latest year for which estimates are

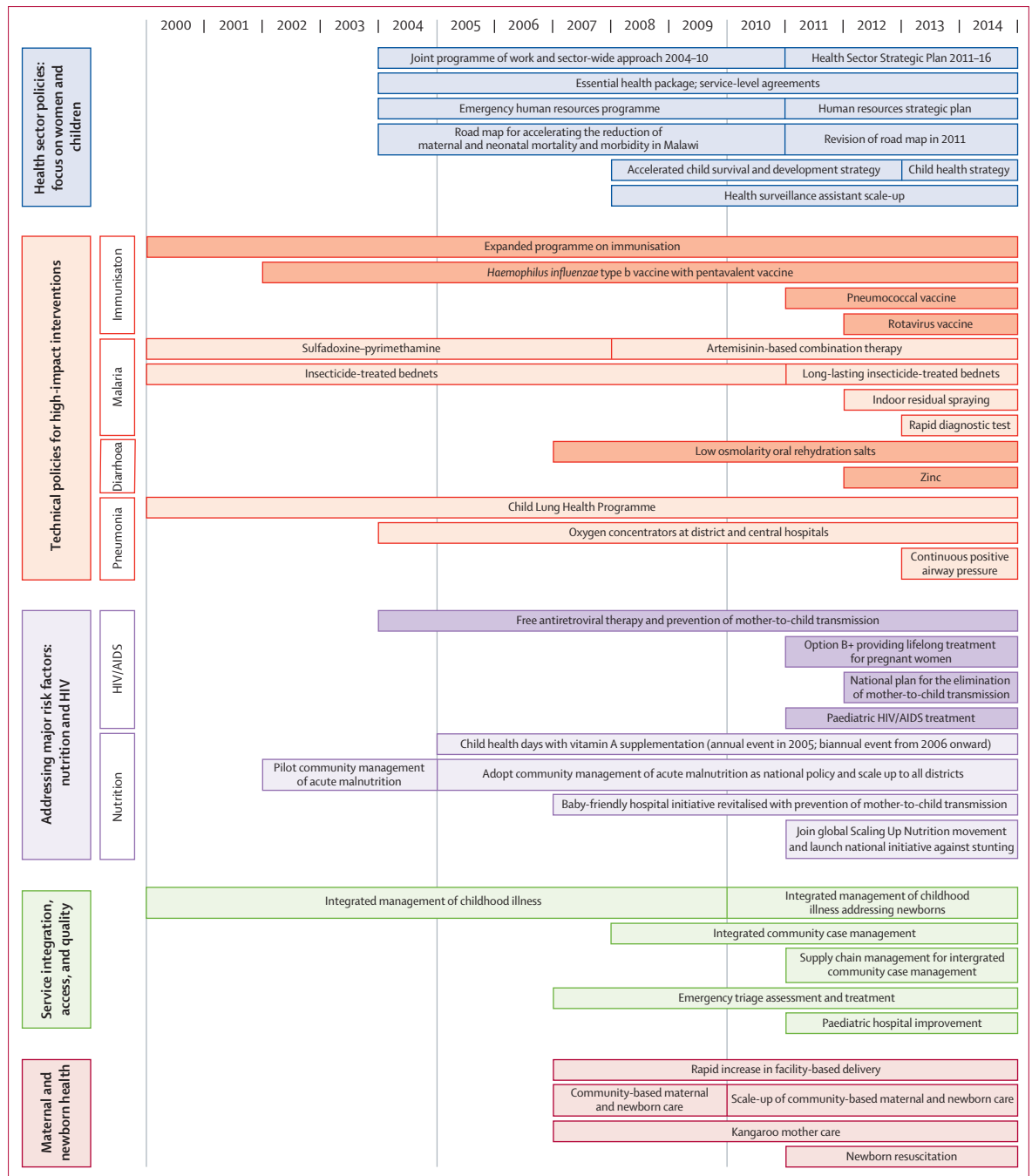


Figure 6: Timelines for Malawi's policy and programme initiatives for Millennium Development Goal 4

available, many fewer deaths and a lower proportion of the total were attributable to malaria (14%) and diarrhoea (7%), fewer deaths but similar proportions were attributable to pneumonia (13%) and AIDS (12%), and 34% of deaths occurred in the neonatal period.²²

Most high-impact interventions along the maternal, newborn, and child health continuum of care had gains in coverage, with the exception of a decrease of 8 percentage points in the proportion of women who

report four or more antenatal care visits (figure 3). Coverage for nearly half of the interventions increased by more than 20 percentage points during this period. Some interventions—particularly those such as vaccination that could be planned and delivered in a scheduled manner—were introduced and scaled up to high population coverage rapidly. Rapid increases also occurred in coverage of prevention of mother-to-child transmission of HIV and skilled care at birth. Coverage of prevention of

mother-to-child transmission of HIV increased steadily over 12 years, and by 2014 had achieved population coverage of 76%. The proportion of women who reported giving birth in a health facility increased rapidly from 53–56% in 2000–06 to 90% in 2014. Of the remaining interventions, we see slow growth for care seeking and treatment of childhood illnesses (pneumonia, malaria, diarrhoea), with 36–69% of children still not receiving the interventions in 2014. Full results for all indicators at national level including 95% CIs are available in the appendix, p 36. Important differences were noted in patterns of coverage change for high-impact child survival interventions by district (appendix pp 37–45).

To determine whether it was appropriate to use LiST to attribute changes in mortality to specific interventions or behaviours, we compared the under-5 mortality rate generated by LiST for the period 2000–13 to the under-5 mortality rate estimated using the IGME methods for the same period. The IGME under-5 mortality rate fell from 174 (90% CI 167–189) per 1000 livebirths in 2000 to 71 (58–83) in 2013. The rate projected by LiST fell from 174 to 92 per 1000 livebirths in 2013, representing 80% of the reduction reported by IGME. Similar to the Countdown case study in Niger,⁸ this level of concordance is high, strengthening the case for using LiST as a method to attribute changes in mortality to changes in intervention coverage, stunting and wasting status, and behaviour.

Figure 4A shows the cumulative numbers of lives saved by intervention or intervention group during the years 2001–13. We use the term intervention group as shorthand for changes in intervention coverage, changes in stunting and wasting rates, and behaviour. Of the roughly 280 000 lives saved during this period, increases in treatment for diarrhoea, pneumonia, and malaria accounted for 23%, insecticide-treated bednets accounted for roughly 20%, and vaccines (mainly *Haemophilus influenzae* type b [Hib] and pneumococcal vaccines, but also the measles and diphtheria, pertussis, and tetanus vaccines) for 17%. The numbers of lives saved due to reductions in the prevalence of stunting (8·6%) and wasting (11·0%) are assumed by the LiST model to be a result of the measured change in age-specific stunting and wasting rates rather than changes in intervention coverage, for which data were not available (appendix p 18). The lives saved attributed to HIV interventions (7·1%) are as a result of the increased coverage of prevention of mother-to-child transmission of HIV (including a shift to more efficacious regimens), but also treatment with antiretrovirals and co-trimoxazole. Lives saved attributed to birth care (7·1%) are as a result of increases in the number of births in facilities and the resulting access to additional facility interventions including emergency obstetric care.

The cumulative lives saved depend on the efficacy of the interventions and the timecourse of the scale-up. Some interventions, such as insecticide-treated bednets and Hib vaccines, were scaled up early in Malawi, with

coverage increasing slowly over time. Other interventions, such as pneumococcal vaccine, were not rolled out until late 2011, so the cumulative impact was less. To show this effect, figure 4B shows the estimated lives saved in each year by intervention groups.

From 2000 until 2006, the lives saved were mainly due to increased coverage of insecticide-treated bednets, vaccines (almost entirely due to roll-out of Hib vaccine in 2002), and coverage of treatment for childhood illness (figure 4B). A reduction in wasting rates in children also occurred during this period, and has been shown in multicountry analyses to result in lower mortality.³³ In 2006, we see the first substantial impact of HIV/AIDS interventions on lives saved.

In 2006–10, the lives saved due to insecticide-treated bednets and treatment for diarrhoea, pneumonia, and malaria continued to increase and we noted an increasing impact of HIV/AIDS interventions and the positive effects of large increases in births in health facilities rather than at home. Stunting rates in children younger than 5 years also dropped substantially between 2006 and 2010 (appendix p 46). Between 2010 and 2013, we noted a dramatic increase in lives saved as a result of vaccination, reflecting the roll-out of pneumococcal vaccine from late 2011, and, to a lesser extent, rotavirus vaccine from late 2012. Coverage of HIV/AIDS interventions and insecticide-treated bednets continued to increase in this period, resulting in an increasing number of lives saved.

Financial inputs to maternal, newborn, and child health in Malawi are summarised in figure 5 and the appendix, p 47. The share of the total government budget allocated to health increased from 4·6% in 2006 to 7·2% in 2011 (appendix p 47), so the Abuja target of allocating 15% of total government expenditure to the health sector³⁴ was not achieved.

The increase in funding to the health sector was largely driven by increased donor funding, which represents 66–70% of total health expenditure (figure 5A). The share of out-of-pocket payments remained fairly constant over time, at around 10%. When considering funds to maternal, newborn, and child health specifically, funding to child health increased substantially over the period of study, but funds to maternal and newborn health and family planning increased much less (figure 5B).

The increase in donor funding was also evident through the Countdown database,³⁵ which provides annual estimates of RMNCH expenditures, including expenditures on nutrition, which are a subset of child health expenditures (figure 5B). Donor funding for child health was much higher than for maternal and newborn health, starting from \$31·2 million in 2003, with funding increasing between 2005 and 2008, and again from 2010 to \$102·2 million in 2012. By contrast, funding for MNH started at \$16·5 million in 2003, peaked in 2009, after which it decreased before increasing again to \$42·6 million in 2012. Newborn health has remained the

	2000	2004	2006	2010	2013
GNI per person, PPP (current international \$) ⁴⁰	\$490	\$520	\$550	\$710	\$750
Poverty gap at \$1.25 a day (PPP) ⁴¹	..	33%	..	34%	..
Annual inflation, consumer prices ⁴²	30%	11%	14%	7%	27%
HIV prevalence in adults ⁴³	18%	16%	15%	12%	10%
Northern region*	..	8% ¹⁷	..	7% ¹⁸	..
Central region*	..	7% ¹⁷	..	8% ¹⁸	..
Southern region*	..	18% ¹⁷	..	15% ¹⁸	..
HIV prevalence in women aged 15–24 years ⁴⁴	10%	8%	7%	5%	4%
Female literacy†	57% ¹⁶	62% ¹⁷	67% ¹⁹	68% ¹⁸	72% ²⁰
Northern region	63% ¹⁶	78% ¹⁷	75% ¹⁹	80% ¹⁸	86% ²⁰
Central region	49% ¹⁶	61% ¹⁷	66% ¹⁹	65% ¹⁸	70% ²⁰
Southern region	46% ¹⁶	59% ¹⁷	66% ¹⁹	68% ¹⁸	72% ²⁰
Total fertility rate (births per woman)	6.3 ^{16,45}	6.0 ⁴⁵	5.9 ⁴⁵	5.6 ⁴⁵	5.0 ²⁰
Proportion of births after short interval (<18 months)‡	3.6%	3.4%	3.7%	3.4%	2.8%
Proportion of first births‡	23.3%	22.3%	22.0%	19.9%	22.3%
Proportion of births to mothers aged <18 years‡	4.2%	3.3%	4.4%	3.5%	3.9%
Prevalence of contraceptive use in women aged 15–49 years ⁴⁶	30.6%	32.5%	41.0%	46.1%	..
Urban households ⁴⁷	14.6%	15.0%	15.1%	15.5%	15.9%
Extent of food deficit (kcal/day per person) ⁴⁸	217	186	189	153	149

GNI=gross national income. PPP=purchasing power parity. *These data might differ from The World Bank data for the whole country. †Defined as attendance at secondary school or higher and ability to read at least part of a sentence; all estimates are about 8 percentage points lower when women who can only read part of a sentence are excluded. ‡Based on births in the 2 years preceding the survey and calculated from pooled Demographic and Health Surveys, Multiple Indicator Cluster Surveys, and MDG Endline Survey full birth history datasets.^{16–20} §Including lactational amenorrhea and folk methods of contraception.

Table: Trends in selected contextual factors that might be related to trends in child survival in Malawi

smallest priority, with funds specifically targeting neonates not visible on figure 5B; although funding has increased for projects mentioning neonates, from \$48 000 in 2007 to \$18.1 million in 2012.

Figure 6 provides timelines for the implementation of key policies and programme strategies that the Government of Malawi used to increase coverage of life-saving interventions between 2000 and 2014. Figure 6 is organised in five sections: major health sector policies affecting women and children; technical policies and programmes for high-impact interventions; policies and programmes addressing major risk factors; policies for integration, access, and quality of high-impact interventions; and specific maternal and newborn health policies. Further descriptions of these initiatives, including priority interventions and packages of interventions targeting reductions in child mortality, can be found in the appendix, pp 48–51.

Large and important differences have occurred in programme implementation across districts in Malawi. We show these differences through a LiST analysis in two districts (appendix pp 52–55). A full analysis of all districts in the country has been completed, but will be reported elsewhere. The results of our bottleneck analysis in ten districts show that four types of health systems

barriers are limiting the extent and quality of implementation of child survival, nutrition, and other RMNCH programmes at district level. The first is the health workforce: despite increases during the emergency human resources plan of 2004–10,³⁶ a substantial proportion of positions in the established plan remained vacant (unpublished data). WHO's current projections for Malawi suggest that massive investment in training and retention of skilled health personnel (doctors, nurses, and midwives) is needed. For example, to reach the minimum recommended density of 22.8 skilled health personnel per 10 000 population by 2030, the number of skilled health personnel will need to increase to 59 188 at an annual rate of about 12.4%, and to achieve the universal health access ratio of 41.1 skilled health personnel per 10 000 population, the number of skilled health personnel will need to increase to 106 694 by 2030 at an average annual rate of 15.6% (Siyam A, WHO, personal communication). Additionally, available evidence suggested that the performance of trained personnel might not meet required standards.^{37,38} The second health systems barrier is medicines and supplies. Available data show frequent stock-outs of essential life-saving commodities in health facilities and village health clinics.^{38,39} The third barrier is mentorship and skills improvement. Supervision of health workers is infrequent, and often does not include observation of case management by the supervisor with immediate feedback to the health worker.^{38,39} The final barrier is governance: our findings suggest that there is limited predictability of health sector funding at district level, and that budget allocations are insufficient relative to basic needs.^{28,29}

The role of contextual factors—both positive and negative—have to be taken into account to understand Malawi's achievement of MDG 4 (table). Socioeconomic factors have generally improved, such as gross national income per person, and these factors might have had a positive impact on child mortality. The total fertility rate in Malawi has declined by more than one child in the past decade, and contraceptive prevalence significantly increased between 2000 and 2010. Despite declining total fertility, essentially no change occurred in biodemographic risk factors such as the proportion of births after a short birth interval (of <18 months), the proportion of first births, and the proportion of births to mothers younger than 18 years. The only biodemographic change likely to have an effect on under-5 mortality was the decline in HIV prevalence in women aged 15–24 years, from 10% in 2000 to 4% in 2013 (table). Regional differences in these contextual factors have to be taken into account in future district-level analyses. For example, biodemographic and sociodemographic indicators, including HIV prevalence and female literacy (table), are generally better in the northern region of Malawi than the southern region, with the central region falling in between. The northern region is also less densely

populated and has a higher density of health facilities and better indicators of household wealth than the other two regions.^{20,49} These differences probably explain the regional gradient in mortality noted during both the 1999–2001 and 2009–11 evaluation periods (appendix p 28).

The effect of other important contextual factors is less clear. Malawi has serious problems with corruption and governance, but less so than other low-income countries.⁵⁰ Levels of perceived corruption have gone down and up twice in the last 25 years in Malawi, but no clear evidence links such changes to changes in health outcomes.⁵⁰ Although only 47% of neonates lived within 5 km of delivery services in 2004, distance to such facilities was not linked to early neonatal mortality in a study of Malawian Demographic and Health Survey data.⁵¹ We could not find sufficient data to support analyses of trends in referral system functioning or in availability and access of essential drugs.^{49,52}

Our equity analyses of under-5 mortality show that mortality differentials are relatively small by international standards. Children in rural areas had a risk of dying that was 21% higher than those in urban areas, and did not change between 2000 and 2010 (appendix p 33). Children of mothers with no education had an excess mortality risk of only 14% relative to children of women with secondary or higher education in 2010, much lower than their excess risk of 67% in 2000 (appendix p 34). The distribution of births by mothers' education shifted towards those with higher levels of education, but the mortality advantage of being born to an educated mother declined, so the net effect was small (appendix).

Gaps in intervention coverage between the bottom and top wealth quintiles have narrowed for ten key interventions between 2000 and 2014 (appendix p 56).

Discussion

This in-depth case study provides plausible evidence that policy, programme, and financial inputs to child survival in Malawi from 2000 to 2014 led to increases in population coverage for high-impact interventions, and contributed in important ways to Malawi's achievement of MDG 4 by 2013, and improvements in child nutrition. The key findings are summarised in the panel.

Inputs to child survival included strong commitments by the Government of Malawi to survival-enhancing policies and programme strategies for children. Malawi was an early adopter of many policies supporting increased access to and coverage of essential, life-saving interventions. For example, Malawi was among only 12 of 49 African countries that adopted community treatment of pneumonia with antibiotics before 2008, and was among the 25 of these 49 countries that adopted low osmolarity oral rehydration solution and zinc for management of diarrhoea before 2008.^{4,53–55}

This policy support, combined with the expansion of human resources for health and the rapid scale-up in IMCI, made quality child health services more accessible

Panel: Key findings and future directions

- Malawi achieved MDG 4 by increasing equitable national coverage for high-impact interventions addressing the major causes of child deaths, including treatment of childhood pneumonia, diarrhoea, and malaria, prevention of these diseases through the timely introduction of vaccines and insecticide-treated bednets, and reduction of child undernutrition
- Contributors to national success include early adoption of evidence-based policies, government leadership, and partner coordination for rapid scale-up of new initiatives such as integrated community case management and Scaling Up Nutrition, attention to health system strengthening and innovation, and active use of periodic survey and independent assessment data to improve programmes
- Further reductions in under-5 mortality can be realised by addressing remaining system constraints, identifying women and children who are not being served, and developing effective strategies for reaching them and promoting service use, and increased harmonisation of implementation strategies across communities, at the first-level and at referral facilities
- Newborn mortality has decreased more slowly than under-5 mortality, and should be prioritised in future actions; improving quality of care around the time of birth and providing adequate care for small and sick babies should be prioritised, while unmet need for family planning should be minimised
- Available evidence suggests wide disparities in achievement across districts; continuing work should seek to explain the determinants of district success

to the population, and seems likely to be responsible for the dramatic increase in care seeking for childhood illness that occurred between 2006 and 2010. Malawi achieved MDG 4 despite assessment results showing gaps in the quality of child health services,^{49,56,57} suggesting that all-or-nothing approaches to monitoring of progress might be unduly pessimistic. Reductions in stunting occurred during the assessment period, and were probably attributable to a combination of the scale-up of direct nutrition interventions (appendix p 46), declines in childhood illness, and other environmental factors such as economic growth.

Despite Malawi's success in achieving MDG 4, important work remains to be done. The slower decline in newborn mortality relative to under-5 mortality calls for a redoubling of efforts, including care for small and sick babies. At 18%, Malawi has the highest recorded rate of babies born prematurely in the world.⁵⁸ Prematurity is related to infections such as malaria, physical and psychological stress, and poor nutrition, during pregnancy.^{58,59} The launch of the national Every Newborn Action Plan in July, 2015, has provided additional momentum for an

accelerated scale-up of effective neonatal interventions, including improvements in the quality of care around the time of childbirth for mother and baby.

Additionally, the agenda for children aged 1–59 months is unfinished. Treatment interventions for childhood pneumonia, diarrhoea, and malaria accounted for 23% of the lives saved in this analysis, and yet coverage remains relatively low with only around 60% of children with pneumonia or diarrhoea being taken to a trained provider for care or given oral rehydration solution, respectively, and only 30% of children with fever or malaria received the first-line antimalarial. These coverage levels must be maintained, and further gains must be made. The Ministry of Health and partners should continue to refine their delivery strategies for the management of child illness at both facility and community levels, building a better understanding of why some women and children are not accessing services even when the services are geographically accessible.

Similarly, current efforts to improve infant and young child feeding and to tackle child malnutrition at an early stage in the community must be sustained and expanded. Care around labour and delivery also needs to be strengthened, to ensure that the rapid increases in facility delivery result in their full life-saving potential for mothers and babies in Malawi. Quality of health services across the continuum of care for women, newborn babies, children, and adolescents needs deliberate and massive attention to ensure every service contact is used to provide high-impact interventions. Supply chains for essential drugs and commodities need to be reliable and human resources for health need to be further strengthened through quality improvement processes in health facilities, better retention of personnel, fewer transfers of personnel (including managerial staff), and increased production of competent nurses and midwives with adequate supports for health worker performance.

Despite increases in spending in health in general and child health specifically at the national level, overall health sector funding in Malawi is still insufficient, and below internationally agreed thresholds such as the Abuja target. The health sector is increasingly dependent on external funds, which is of concern given recent evidence of a plateauing of development assistance for health⁶⁰ and decreases of funding through the Government of Malawi as a result of concerns with public financial management practices. This dependency on external funds not only decreases the Malawian Government's ability to plan, but also concentrates decision-making power on the donors, who have continued to disburse funding in the form of vertical projects, in which the government has little involvement. Furthermore, out-of-pocket expenditures were around 10% of total health expenditure, despite health services being free at the point of care in Malawi. The Malawian health sector would benefit from increased funding, particularly from the government and targeted to

newborn health, but better data are also needed to undertake more in-depth subsector financing analyses. External partners should find a way to ensure predictable long-term funding, given the dependence on external funds and the impact that out-of-pocket payments can have on households.

Our finding of important differences in the choices made at district level about how, and how strongly, to implement evidence-based programmes also merits further attention. The major health system bottlenecks we identified at district level will not be easy to address. Massive investment will be needed in the health workforce to reach the minimum recommended density and standards. Stock-outs of essential life-saving commodities in health facilities and village health clinics must be addressed. Mentorship and skills improvement strategies will need to be implemented more widely, and revised to include observation of case management by the supervisor with immediate feedback to the health worker. Health sector funding at district level must be both increased and made more predictable.

Our study has a number of strengths. Our methods draw on many disciplines (demography, epidemiology, health economics, social science, policy analysis) and permit in-depth analysis. Regular, high-quality household surveys with samples at district level provided the data needed to undertake mortality, coverage, and LiST analyses. Involving key stakeholders across the health system and government in the review of the preliminary results strengthened the interpretation of our findings, and will provide a strong foundation for dissemination and subsequent action.

Our study also has limitations. Most importantly, insufficient data were available to support attribution of declines in stunting to specific interventions, or to quantify the impact of changes in contextual factors on the delivery of health interventions or on under-5 mortality. The fact that we found no overlap in the sets of districts that did best in reducing neonatal mortality and those that did best in reducing post-neonatal mortality suggests that considerable sampling error might have occurred. A large decline (by statistical chance perhaps) in the neonatal mortality rate makes a large decline in mortality in children aged 1–59 months less likely, since the 1–59-month mortality rate is calculated in infants who have survived to 1 month of age; however, we observe no association between the two declines across districts. Additionally, although the LiST estimates of mortality reduction based on increases in intervention coverage, changes in stunting and wasting rates, and behaviour change match well with the measured mortality reduction, questions about some of the LiST inputs remain. Specifically, in the LiST analyses we were forced to use trends in skilled birth attendance and facility deliveries to estimate access to interventions for childbirth, including clean delivery, access to emergency care, and active

management of the third stage of labour, because the national programme does not have coverage estimates of these interventions. This is a crucial weakness in the monitoring of maternal and child health programmes in almost all low-income countries and makes the attribution of mortality reduction to improved birth care less robust than other interventions such as insecticide-treated bednets and vaccination, for which the national programme does have good measures of coverage trends. A final limitation is that attempting to tell the full story of Malawi's achievement of MDG 4 in one report required a series of hard choices about which results and supporting documentation to present, and which to present in the appendix or to hold for future reports. The in-depth country case studies are urgently needed, but are challenging to present in a traditional scientific format.

This is the most detailed study of child survival in Malawi that we are aware of. It contributes to global efforts to understand why some countries have achieved MDG 4 while others have yet to make sufficient progress.⁶¹ Further detailed analyses of district-level progress are underway, and will inform continuing efforts to make further gains in reducing child mortality in Malawi.

Contributors

JBr and MK conceived the study, which was developed by all authors. The five teams who collected or collated the relevant data, analysed the data, and wrote the corresponding sections of the report including panels, tables, figures, and appendix were as follows: mortality, KH, AA, JN, and MM; coverage, TM, EH, RH, and LP; Lives Saved Tool, LC and NW; documentation, JD, RF, LM, BN, HN, BD, and TC; financing, MMÁ, SM, and JBo. JBr wrote the first draft of the report from the contributions of all authors. All authors contributed intellectual content during and between the collaborative analysis and writing workshops, contributed to revising drafts, and read and approved the final version of the report, which was collated and finalised by TC. MK, JBr, and TC are the guarantors of the work.

Declaration of interests

KH and TC report personal fees from the World Health Organization. All other authors declare no competing interests.

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References

- UN. The Millennium Development Goals report 2015. New York: United Nations, 2015.
- Habicht JP, Victora CG, Vaughan JP. Evaluation designs for adequacy, plausibility and probability of public health programme performance and impact. *Int J Epidemiol* 1999; **28**: 10–18.
- UNICEF. Progress for children. Beyond averages: Learning from the MDGs. New York: UNICEF, 2015.
- Countdown to 2015 for Maternal Newborn and Child Survival. A decade of tracking progress for maternal, newborn and child survival: the 2015 report. <http://www.countdown2015mnch.org/reports-and-articles/2015-final-report> (accessed Dec 12, 2015).
- Claeson M, Gillespie D, Mshinda H, Troedsson H, Victora CG, and the Bellagio Study Group on Child Survival. Knowledge into action for child survival. *Lancet* 2003; **362**: 323–27.
- Walker N, Yenokyan G, Friberg IK, Bryce J. Patterns in coverage of maternal, newborn, and child health interventions: projections of neonatal and under-5 mortality to 2035. *Lancet* 2013; **382**: 1029–38.
- El Arifeen S, Hill K, Ahsan KZ, Jamil K, Nahar Q, Streatfield PK. Maternal mortality in Bangladesh: a Countdown to 2015 country case study. *Lancet* 2014; **384**: 1366–74.
- Amouzou A, Habi O, Bensaïd K, and the Niger Countdown Case Study Working Group. Reduction in child mortality in Niger: a Countdown to 2015 country case study. *Lancet* 2012; **380**: 1169–78.
- Afnan-Holmes H, Magoma M, John T, et al, for the Tanzanian Countdown Country Case Study Group. Tanzania's countdown to 2015: an analysis of two decades of progress and gaps for reproductive, maternal, newborn, and child health, to inform priorities for post-2015. *Lancet Glob Health* 2015; **3**: e396–409.
- The World Bank. Malawi population, total. <http://data.worldbank.org/indicator/SP.POP.TOTL/countries/MW?display=graph> (accessed Dec 8, 2015).
- Interagency Group on Mortality Estimation (IGME). Child mortality estimates. <http://www.childmortality.org/> (accessed May 30, 2015).
- UNDP. Human development report 2014. Sustaining human progress: reducing vulnerabilities and building resilience. New York: United Nations Development Programme, 2014.
- The World Bank. Malawi GDP per capita, PPP (current international \$). <http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD/countries/MW?display=graph> (accessed May 20, 2015).
- The World Bank. Malawi poverty headcount ratio at \$1.25 a day, PPP (2005 international \$) (% of population), 2010 (latest available data). <http://data.worldbank.org/indicator/SI.POV.DDAY/countries/MW?display=graph> (accessed May 20, 2015).
- Bryce J, Victora CG, Boerma T, Peters DH, Black RE. Evaluating the scale-up for maternal and child survival: a common framework. *In Health* 2011; **3**: 139–46.
- National Statistics Office of Malawi, Macro International. Malawi Demographic and Health Survey 2000. Zomba, Malawi, and Calverton, MD: National Statistics Office of Malawi and Macro International, 2001.
- National Statistics Office of Malawi, ORC Macro. Malawi Demographic and Health Survey 2004. Calverton, MD: National Statistics Office of Malawi and ORC Macro, 2005.
- National Statistical Office of Malawi. Malawi Demographic and Health Survey 2010. Zomba, Malawi, and Calverton, MD: National Statistics Office of Malawi and ICF Macro, 2011.
- National Statistics Office of Malawi, UNICEF. Malawi Multiple Indicator Cluster Survey 2006, final report. Lilongwe, Malawi: National Statistical Office and UNICEF, 2008.
- National Statistical Office of Malawi. Malawi MDG Endline Survey 2014. Zomba, Malawi: National Statistical Office, 2015.
- Efron B, Tibshirani R. An introduction to the bootstrap. Boca Raton, FL: Chapman and Hall/CRC, 1993.
- Liu L, Oza S, Hogan D, et al. Global, regional, and national causes of child mortality in 2000–13, with projections to inform post-2015 priorities: an updated systematic analysis. *Lancet* 2015; **385**: 430–40.
- Walker N, Tam Y, Friberg IK. Overview of the Lives Saved Tool (LiST). *BMC Public Health* 2013; **13** (suppl 3): S1.
- Fischer Walker CL, Fontaine O, Black RE. Measuring coverage in MNCH: current indicators for measuring coverage of diarrhea treatment interventions and opportunities for improvement. *PLoS Med* 2013; **10**: e1001385.
- Bhutta ZA, Das JK, Bahl R, et al, for the Lancet Newborn Interventions Review Group, and the Lancet Every Newborn Study Group. Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? *Lancet* 2014; **384**: 347–70.

- 26 Alkema L, New JR, Pedersen J, You D, and the UN Inter-agency Group for Child Mortality Estimation, and the Technical Advisory Group. Child mortality estimation 2013: an overview of updates in estimation methods by the United Nations Inter-agency Group for Child Mortality Estimation. *PLoS One* 2014; **9**: e101112.
- 27 WHO. Everybody's business. Strengthening health systems to improve health outcomes. WHO's framework for action. Geneva: World Health Organization, 2007.
- 28 Government of Malawi. Malawi National Health Accounts with sub-accounts for HIV/AIDS, Malaria, Reproductive Health, and Child Health for 2006/07, 2007/08 and 2008/09. Lilongwe, Malawi: Ministry of Health, Department of Planning and Policy Development, 2012.
- 29 Government of Malawi. Malawi National Health Accounts with Sub-Accounts for HIV/AIDS, Malaria, Reproductive Health, and Child Health for 2009/10, 2010/11 and 2011/12. Lilongwe, Malawi: Ministry of Health, Department of Planning and Policy Development, 2014.
- 30 Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: an application to educational enrollments in states of India. *Demography* 2001; **38**: 115–32.
- 31 Zimba E, Kinney MV, Kachale F, et al, and the Malawi Newborn Change and Future Analysis Group. Newborn survival in Malawi: a decade of change and future implications. *Health Policy Plan* 2012; **27** (suppl 3): iii88–103.
- 32 Lawn JE, Kinney MV, Black RE, et al. Newborn survival: a multi-country analysis of a decade of change. *Health Policy Plan* 2012; **27** (suppl 3): iii6–28.
- 33 Black RE, Allen LH, Bhutta ZA, et al, and the Maternal and Child Undernutrition Study Group. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* 2008; **371**: 243–60.
- 34 Organisation of African Unity. Abuja declaration on HIV/AIDS, tuberculosis and other related infectious diseases. African Summit on HIV/AIDS, Tuberculosis and Other Infectious Diseases; Abuja, Nigeria; April 24–27, 2001.
- 35 Hsu J, Berman P, Mills A. Reproductive health priorities: evidence from a resource tracking analysis of official development assistance in 2009 and 2010. *Lancet* 2013; **381**: 1772–82.
- 36 Department for International Development (DFID). Evaluation of Malawi's emergency human resources programme. Cambridge, MA: Management Sciences for Health, Management Solutions Consulting, 2010.
- 37 Bayley O, Colbourn T, Nambiar B, et al. Knowledge and perceptions of quality of obstetric and newborn care of local health providers: a cross-sectional study in three districts in Malawi. *Malawi Med J* 2013; **25**: 105–08.
- 38 Gilroy KE, Callaghan-Koru JA, Cardemil CV, et al, and the CCM-Malawi Quality of Care Working Group. Quality of sick child care delivered by Health Surveillance Assistants in Malawi. *Health Policy Plan* 2013; **28**: 573–85.
- 39 Callaghan-Koru JA, Gilroy K, Hyder AA, et al. Health systems supports for community case management of childhood illness: lessons from an assessment of early implementation in Malawi. *BMC Health Serv Res* 2013; **13**: 55.
- 40 The World Bank. Malawi GNI per capita, PPP (current international \$). <http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD/countries/MW?display=graph> (accessed Sept 16, 2015).
- 41 The World Bank. Malawi poverty gap at \$1.25 a day (PPP) (%). <http://data.worldbank.org/indicator/SI.POV.DDAY/countries/MW?display=graph> (accessed Sept 16, 2015).
- 42 The World Bank. Malawi inflation, consumer prices (annual %). <http://data.worldbank.org/indicator/FP.CPI.TOTL.ZG/countries/MW?display=graph> (accessed Sept 16, 2015).
- 43 The World Bank. Malawi prevalence of HIV, total (% of population ages 15–49). <http://data.worldbank.org/indicator/SH.DYN.AIDS.ZS/countries/MW?display=graph> (accessed Sept 16, 2015).
- 44 The World Bank. Malawi prevalence of HIV, female (% ages 15–24). <http://data.worldbank.org/indicator/SH.HIV.1524.FE.ZS/countries/MW?display=graph> (accessed Sept 16, 2015).
- 45 The World Bank. Malawi fertility rate, total (births per woman). <http://data.worldbank.org/indicator/SP.DYN.TFRT.IN/countries/MW?display=graph> (accessed Sept 16, 2015).
- 46 The World Bank. Malawi contraceptive prevalence (% of women ages 15–49). <http://data.worldbank.org/indicator/SP.DYN.CONU.ZS/countries/1W-MW?display=graph> (accessed Sept 16, 2015).
- 47 The World Bank. Malawi urban population (% of total). <http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS/countries/MW?display=graph> (accessed Sept 16, 2015).
- 48 The World Bank. Malawi depth of the food deficit (kilocalories per person per day). <http://data.worldbank.org/indicator/SN.ITK.DFCT/countries/MW?display=graph> (accessed Sept 16, 2015).
- 49 Ministry of Health, Government of Malawi, ICF International. Malawi Service Provision Assessment (MSPA) 2013–14. Lilongwe, Malawi, and Rockville, MD: Ministry of Health and ICF International, 2014.
- 50 Kukutschka RMB. Overview of corruption in Malawi. Anti-Corruption Helpdesk, Transparency International, 2014. http://www.transparency.org/whatwedo/answer/malawi_overview_of_corruption_and_anti_corruption (accessed Sept 24, 2015).
- 51 Lohela TJ, Campbell OMR, Gabrysch S. Distance to care, facility delivery and early neonatal mortality in Malawi and Zambia. *PLoS One* 2012; **7**: e52110.
- 52 Ministry of Health, Government of Malawi. Integrated Management of Childhood Illness health facility survey. Lilongwe, Malawi: Ministry of Health, 2004. http://www.afro.who.int/index.php?option=com_docman&task=doc_download&gid=649 (accessed Sept 30, 2015).
- 53 Countdown to 2015 for Maternal Newborn and Child Survival. Tracking progress in maternal, newborn and child survival: the 2008 report. <http://www.countdown2015mnch.org/reports-and-articles/previous-reports/2008> (accessed Jan 12, 2015).
- 54 Countdown to 2015 for Maternal Newborn and Child Survival. Countdown to 2015 decade report (2000–2010). <http://www.countdown2015mnch.org/reports-and-articles/previous-reports/2010-decade-report> (accessed Jan 12, 2016).
- 55 Countdown to 2015 for Maternal Newborn and Child Survival. Building a future for women and children: the 2012 report. <http://www.countdown2015mnch.org/reports-and-articles/previous-reports/2012-report> (accessed Jan 12, 2016).
- 56 Ministry of Health, Government of Malawi. Assessment of emergency obstetric care services in Malawi. Lilongwe, Malawi: Ministry of Health, 2005.
- 57 Ministry of Health, Government of Malawi. Malawi 2010 EmONC needs assessment: final report. Lilongwe, Malawi: Ministry of Health, 2010.
- 58 March of Dimes, PMNCH, Save the Children, WHO. Born too soon: the global action report on preterm birth. Geneva: World Health Organization, 2012.
- 59 van den Broek NR, Jean-Baptiste R, Neilson JP. Factors associated with preterm, early preterm and late preterm birth in Malawi. *PLoS One* 2014; **9**: e90128.
- 60 Institute for Health Metrics and Evaluation. Financing global health 2013: transition in an age of austerity. Seattle, WA: Institute for Health Metrics and Evaluation, 2014.
- 61 Requejo JH, Bryce J, Barros AJ, et al. Countdown to 2015 and beyond: fulfilling the health agenda for women and children. *Lancet* 2015; **385**: 466–76.