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UNDER-FIVE MORTALITY REDUCTION IN RWANDA

June 2020



NAVIGATING THIS EXEMPLAR NARRATIVE

This document is an excerpt from one of the country narratives on our platform (<https://www.exemplars.health>).

Each country narrative contains the same set of elements. To ease the navigation of this narrative, we have summarized the elements here.

EXECUTIVE SUMMARY—WHY IS RWANDA AN EXEMPLAR?

An overview that includes indicators to measure the progress achieved by the country and a summary of the policies, programs, and strategies we believe helped the country make that progress.

WHAT DID RWANDA DO?

This section contains an explanation of the programs that proved critical in helping the country make progress.

CONTEXT

This section provides background on the country's historical, economic, and cultural circumstances, focusing on factors that may have helped or hindered its progress.

HOW DID RWANDA IMPLEMENT?

This section identifies the strategies for implementation that helped key programming achieve and maintain scale and impact.

MILESTONES

A graphic illustrating the turning points in the country's efforts to achieve success.

CHALLENGES

This section provides an overview of some of the challenges, both resolved and unresolved, that the country must overcome to achieve enduring impact.

METHODOLOGY

An overview of the data, frameworks, and approach our research partners utilized to arrive at their conclusions.

EXEMPLARS IN GLOBAL HEALTH

EXEMPLARS IN GLOBAL HEALTH AIMS TO HELP PUBLIC HEALTH DECISION MAKERS AROUND THE world find success at scale. With input from in-country and global experts, we analyze countries that have made extraordinary progress in important health outcomes and disseminate the key takeaways. Our hypothesis is that the lessons contained in this growing list of data-driven narratives will be a resource to leaders committed to improving health and achieving success in their countries.

We use all available and globally accepted data sets within an identified time horizon to pinpoint countries that outperformed peers in key areas of public health, controlling for factors like economic growth. Guided by research partners and technical advisors, we also consider geographic diversity, data availability, and research feasibility to select Exemplar countries. We then conduct further research and analysis to validate our initial assessment.

The Exemplars in Global Health program has identified a set of countries that have made notable progress in curbing mortality rates among children under the age of five. This under-five mortality (U5M) report seeks to identify the policies and practices that have made these gains possible—and to determine which of them might be applicable elsewhere.

Child mortality is a fundamental benchmark of public health and societal advancement, and by this standard, the human condition has improved significantly in recent decades.

The number of children who die before reaching their fifth birthday has been cut in half—from 12.1 million in 1990 to 5.8 million in 2015—even as the global population has continued to climb. This remarkable decline in U5M has resulted in the saving of 122 million children's lives over a decade and a half.

This achievement reflects the widening adoption of well-established practices, notably vaccination against childhood diseases and the improvement of basic primary-care systems in rural and impoverished areas.

Yet there are important national variations in the fight against under-five mortality, and distinctive lessons to be drawn from the experience of specific countries. The Exemplars in Global Health Program and its research partners are studying those success stories in detail, to identify policies and practices that other countries may use to generate further progress against U5M.

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WHY IS RWANDA AN EXEMPLAR?

IN THE TWO DECADES FOLLOWING A GENOCIDE THAT KILLED NEARLY ONE MILLION PEOPLE, displaced another two million, ravaged the public-health sector, and left it one of the most destitute nations on Earth, Rwanda has made extraordinary gains in protecting the lives and health of its youngest citizens.

KEY POINTS

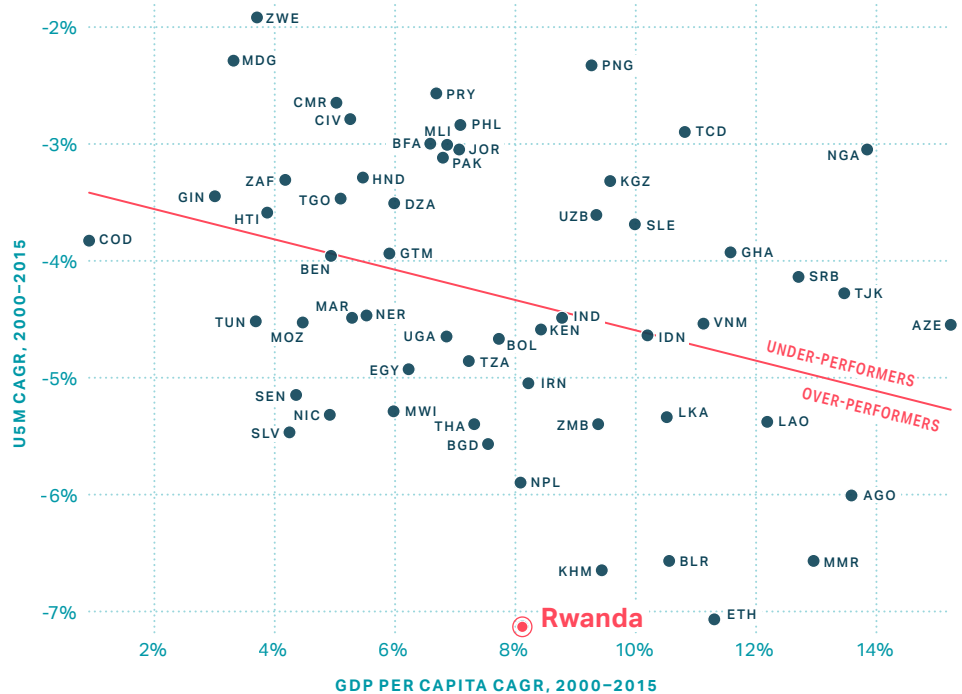
- » In just a decade and a half, this small, landlocked nation has cut its under-five mortality (U5M) rate by 67 percent—achieving outcomes comparable to considerably wealthier African countries.
- » Rwanda’s impressive gains are the result of principles that the Rwandan government upheld over several years, including a system-wide insistence on training and accountability at all levels of the health system; a commitment to health equity and access to care; and the use of evidence-based interventions to generate large-scale improvements in U5M.

In 2000, when it was only six years removed from the genocide, Rwanda’s U5M rate stood at 158 deaths per 1,000 live births. As of 2015, that figure was 52 per 1,000—a 67 percent decline that greatly outpaced expectations based on the country’s gross domestic product and the historical patterns¹ of other nations.² In fact, this small, landlocked, resource-poor country had already achieved a U5M rate comparable with its much wealthier East African neighbors.

Regional and Global Comparisons of U5MR Reduction. Rwanda has outperformed on under-5 mortality indicators relative to expectation based on GDP per capita and GDP growth.

CAGR refers to the compound annual growth rate.

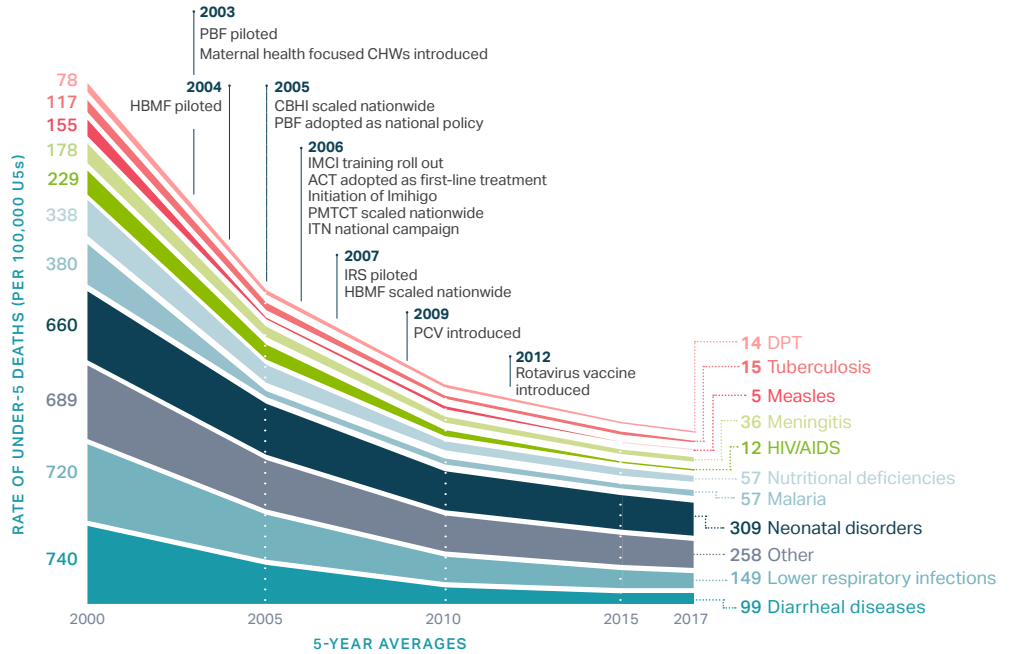
Change in under-5 mortality rate versus change in GDP per capita



Data Source: Institute for Health Metrics and Evaluation (IHME) GBD 2017, World Bank

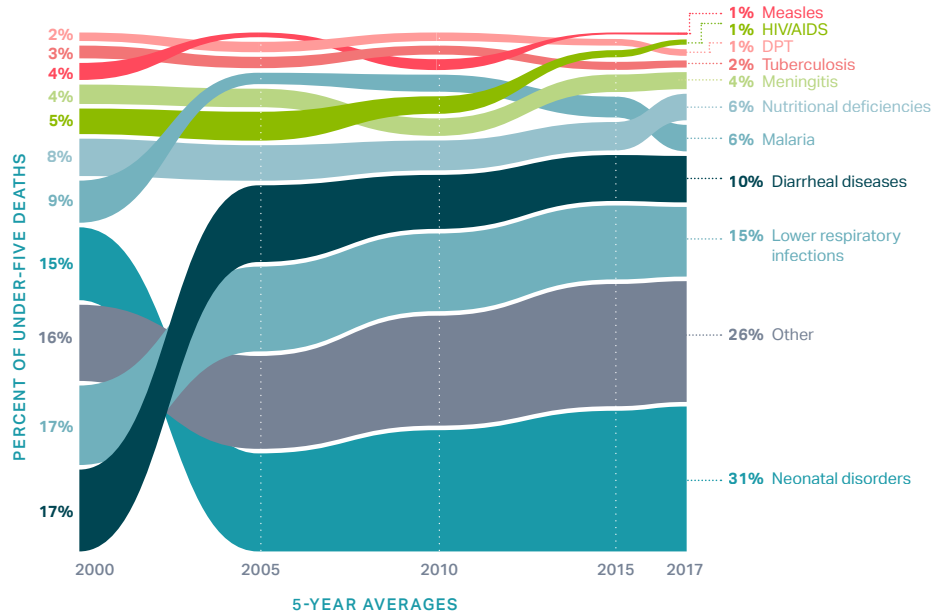
Embedded in the overall rate are some even more extraordinary gains against specific diseases. While every major cause of U5M in Rwanda has diminished since 2000, measles deaths have plummeted to nearly zero (from a rate of 267 deaths per 100,000 U5 population in 2000 to 3 per 100,000 in 2015), while death rate due to malaria has plunged from 517 per 100,000 U5 population to 81 per 100,000 in 2015.¹

Under-five mortality in Rwanda over time, death rates per 100,000 children under five



Data Source: Institute for Health Metrics and Evaluation (IHME) GBD 2017

Under-five causes of death in Rwanda over time

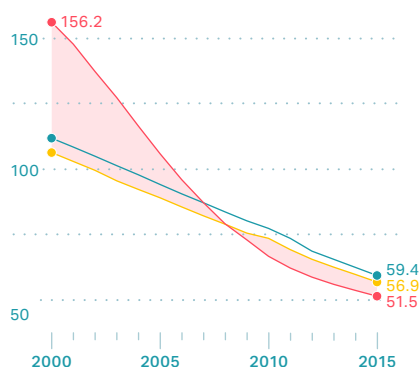


Data Source: Institute for Health Metrics and Evaluation (IHME) GBD 2017

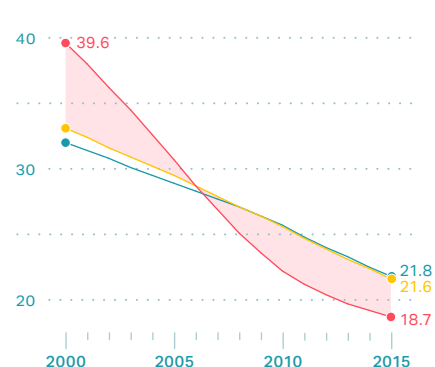
Rwanda has outperformed across other indicators relative to East African and Countdown to 2030 peers.

— RWANDA — EAST AFRICA AVG — COUNTDOWN 2030 AVG

UNDER-5 MORTALITY RATE



NEONATAL MORTALITY RATE



East Africa as indicated includes Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, Rwanda, Somalia, South Sudan, Tanzania, Ugandan and Zambia

Data Source: Institute for Health Metrics and Evaluation (IHME) GBD 2017

As has been the case with many other countries in the region, Rwanda’s mortality reductions have been concentrated in the post-neonatal time period; 80 percent of the overall U5M decline represents post-neonatal survival. Neonatal mortality also decreased, though at a slower rate: from 40 deaths per 1,000 live births in 2000 to 19 per 1,000 in 2015.¹

How is it possible that a nation facing Rwanda’s many disadvantages could achieve such notable gains over such a relatively short period? While improvement of their economy was indeed a contributing factor (its annual GDP averaged 8.1 percent growth between 2000 and 2015,³ and the human development index score rose by 52 percent from 2000 to 2015⁴), five primary drivers stand out:

- » Commitment to “horizontal” health system improvements
- » Government-led donor/NGO coordination
- » Strong community-based health services
- » Emphasis on data and evidence
- » Decentralization of authority and responsibility

Broadly speaking, these five drivers manifested themselves in the effective implementation of evidence-based interventions to reduce child mortality. Rwanda’s success also reflects broader contextual factors that both facilitated interventions and indirectly reduced child mortality, through improvements in risk factors, improved overall health status, and resiliency of children and families.

References

- 1 Institute for Health Metrics and Evaluation (IHME). Global Burden of Disease (GBD) 2016. Seattle, WA.
- 2 Under-five mortality rates estimated from alternative sources indicate a 79 percent reduction during this period from 195 to 41 per 1,000 live births (UN Inter-Agency Group for Child Mortality Estimates. <http://www.childmortality.org/> or a 74 percent reduction from 196 to 50 per 1,000 live births (ICF, 2015. The DHS Program STATcompiler. Funded by USAID. <http://www.statcompiler.com>. September, 2018).
- 3 Rwanda GDP Estimates, World Bank, <http://databank.worldbank.org>
- 4 United Nations Development Programme, Human Development Reports, <http://hdr.undp.org/en/data>, Accessed Nov 1, 2018.

WHAT DID RWANDA DO?

KEY POINTS

- » The government prioritized a shift from disease-specific “vertical” strategies towards a more comprehensive “horizontal” approach, as evidenced by the development of integrated community case management (iCCM) for diarrhea and pneumonia.
- » Rwanda deployed a variety of major programs to address malaria and malnutrition, prevent mother-to-child transmission of HIV, vaccinate against pneumonia and rotavirus, and improve neonatal outcomes.
- » Rwanda’s community health workers played a key role in expanding coverage of these interventions.

MALARIA TREATMENT AND PREVENTION

Home-based management of fever (HBMF) and integrated community case management (iCCM)

By 2004, Rwanda had learned that Kenya and Uganda were using trained volunteers to screen children with fevers as a way to identify and treat cases of malaria.³ Rwanda soon followed their lead and expanded its CHW program to include management of childhood illnesses, starting with the adoption of home-based management of fever (HBMF).

Over a two-year pilot program, the health ministry tested CHW delivery of HBMF in six districts.⁴ In most locations, the proportion of children receiving treatment within 24 hours of the onset of fever had increased to more than 80 percent, and health centers were reporting fewer cases of malaria.⁴ Such early treatment is critical to the reduction of malaria fatality rates.

After the nationwide rollout of HBMF, rates of fever treatment for children under five within 24 hours of onset increased to 63 percent in 2008, 84 percent in 2009, and 89 percent in 2010.⁶

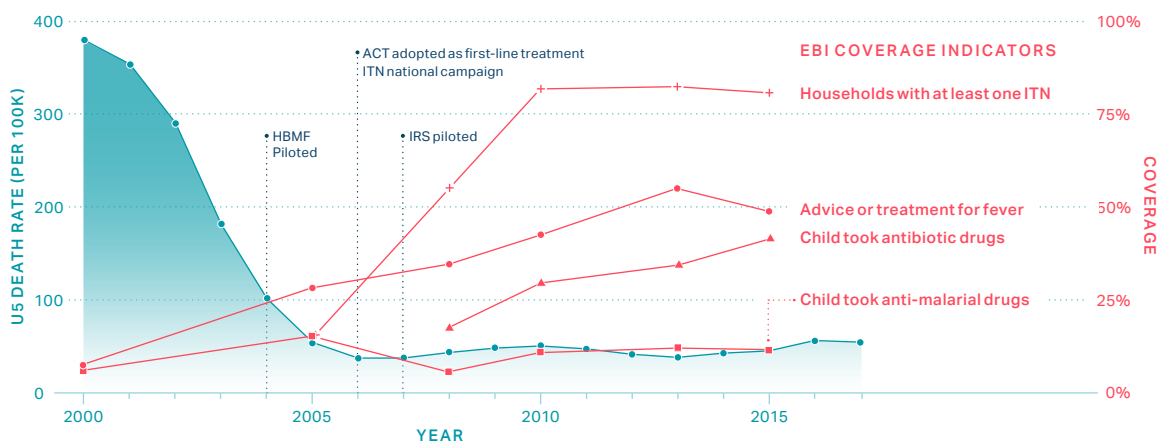
However, the systematic association of fever with malaria led to overdiagnosis,⁷ and in 2008, the ministry piloted the training of CHWs to use rapid diagnostic tests (RDTs) for malaria in order to treat only confirmed cases of the disease. In addition, CHWs began distributing bednets and training village residents on their proper use.

At the same time that it was ramping up the nationwide HBMF campaign, the MOH looked into expanding the CHWs’ responsibilities to include integrated community case management (iCCM) of diarrhea and pneumonia in children under five. This approach aims to support the integration of delivery of treatments to children for diarrhea, pneumonia and malaria by community health workers.

Following a pilot program and a close review of Senegal’s successful iCCM implementation,⁸ the MOH approved a nationwide inclusion of iCCM into the CHW portfolio.

Just one year after the 2008 implementation of iCCM, districts saw increases in the number of children receiving treatment for diarrhea and pneumonia.⁸ These early interventions eventually translated into lower rates of severe illness and mortality; overall U5M declined by 38 percent and health facility use went down by 15 percent.⁸

Malaria mortality and intervention coverage in Rwanda



Data Source: Demographic and Health Survey (DHS); IHME GBD 2017

Insecticide-treated bednets

In 2000, malaria was among the leading causes of death for children under five in Rwanda, killing just over 380 per 100,000.⁹ By 2015 the malaria U5M rate was 47 per 100,000. A nationwide campaign to distribute insecticide-treated bednets was the centerpiece strategy of this achievement.

During the late 1990s and early 2000s, Rwanda distributed non-treated bednets to pregnant women; children under five; and people with HIV.¹⁰ In 2006, the MOH began a mass distribution campaign that issued more than three million ITNs within a year.

As a result of this campaign, the percentage of the population sleeping under ITNs increased from 13 percent in 2005 to 28 percent in 2006, and then to 59 percent in 2007.¹¹ Rwanda embarked on another country-wide campaign in 2008 and 2009, distributing over six million additional ITNs and banning the importation of untreated nets.¹²

The decline in malaria cases changed unexpectedly in 2009, when 28 of 30 districts reported sudden upticks in malaria incidence and mortality.¹³ In an important example of how Rwanda’s rigorous ongoing monitoring-and-evaluation processes could head off problems and improve long-term outcomes, the problem was swiftly identified—and traced to the bednets themselves.

While the WHO had certified the nets to be effective for three to five years, independent tests showed that the efficacy of the ITNs had actually begun to decline at only 18 months. By the end of 2009, effective ITN coverage had fallen to 24 percent.¹³

The MOH responded by analyzing health data to identify the places where coverage rates had declined most sharply. It then strategically distributed its remaining ITNs to those areas. Using the same data, the ministry applied successfully for a Global Fund grant for another mass-distribution campaign targeting the districts at highest risk and replacing ITNs every two years. By 2010, 82 percent of homes possessed at least one mosquito net, and 70 percent of all children under five slept beneath one.¹⁴

Indoor residual spraying

Indoor residual spraying (IRS) has advanced more slowly than ITNs, due to its relatively high costs.¹⁵ Three districts in Kigali underwent a US President’s Malaria Initiative (PMI)-supported pilot spraying program in 2007, with five additional high-transmission districts included over the following two years.

Altogether, the seven districts in the spraying program represented approximately 70 percent of Rwanda’s malaria caseload,¹⁶ and IRS coverage in the targeted areas ranged from 87 percent to 99 percent.¹⁷

A five-district PMI-sponsored IRS campaign took place in 2011,¹⁸ with three-district campaigns occurring over the 2012–2014 period, and a fourth district added in 2015.¹⁸ All districts targeted for IRS are selected based on their relatively high rates of malaria.

A statistical analysis from the Institute for Health Metrics and Evaluation (IHME) found that 2.0 percent of the reduction in under-five deaths was attributable to insecticide-treated nets and indoor residual spraying.⁷¹

Malaria diagnosis and treatment protocol updates

In 2001, Rwanda changed its first-line antimalarial treatment from chloroquine to amodiaquine and sulfadoxine-pyrimethamine (AQ+SP) based on resistance monitoring within the country.¹⁹

Five years later, the MOH introduced artemisinin-based combination therapy (ACT) as the nation’s new first-line treatment for facility-based care.²⁰ After health centers showed sharp drops in malaria mortality in children with this change in treatment, the MOH adopted ACT in 2007 as the first-line treatment in community settings as well.

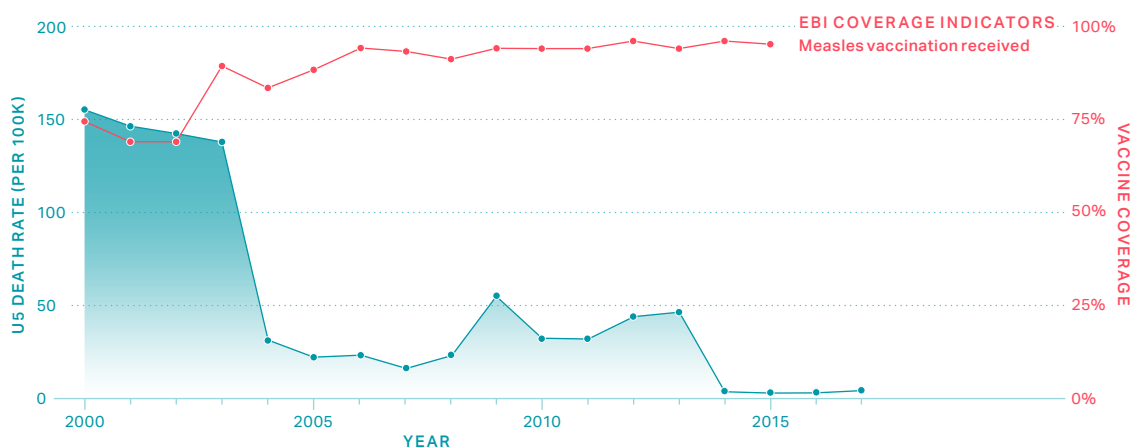
As a result of these and other interventions, malaria’s death rate was reduced by 88 percent among children under five during the period from 2000 to 2015.⁹

MEASLES VACCINE

Rwanda’s campaign against measles represented one of the nation’s earliest U5M interventions and became a model for later achievements—especially in vaccine delivery.

Measles vaccine was introduced in Rwanda in 1980, and national coverage of the vaccine ranged between 74 and 89 percent prior to the 1994 genocide.²¹ By 1995, just after the genocide and destruction of the health sector, measles became one of the leading causes of death for children under five.⁹

Measles mortality and vaccine coverage in Rwanda



Data Source: Demographic and Health Survey (DHS); IHME GBD 2017

By 2002, measles vaccination rates had recovered to just below pre-genocide levels—69 to 74 percent—with thousands of cases still occurring each year.²⁴ In 2003, the vaccination rate increased to 90 percent and the vaccination rate has remained in the nineties since 2006.²²

With the rapid expansion of the vaccination program, cases of measles decreased from over 3,000 deaths in 2000 to hundreds annually by 2004, and to only six nationwide by 2008.²³ Rwanda has set a goal to eliminate measles by 2020—an objective no other African nation has yet achieved.

The national government has established a technical committee to consider the introduction of new vaccines, and this body supported the rollout of a measles-rubella (MR) combined vaccine in 2012. In 2013, the MOH began a program to administer the MR vaccine to all children from nine months to 15 years old. The campaign targeted sites including schools, community centers, and border stations, as well as hospitals and clinics.

The MOH used a household survey to identify and target regions with low coverage.²⁴ By the time the campaign ended, 93 percent of Rwandan children had undergone a full vaccination round for measles and rubella.²⁵ As a result of the MR campaign, measles deaths have plummeted to nearly zero (from a rate of 155 per 100,000 population under 5 in 2000 to 4 per 100,000 in 2015).⁹

The success of the measles vaccination campaigns has given Rwanda an EBI template for maintaining high vaccine coverage for other diseases. Thanks to a comprehensive diphtheria-pertussis-tetanus (DPT) vaccination program from 2000 to 2015, Rwanda has seen low incidence of that disease since 2005.²⁶

Nor have there been any documented cases of polio since 2000—again, thanks to a thoroughgoing vaccination program that reached virtually the entire population.²⁷

However, challenges remain. With the flow of refugees into Rwanda, primarily from Burundi and the Democratic Republic of the Congo, there is still a significant risk of measles outbreaks among the unvaccinated.

PCV VACCINATION CAMPAIGN

Along with other lower-respiratory infections (LRIs), pneumonia has been the leading cause of death for children under five throughout the period covered by this report.⁹ To address this, Rwanda has introduced two pneumonia vaccines—the pneumococcal conjugate vaccine (PCV) and Haemophilus influenzae type B vaccine (HiB).

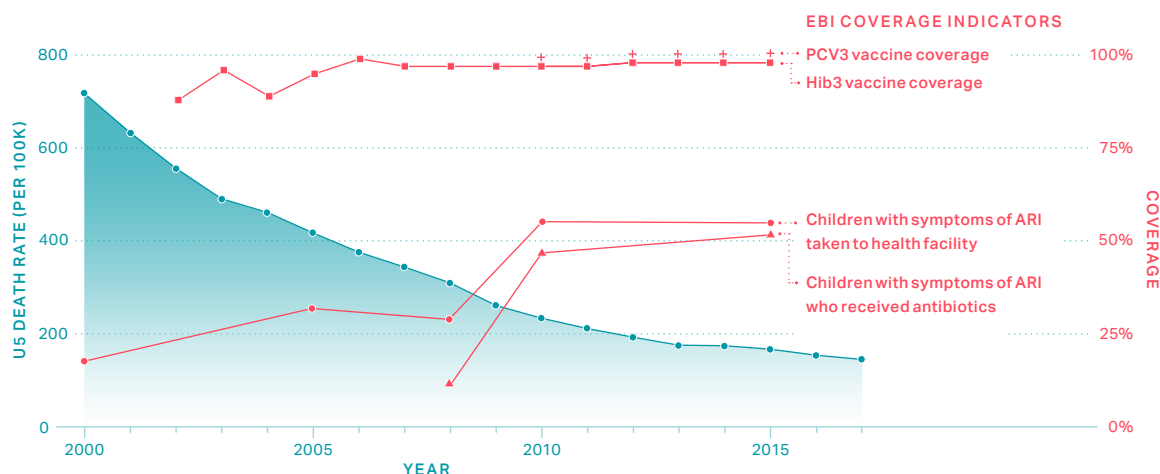
The success of the vaccination introductions is a major factor in the sharp decline in LRI deaths from 2000 (720 deaths per 100,000) to 2015 (170 per 100,000 children).⁹

In 2007, the WHO added PCV to its list of recommended routine childhood immunizations.²⁸ Two years later, Rwanda became the first country in sub-Saharan Africa to deploy PCV.²⁹

Rwanda completed the rollout within five months, and vaccination coverage levels have remained at around 97 percent since 2010.²⁷ In 2011, Rwanda switched from PCV-7 to the newly available PCV-13, which protected against six more strains of the bacteria, and required less cold storage space and lower incineration temperatures for waste management.

PCV is now included in the standard pediatric vaccine schedule, and CHWs gather monthly data to identify any gaps in coverage.³⁰

Lower respiratory infections mortality and intervention coverage in Rwanda



Data Source: Demographic and Health Survey (DHS); IHME GBD 2017; WHO/UNICEF Coverage Estimates (2019 global summary)

ROTAVIRUS VACCINATION CAMPAIGN

The PCV drive gave Rwanda the cold chain capacity, the monitoring capacity, and the institutional expertise to carry out similar large-scale vaccine introductions—including a new one targeting diarrhea.³¹

A year after the PCV campaign, the laboratory at the University Teaching Hospital of Rwanda (CHUK) found that 30 percent of hospitalized pediatric patients’ stool samples tested positive for rotavirus.³²

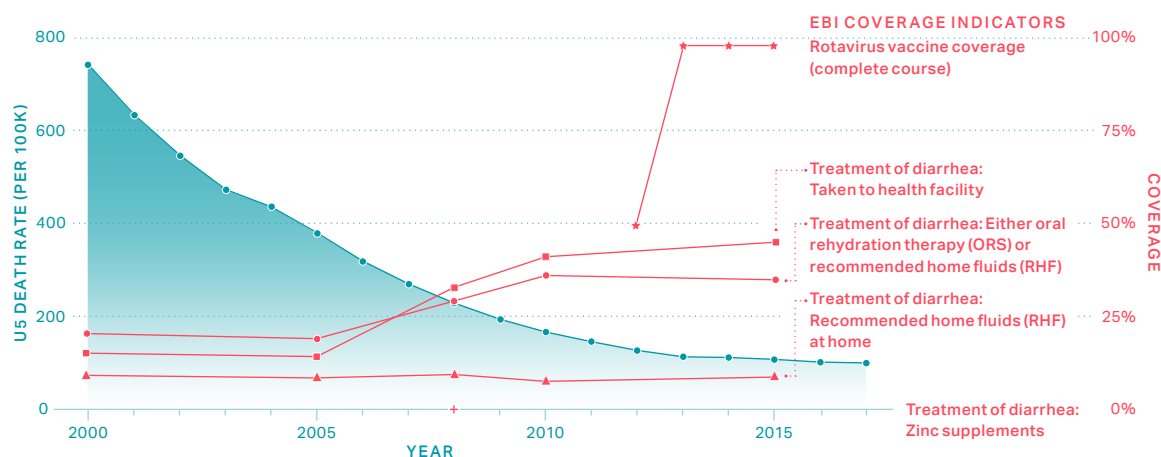
In 2010, Rwanda initiated implementation strategies for the rotavirus vaccine, including further upgrades to the cold chain. In May 2012, Rwanda became the first low-income African country to introduce routine rotavirus vaccinations³³—and the first nation to introduce both the pneumococcal and rotavirus vaccines.

Rotavirus vaccination rates in children under one year of age increased from 50 percent in 2012 to 98 percent in 2013.³⁴

Hospital admissions for severe diarrhea in children under five declined by 49 percent between 2011 and 2013.³⁴ By 2015, U5M attributable to diarrheal diseases had fallen to 106 deaths per 100,000 children under five.⁹

Diarrhea-related hospital admissions tumbled immediately following the introduction of the vaccine among both vaccine-eligible infants (those less than one year of age) and among older children who were not eligible for the vaccine (those between the ages of one and five). This suggested an element of collective protection through reduced transmission—an important additional benefit of Rwanda’s rotavirus-vaccine rollout.³⁶

Diarrheal diseases mortality and intervention coverage in Rwanda



Data Source: Demographic and Health Survey (DHS); IHME GBD 2017; WHO/UNICEF Coverage Estimates (2019 global summary)

Overall, across all vaccines, statistical analysis found that 19.4 percent of the reduction in under-five deaths was attributable to vaccine interventions, including Hib vaccine (6.6 percent), PCV (5.1 percent), DTP3 (3.6 percent), rotavirus vaccine (2.6 percent) and measles first dose vaccine (1.5 percent).⁷¹

PREVENTION OF MOTHER-TO-CHILD TRANSMISSION (PMTCT) PROGRAM

In 1989, the University Teaching Hospital of Rwanda (CHUK) began testing for HIV among pregnant women. And in 1999, the MOH began Rwanda's first prevention of mother-to-child transmission (PMTCT) program. This program included pretest HIV counseling; routine HIV testing at antenatal care visits; and prophylactic antiretroviral treatment (ART) for HIV-positive pregnant women.³⁷

To meet the high demand for PMTCT programs, Rwanda secured over \$75 million in grant funding from UNICEF, the Global Fund, the Elizabeth Glaser Pediatric AIDS Foundation, and other sources to underwrite a national HIV program, including broad-scale PMTCT and ART implementation.

In 2001, the Treatment and Research on AIDS Center (TRAC) defined national goals for PMTCT in the National Strategic Plan against HIV.³⁸ Rwanda enacted the plan four years later. The MOH created a new health-information management system called TRACnet, which drew upon reports submitted by CHWs via mobile phone to provide timely data on HIV cases.³⁹ In 2006, a national scale-up plan was introduced, with the goal of integrating comprehensive PMTCT into community-based maternal and children's health services.⁴⁰

In 2010, Rwanda introduced the Option B treatment regimen for PMTCT, which recommended triple therapy for new mothers from birth through weaning. It was criticized for being costlier than the Option A program, which ceased triple therapy one week after childbirth and had been endorsed by the WHO.⁴¹ The MOH believed that Option B would be most cost-effective option in the long run because it would prevent more new cases of HIV.⁴² Later studies proved these national findings correct.⁴²

When Rwanda implemented Option B, it chose to continue triple therapy for mothers for life. It was not until two years later that the WHO officially recommended this strategy (now known as Option B+) as a superior alternative to Option A.⁴³

By 2009, all health centers in Rwanda offered antenatal care, the main entry point for PMTCT treatment.⁴⁴ Rwanda's MTCT rates came down from 9.7 percent in 2006 to 1.8 percent in 2015.⁴⁵ In 2011, the First Lady of Rwanda launched a campaign to eliminate MTCT in Rwanda, further marking this issue as a national priority.⁴⁶

Rwanda has had greater difficulty implementing early infant diagnosis (EID)—a critical tool for reducing HIV-related mortality. Without treatment, more than half of HIV-positive infants will die by the age of two.

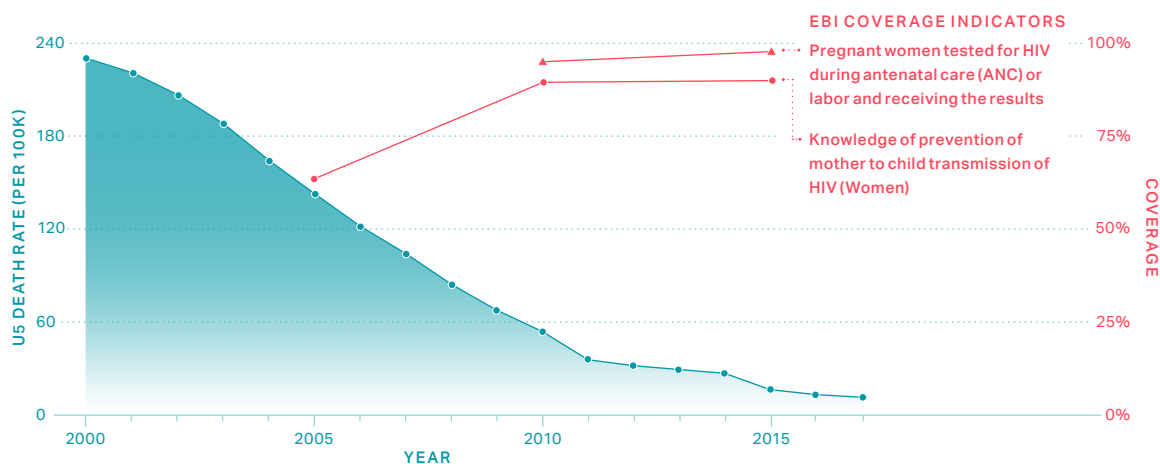
By 2008, half of all health facilities in Rwanda were offering EID services, and 70 percent were doing so by the following year. Yet only 28 percent of children born to HIV-positive mothers were receiving EID.⁴⁷

The MOH organized the first National Symposium on Early Infant Diagnosis in 2009.⁴⁸ This conference assisted the MOH in mapping out specific problems, including poor integration with maternal and child-health programs; delays in the processing of HIV tests; and lack of follow-up with caregivers.⁴⁸

The MOH adopted specific changes in its EID and pediatric ART programs to address these identified gaps, including adjustments of the routine immunization schedule to include HIV testing for exposed infants at six weeks, nine months and 18 months.⁴⁹

Even with these improvements in testing and vastly expanded access to ART, treatment of HIV-positive children remains limited. In 2013, only 60 percent of HIV-positive children up to 14 years old were receiving ART, compared to 95 percent of HIV-positive adults.⁵⁰

HIV/AIDS mortality and intervention coverage in Rwanda



Data Source: Demographic and Health Survey (DHS); IHME GBD 2017

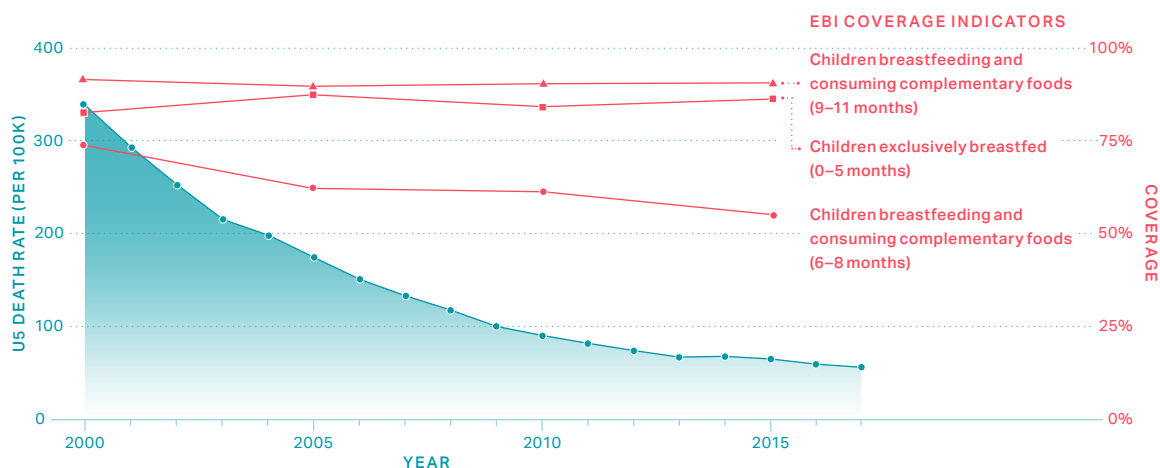
MALNUTRITION INTERVENTIONS

In 2000, 6.8 percent of Rwandan children under five were acutely malnourished and 48 percent of children were stunted.⁵¹ According to the 2003 MOH annual report, severe acute malnutrition was the fourth most common cause of death for children up to one year old, and the second most common cause of death for children between the ages of one and 14.⁵²

In 2009, the President’s Initiative to Eliminate Malnutrition was approved, and 30,000 CHWs were trained in identifying malnutrition in children under five, and in appropriate interventions and referral processes.⁵³

CHWs measure children at monthly community meetings. If a child misses one meeting, the CHW will follow up with a home visit. Parents of children deemed at risk based on their measurements are then invited to “kitchen demonstration activities,” where families bring in food and cook together to learn about nutrition from the CHW. Any children who are deemed malnourished are given ready-to-use therapeutic foods and referred to health facilities for treatment.⁵⁴

Nutritional deficiencies mortality and intervention coverage in Rwanda



Data Source: Demographic and Health Survey (DHS); IHME GBD 2017

Even as Rwanda has led the region in reducing severe acute malnutrition, it has lagged in efforts to reduce chronic malnutrition and stunting. While severe acute malnutrition is the more urgent issue from an infant-mortality standpoint, Rwanda’s difficulty in addressing chronic malnutrition has U5M consequences of its own, given the impact of long-term undernourishment on children’s health, mental abilities, and future earning potential.⁵⁵

To better address chronic malnutrition, the MOH started a new nutrition program to provide free nutrient-rich porridge to children aged six months to two years in the nation’s poorest families.

IMPROVEMENTS IN ANTENATAL AND NEONATAL CARE

Although Rwanda significantly outperformed its regional and global counterparts on U5M overall between 2000 and 2015, its record on neonatal mortality is considerably more modest.⁵⁶

The 2010 Global Burden of Disease report showed that neonatal deaths in Rwanda had increased from 22 percent of all under-five deaths in 2000 to 34 percent in 2010, even as the absolute number of neonatal deaths was decreasing. The mortality rates among infants under one month of age showed the least progress of all.⁵⁷

The Ministry of Health initiated weekly neonatal death audits in 40 public and faith-based health facilities in 2012. Using a standardized questionnaire, all neonatal deaths in these facilities were reported to the Ministry of Health in Kigali.⁵⁸ Based on these findings, the MOH adopted interventions based on specific causes of death affecting newborns, the two most common being asphyxia and complications due to prematurity.⁵⁹

The CHW program began in 2003 to train local traditional birth attendants—who qualify to be animatrices de santé maternelle (ASMs)—to advise women to deliver in health facilities. As noted earlier, these birth attendants also serve as a third community health worker, supplementing the original male-and-female CHW pair. Over the following 15 years, the rate of facility-based delivery increased significantly. This reflects both the work of ASMs encouraging women to deliver in a health facility and the improved quality of care available at health facilities as the number of formally trained health providers grows. As the country established more nursing schools, the number of nurses and midwives nearly tripled from an estimated 3,600 in 2004 to 9,600 in 2015.⁶⁰

In addition, health providers now teach post-partum mothers how to breastfeed while they are still in the health facility. This practice—accompanied by the fact that over 90 percent of Rwandan women now deliver in health facilities—has resulted in a sharp rise in the proportion of children breastfed within one hour of birth, from 41 percent in 2005 to 71 percent in 2010 and 81 percent in 2015.⁶¹

After finding that approximately three-quarters of newborns who died were hypothermic when admitted, the MOH began providing incubators for health facilities. In 2012, it established skin-to-skin contact, or kangaroo mother care (KMC), in its neonatal protocol for premature and low-birth-weight infants.⁶²

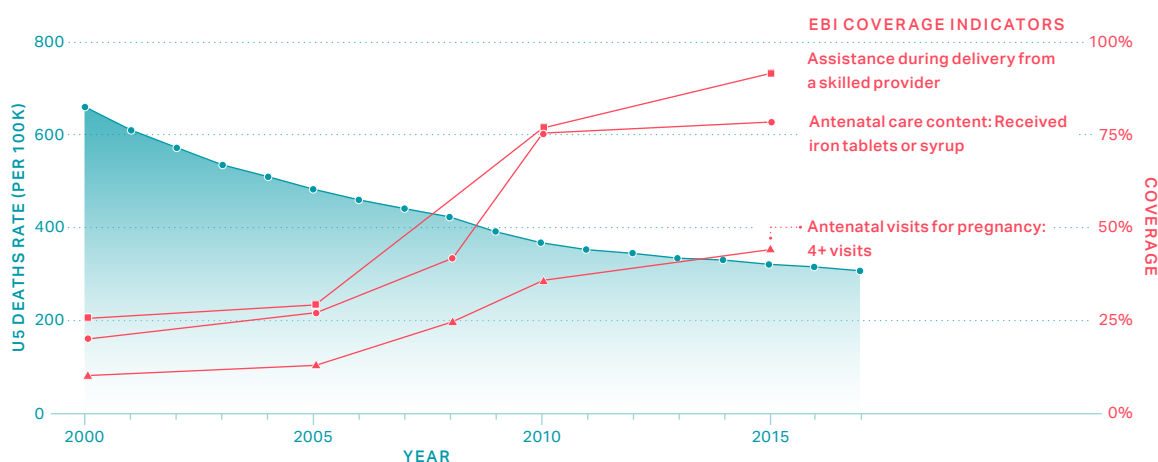
According to a 2012 quality of care study, 100 percent of children born in health facilities in Rwanda are immediately dried with a towel, but only about half of those infants are then placed skin-to-skin with mother or covered with a dry towel or blanket, a proportion that will need to rise if neonatal-survival outcomes are to improve.⁶³

The leading causes of neonatal mortality are now low birth weight, prematurity, and congenital heart disease—factors that will require more advanced neonatal care. An important step will be an increase in the number of women who receive the four or more antenatal-care visits recommended by the WHO.

Rates of ANC by a skilled provider have increased from 25 percent of women in 2000 to 92 percent in 2015.⁶⁴ However, as of 2015, only 44 percent of pregnant women had four or more ANC visits.⁶⁵

Another area for improvement is in the use of partographs—graphical records of health indicators during the labor process, to ensure that health workers throughout a woman’s entire labor process receive an unbroken sequence of vital information. Blank partographs are available at all health facilities, and the use of partographs has been added as an indicator for performance-based financing. While partographs are used in approximately 84 percent of deliveries in health care facilities, only eight percent of them are filled in completely.⁶⁶

Neonatal disorders mortality and intervention coverage in Rwanda



Data Source: Demographic and Health Survey (DHS); IHME GBD 2017

DECOMPOSITION

A decomposition analysis undertaken in collaboration with the Institute for Health Metrics and Evaluation (IHME) at the University of Washington identified the top interventions and risk factors that contributed to reductions in under-five deaths in Rwanda. These interventions and risk factors can be seen in the bottom two bars of the visualization below.

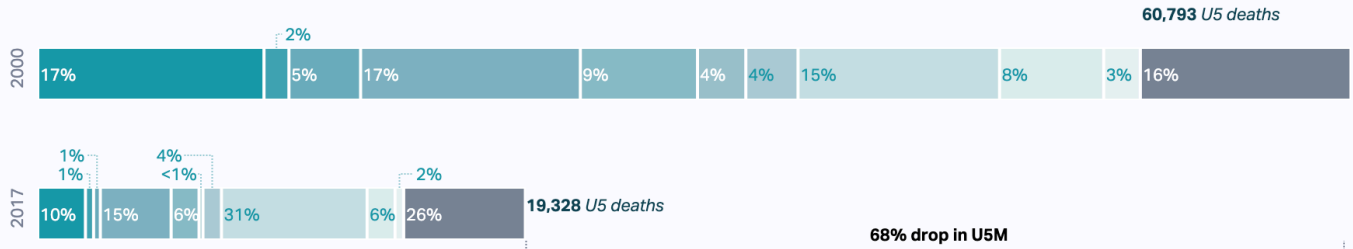
Below are some of the key takeaways from this analysis:

- » Some of the largest contributors to reduction in under-five mortality were health system interventions, which were responsible for 51 percent of the reduction in under-five deaths from 2000 to 2017.
- » Within this, vaccines (especially Hib vaccine, PCV, and DTP3) were a significant factor, and were attributed to 19.4 percent of the reduction.
- » Beyond health system interventions, population age structure, reductions in child growth failure, and reductions in other communicable disease risk factors were also found to have significant contributions to reduction in under-five deaths.⁷¹

Decomposition analysis

TOP COD CONTRIBUTING TO U5M REDUCTION

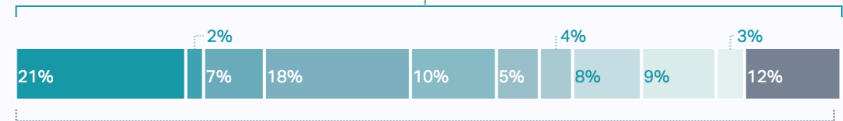
Percent of under-5 mortality



- Diarrheal diseases
- DPT
- HIV/AIDS
- Lower respiratory infections
- Malaria
- Measles
- Meningitis
- Neonatal disorders
- Nutritional deficiencies
- Tuberculosis
- Other

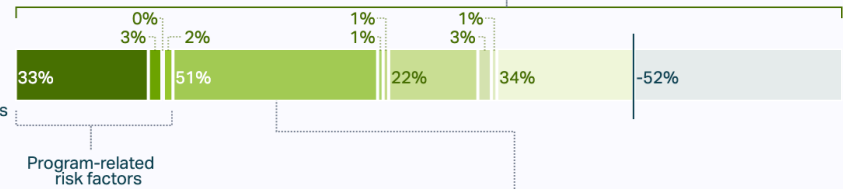
REDUCTION IN CAUSE OF DEATH

Percent of reduction in under-5 mortality



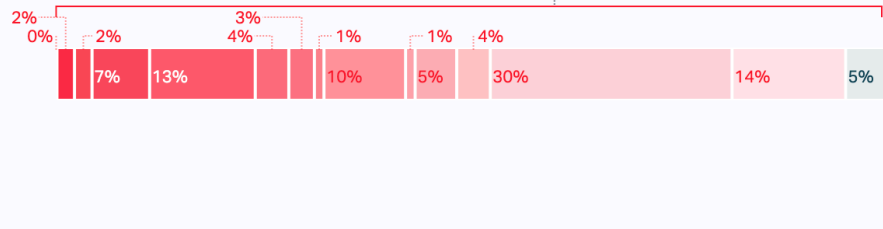
REDUCTION DECOMPOSITION

Proportion of reduction due to each factor, 2000 to 2017



HEALTH SYSTEMS INTERVENTION BREAKDOWN

Proportion of intervention-attributed reduction, 2000 to 2017



Data Source: Analysis from GBD Risk Factors Collaborators, GBD 2017, IHME

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HOW DID RWANDA IMPLEMENT?

KEY POINTS

Rwanda's success in curbing under-five mortality (U5M) has been the result of several distinctive implementation strategies.

- » Rwanda inaugurated a community health worker (CHW) program in 1995 to compensate for a severe shortage of health care workers; the nation now has 45,000 CHWs working across 15,000 villages.
- » Rwanda's campaign to reduce U5M has relied heavily on data and evidence; focused on health care access and equity; and developed a strong institutional culture of accountability.
- » One of the most distinctive features of Rwanda's approach has been its insistence that foreign donors and partners follow—and contribute to—a nationally-led agenda.

THE COMMUNITY HEALTH WORKER (CHW) PROGRAM

Rwanda inaugurated its community health worker (CHW) program in 1995 to compensate for a severe shortage of doctors, nurses, and midwives in the immediate aftermath of the genocide.

At the start of the program, there were 12,000 CHWs. Within a decade, there were 45,000—three for each of Rwanda's approximately 15,000 villages. A CHW trio typically includes one male and one female generalist, plus an animatrice de santé maternelle (ASM) dedicated to maternal health.

Villages—which consist of roughly 100 to 200 households each—elect their own CHWs, who must meet minimum requirements for age and literacy. Once elected, they undergo a standardized six-week training program, with regular refresher sessions thereafter.

CHWs are responsible for general health interventions for the entire community, including for children under five. CHWs are trained in a cascading, train-the-trainer model on their assigned community-health activities, which have varied over time. By 2007, CHWs nationwide had undergone training at their local health centers on home-based management of fever (HBMF).

For this program, the CHWs were taught signs and symptoms of malaria, treatment of disease, warning signs requiring referral to a health facility, drug management, and reporting systems. They used prepackaged medications with instructions in Kinyarwanda, illustrated with drawings to assist both the CHWs and the children's care givers in fidelity and adherence to recommended treatment. Their training has expanded over time to address other significant causes of U5M.

CHWs report each month to the local health center on a series of indicators, the data from which is then fed to district and national reporting systems. When dropping off these monthly reports, CHWs also pick up medications and supplies for their villages.¹²

Although the program is embedded within the national health system, and the system is deeply reliant on their work, the CHWs remain unpaid volunteers. Because of this status, there is concern about the program's sustainability, and worker motivation has been a concern from the start.

To improve retention and morale, Rwanda created a network of CHW-managed cooperatives in 2005, financed through a CHW performance-based financing (PBF) scheme. However, few CHWs have training in finance or management, and the cooperatives have generated little benefit.¹³ To address this problem, the MOH has asked the cooperatives to recruit accountants. In a perhaps more substantive move, the ministry is also overseeing an external evaluation of the CHW model and looking into ways to strengthen it as the nation works to attain the health-related Sustainable Development Goals.

AN EARLY AND CONSISTENT EMPHASIS ON PRIMARY CARE AND U5M

A consistent theme of the research and interviews was the clarity of the Rwandan national government's public health priorities and its insistence on disciplined coordination among ministries, regional officials, donors, and other system participants to achieve the twin goals of a strengthened primary care system and reduced rates of U5M.

An emphasis on primary care generally—and U5M specifically—was evident in the government's Vision 2020 document, which was released in 2000. This ambitious plan was a blueprint for transforming Rwanda into a middle-income nation within two decades, setting goals across multiple sectors. The health portion of Vision 2020 included a specific mandate to reduce U5M and had clear targets against which Rwanda assessed progress annually.¹

According to a former Minister of Health, the intent was to “create a system to build health infrastructure with the objective of equitable geographic distribution, grounded on a strong primary-care platform.”

Some elements would require novel collaborations across ministries. The government created innovative governance structures—such as the Social Cluster for senior officials from the Ministries of Health, Education, and Gender—to meet regularly to develop cross-sectoral policies and plans. This Social Cluster collaborated to address key priorities, including gender-based violence and teenage pregnancies, which required coordination and input across these ministries.

From interviews with key informants and a study of available literature, one feature of Rwanda's primary-care strategy stands out as critically important. The government held fast to a system-wide, “horizontal” vision of primary-care improvement, placing a priority on such fundamentals as clinic construction; personnel training and retention; high-quality data systems; and vaccination delivery infrastructure.

When well-meaning donors earmarked money for disease-specific “vertical” interventions, Rwanda sought wherever possible to steer those funds toward uses that were consistent with broader systemic improvements.

In time, the government's focus on primary care would yield immense dividends, including the reduction of U5M. For example, Rwanda's implementation of the pneumococcal conjugate vaccine was also designed to strengthen future vaccination campaigns, including through cold-chain improvements, monitoring, CHW training, and community engagement. This contributed to the rapid rollout of rotavirus and other vaccines soon afterward. When the government ramped up its efforts against HIV, it designed laboratory and delivery systems so that there was immediate integration with primary-care and other health services.

Beyond the strengthening of its primary-care systems, the payoff of Rwanda's system-minded approach could be quite literal: By meeting basic primary care benchmarks, Rwanda could better meet donors' funding parameters and thereby garner still more funding for general health improvements. For example, by meeting Gavi standards for child vaccinations, Rwanda earned additional funds to strengthen its health system at the government's discretion.²

A GOVERNMENTAL COMMITMENT TO STEERING DONORS AND PARTNERS TOWARD A UNIFIED VISION

The relationship between the Rwandan national government and its outside donors and partners is central to understanding the country's U5M achievements.

One of the most distinctive features of that relationship is Rwanda's insistence that foreign donors and partners follow—and contribute to—a nationally-led agenda.

This has enabled Rwanda to retain national control of its own health policy while benefitting from foreign insight and technical assistance. It can be difficult for recipient nations to maintain true "country ownership" while also receiving outside funding and expertise, but Rwanda has developed a variety of means for sustaining an effective balance.

One is a quarterly meeting between donors and a group of government representatives led by the Ministry of Finance and Economic Planning (MINECOFIN). These meetings assess the quantity and quality of donors' development assistance.

Donors who demonstrate particularly high levels of direct financial support for Rwanda's health sector are permitted to attend the entire budget review process. This has had the dual benefit of keeping important partners apprised of Rwanda's priorities, while also giving them a forum for sharing useful knowledge.

A related donor-coordination mechanism was the Joint Health Sector Reviews (JHSR), which the Minister of Health co-chairs twice a year along with a leading health donor. The forum brings together ministry officials, academics, hospital directors and other partners to assess progress toward health objectives.

Yet even as the national government held its donors close, it took unambiguous steps to make sure everyone understood who wielded ultimate authority. Even during the fragile first decade following the genocide, when much donor funding for health care was earmarked for disease-specific projects, the nascent government strove to ensure that resources were used to build and strengthen primary health care systems.

One interviewee said that if a donor objected to Rwanda's terms, the government "would say no and not take the money." Another described the underlying ethos as "We are in charge and we will tell you what to do. This is a Rwandan program."

One partner who had worked in several other sub-Saharan nations said such an uncompromising emphasis on donor and partner coordination was far from the regional norm; several observers have identified this approach as an important lesson for other countries.

DEVELOPMENT AND SUSTAINMENT OF A STRONG CULTURE OF DATA USAGE FOR DECISION-MAKING

Rwanda's campaign to reduce U5M has relied heavily on collecting, disseminating, and evaluating data. From an early stage, the post-genocide government has emphasized data as an indispensable tool for identifying and addressing a wide range of public health challenges, including U5M.

One interviewee who had worked both within the MOH and with a partner organization said the shift toward a more data-minded health system took some time. Even though health centers and district hospitals had routinely gathered data and sent it to the MOH, "It [was] not really in the culture to analyze that data, to see what happened, and so on."

The ministry set out to build a more sophisticated data culture, beginning at the top. It pushed all department heads at the Ministry of Health and the Rwanda Biomedical Center (RBC) to attain master's degrees, a measure that created a strong internal cadre of technical experts. The ministry has also worked to improve district-level data capabilities, and to empower localities to exploit data for their own decision-making.

These efforts eventually paid off, building data awareness throughout the health policy chain and—as one interviewee put it—enabling the ministry to “produce evidence and science when it may not be available” by generating sound, data-grounded inquiries. In addition, the government was able to draw upon the data expertise of donors and partners through technical working groups.

With these strengthened human and technical capacities in place, the MOH began using data more aggressively to identify gaps and set priorities. In 2010, for example, it reviewed district data to understand where maternal and neonatal deaths were still occurring despite an increase in antenatal care.

This analysis led to an identification of lower-performing districts, whose leaders were then invited to explain both the reasons for their faltering numbers and their plans for improvement.

But the MOH has not merely employed data as a means of exposing underachieving jurisdictions. Consistent with the values of decentralization, the ministry has also worked to improve district-level data capabilities, and to empower localities to exploit data for their own decision-making.

Rwanda’s digital strategy took another important step forward in 2012, when the MOH migrated its Health Management Information System onto a new web-based platform using District Health Information System open-source software (DHIS-2). This made current health data visible to officials and practitioners at all levels of the health system. More than 700 managers and staffers have been trained in DHIS-2, which may be entered from almost any site with an internet connection.³

The development of a data usage culture in turn informed Rwanda’s development of a strong institutional culture of accountability. For example, the national government invoked the concept of *imihigo* (meaning “to vow to deliver”) through creating performance contracts with districts and ensuring districts met the health-related goals specified in these contracts. As such, the culture of data collection and usage enabled the national government to hold districts accountable to key metrics in line with national priorities. (For more information on *imihigo*, see the Context section.)

A further example of developing a culture of accountability was through Rwanda’s application of health data initiatives into performance-based financing (PBF) mechanisms. The MOH piloted a PBF plan in two districts from 2003 to 2005. The success of this trial led to an expanded study of incentive programs in 166 rural health facilities.⁴

That study found significant improvements in the intervention facilities compared with controls, including deliveries at health facilities (a 23 percent improvement), the number of preventative care visits for children under 23 months old (a 56 percent improvement), and the number of such visits for children 24 to 59 months old (a 132 percent improvement).⁴

However, the study also showed that PBF had no significant impact in certain other areas, such as the number of women completing their recommended cycle of four antenatal care appointments. The bottom line was that PBF seemed to work best for services that had the highest payment rates and were the easiest to deliver.⁴

Based on this and other evidence, Rwanda adopted PBF for district hospitals, public health centers, and government-supported nonprofit health centers as part of the 2005-2009 Health System Strategic Plan. Government payments were based on 13 qualitative and 13 quantitative measures, including some directly related to U5M.

Payments were made quarterly, with 80 percent going to the providers themselves, and the remaining 20 percent covering health centers’ non-labor costs such as medical equipment, ambulances, and facility maintenance.⁵

Between 2003 and 2007, PBF funding increased from \$800,000 to \$8.9 million, and wages increased by 60 percent to 100 percent depending on the facility.⁵ From 2005 to 2008, personnel in publicly funded facilities almost doubled, with much of the increase occurring at rural facilities that could now offer better salaries.

A FOCUS ON HEALTH CARE EQUITY AND ACCESS

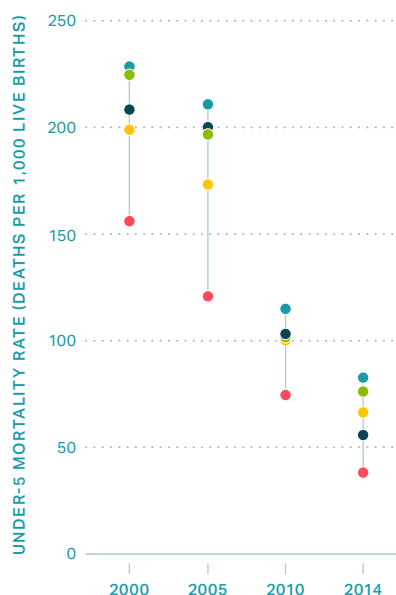
From the start, equity was one of the top health policy priorities for the post-genocide government. For a nation contending with both deep poverty and a legacy of civil strife, this was an understandable and necessary area of emphasis.

Analysis: International Center for Equity in Health, Federal University of Pelotas, Brazil

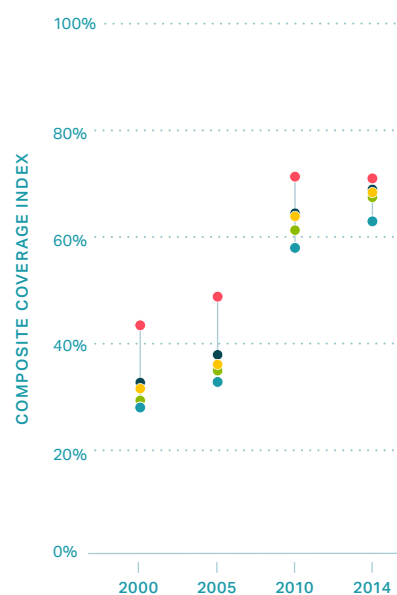
RWANDA 2000–2014
The composite coverage index is the weighted average of the percentage coverage of eight interventions along four stages of the continuum of care: reproductive care; maternal care; childhood immunization; and management of childhood illness.

Under-five mortality rate by wealth quintile

● POOREST ● 2ND ● 3RD ● 4TH ● RICHEST



Countdown composite coverage index by wealth quintile



Data Source: Victora C. Analysis of Rwanda DHS Survey Data

This concern manifested itself in relatively high levels of national health expenditure, including the ambitious rollout of a national health insurance plan. Through these and other measures, the Rwandan government sought to ensure that public health progress touched all economic classes and extended to every corner of the nation’s geography.

To a degree that is unusual among low-income nations, Rwanda has significantly reduced the inequality of U5M outcomes among differing income groups.

As of 2000, the U5M rate for Rwanda’s highest economic quintile was 156 per 1,000 live births, compared with 229 per 1,000 for the lowest economic quintile—an equity gap of 73 deaths per 1,000 live births.¹⁶ By 2014, the U5M rate had sharply decreased for both quintiles: 38 per 1,000 for the wealthiest; 83 per 1,000 for the poorest—a differential of 45 per 1,000.¹⁶

Similar reductions in inequality appeared in the coverage rates for specific interventions, according to the Countdown to 2030 composite coverage index (CCI), a weighted average of the coverage of eight interventions along four stages of the continuum of care: reproductive health; maternal health; immunizations; and childhood-illness management.

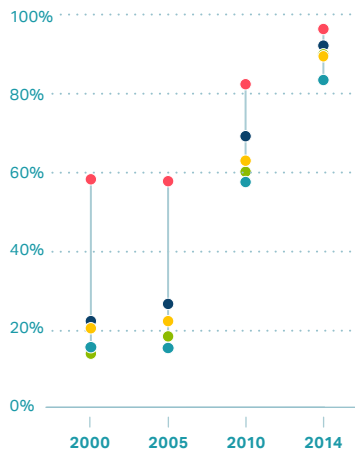
Percent of women with facility-based delivery by wealth quintile and geographic location

Analysis: International Center for Equity in Health, Federal University of Pelotas, Brazil

Facility-based delivery

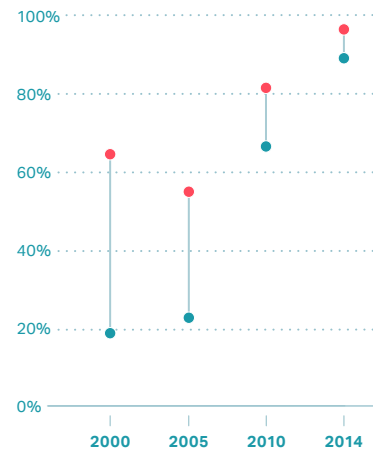
BY WEALTH QUINTILE

● POOREST ● 2ND ● 3RD ● 4TH ● RICHEST



BY GEOGRAPHIC LOCATION

● RURAL ● URBAN



Data Source: Demographic and Health Survey (DHS)

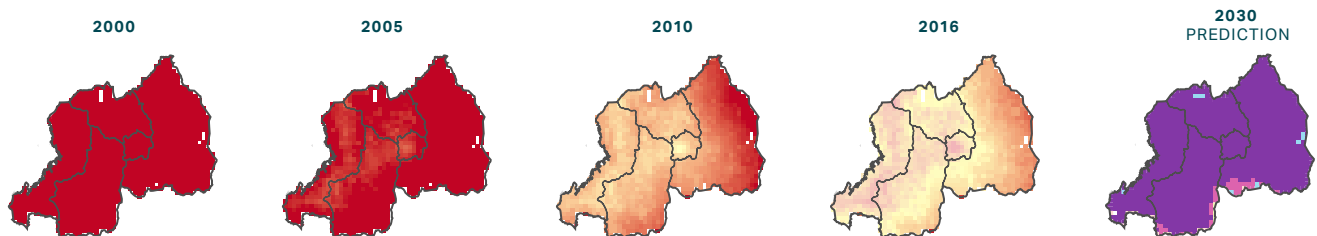
Rwanda’s vaccination campaigns, in particular, achieved high levels of equity across economic strata from an early stage. This is because these campaigns scaled up quickly nationwide, drew upon needs assessments from every village; and integrated closely with community-health programs. As a result of these factors, there tends to be little geographic or socioeconomic variation in vaccination coverage.

For example, measles vaccination rates vary little between urban and rural populations (96.4 percent and 94.9 percent respectively in 2014) or wealth quintile (91.3 percent for the lowest and 97 percent for the highest in 2014).¹⁶

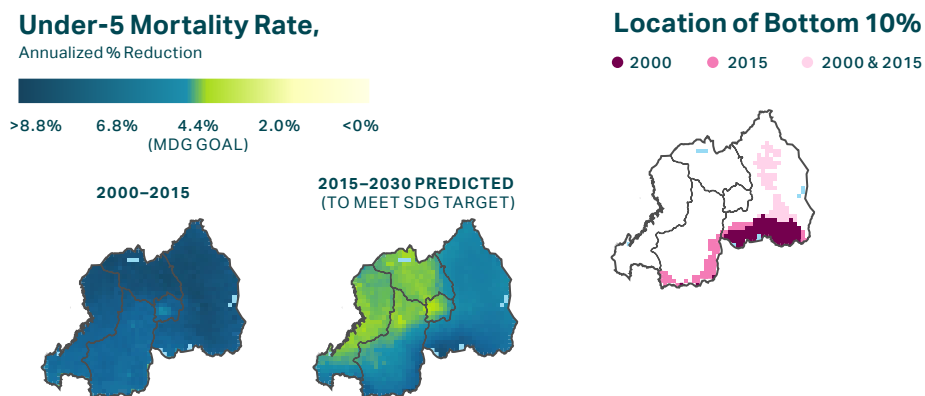
Data from national demographic health surveys for 2000 to 2014 show impressive geographic parity across Rwanda. IHME maps show that no single region of the country is long left behind the others; while U5M continued to decline, the locations of districts with highest rates of U5M in Rwanda have also shifted over time as gains have progressed across Rwanda. The only area that has consistently shown relatively high rates of U5M is the south-central tier along the border with Burundi.

Under-five mortality rate

per 1,000 live births



Data Source: Institute for Health Metrics and Evaluation (IHME) LBD 2017



Data Source: Institute for Health Metrics and Evaluation (IHME) LBD 2017

Thanks in part to its emphasis on decentralization and rural health outreach, Rwanda has narrowed one disparity that bedevils many nations, rich and poor alike—the gap between urban and rural residents.

In 2000, 66 percent of women in Rwanda’s urban areas delivered their babies in a health facility, but only 20 percent of rural women had done so.⁸ By 2014, this margin narrowed as care improved for all groups: 97 percent of women in urban areas were now giving birth in hospitals or clinics—and so were 90 percent of their rural counterparts.⁶

One factor that has supported geographic equity in Rwanda is the government’s consistent emphasis on health infrastructure development. The 2005 National Health Sector Policy identified such development as a top priority for addressing disparities in access. This led to the construction and expansion of hospitals and health centers nationwide.

By 2012, there were five national referral hospitals, 40 district hospitals, 450 health centers, and 157 private health facilities—a respectable level of coverage for a nation only about the size of Haiti, Macedonia, or the U.S. state of Maryland.⁷

On average, each district now has at least one hospital and one health center per 20,000 residents. The average time to reach a health center was 56.5 minutes in 2014, down from 95.1 minutes in 2006.⁸ All told, 60 percent of Rwanda’s population now lives within five kilometers of a health facility, and 85 percent lives within 10 kilometers.⁹

Mutuelle de Santé health insurance

One of the most important ways that Rwanda has sought to ensure health care equity and access is through Mutuelle de Santé, the national community-based health insurance (CBHI) plan. After conceiving of the idea in the late 1990s, the government tested it for feasibility and impact before rolling it out nationwide in the middle of the following decade.¹⁰

In the years since, Rwanda has adapted the system to emphasize coverage of the poorest. Through a Ministry of Local Government-led system known as ubudehe, the families in a village are classified into socioeconomic categories. The families in the lowest categories have their insurance premiums and co-payments funded at all points of care by the government or its development partners. The costs for other enrollees are determined on a sliding scale.¹¹

Rwanda’s CBHI is not a universal-coverage program. Some residents (less than 8 percent of the population) remain enrolled in private health-insurance plans, while civil servants, the military, and law-enforcement personnel have their own coverage under a separate scheme.

Nonetheless, the scope of CBHI is impressive. At peak enrollment, more than 90 percent of Rwanda's population was in the program; current estimates are around 75 percent. By any standard, Rwanda's plan has one of the highest enrollment rates of any CBHI among low-income and lower-middle-income nations worldwide.¹⁴

The success of the program has had several positive implications for U5M, both direct and indirect. These include significant reductions in the cost of maternal, newborn, and child health, including for family-planning services.¹⁵

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CHALLENGES

KEY POINTS

Despite its success in reducing U5M, Rwanda faces challenges to maintain and improve on progress.

- » *Neonatal deaths:* Costlier measures are needed to combat prematurity and low birth weight, as neonatal mortality becomes a growing proportion of overall under-five mortality rate.
- » *Policy setbacks:* Lack of human and physical resources to support the integrated management of childhood illness (IMCI) program led to delays in implementation.
- » *Diagnosis and treatment for HIV-positive infants:* Early infant diagnosis and access to antiretroviral therapy fall short for children under five.

NEONATAL MORTALITY

As noted throughout the Rwanda story, some of the greatest challenges involve precisely those diseases and conditions that the nation has long identified as its most urgent U5M priorities.

For example, while Rwanda is a leader among sub-Saharan African nations in reducing acute malnutrition, it has yet to successfully address the chronic malnutrition that potentially compromises a range of public health objectives, including the health and survival of neonates and young children.

Neonatal-mortality prevention remains an area of relative underachievement. While neonatal deaths are declining, they account for a growing share of Rwanda's overall U5M rate, and outcomes for the youngest infants—those under one month of age—have been a matter of particular concern. In addition, the nation will have to undertake costlier measures to address the problems of prematurity, low birth weight, and heart disease, all of which now account for higher proportions of neonatal mortality.

One of Rwanda's most important means of confronting neonatal mortality and other forms of U5M has been the nation's ambitious and extensive community health worker (CHW) program. However, the funding and retention of CHWs has proved to be difficult, and an inability to address these issues could compromise public health delivery and U5M interventions in rural villages nationwide.

Among the most effective of those interventions has been the prevention of mother-to-child transmission (PMTCT) of HIV. But another critical intervention against the disease—early infant diagnosis, or EID—has been less successful. Because more than half of HIV-positive infants will die by the age of two without treatment, this is an important gap in Rwanda's U5M program. While 70 percent of all health facilities in Rwanda were offering EID services by 2009, only 28 percent of children born to HIV-positive mothers were receiving EID.¹

Furthermore, even with expanded access to antiretroviral therapy (ART), the treatment of HIV-positive children remains limited. In 2013, only 60 percent of HIV-positive children up to 14 years old were receiving ART, compared to 95 percent of HIV-positive adults.²

Evolving external factors could also jeopardize Rwanda's hard-earned gains against U5M.

REGIONAL CHALLENGES

Since 2012, Rwanda's malaria incidence and death totals have steadily risen.³ Contributors to this increase may include delays in ITN procurement and distribution, as well as growing resistance to the insecticides used in Indoor Residual Spraying. Significantly, similar increases in malaria rates have occurred across East Africa, indicating that broader forces may also be at play.

In addition, political instability in neighboring countries could expose Rwandans to new threats, such as the reappearance of measles in areas abutting Burundi and the Democratic Republic of the Congo (DRC).

In 2010, Rwanda registered 121 documented cases of measles—all of them either occurring in districts bordering Burundi and the DRC, or directly traceable to index cases from one of those districts.⁴ The United Nations High Commissioner for Refugees (UNHCR)—in coordination with the Ministry of Health (MOH)—now vaccinates all displaced persons at the Rwandan border for measles and polio, and conducts routine vaccination campaigns in refugee camps.

IMPLEMENTATION SETBACKS

One of Rwanda's earliest U5M initiatives was the adoption in 2000 of the Integrated Management of Childhood Illness (IMCI) protocol, which had shown promise in other countries.⁵

Developed by World Health Organization and UNICEF in 1996, IMCI is intended to help high-U5M nations improve the diagnosis, treatment, and prevention of common childhood illnesses, with an emphasis on strengthening overall health systems.⁶

Even though IMCI's approach dovetailed nicely with the government's health priorities, Rwanda encountered delays in implementing the program. The nation's human and physical resources could not yet provide the level of support IMCI required.

At many facilities, the rotation schedules of thinly stretched staffs couldn't accommodate the program's intensive training regimen, much of which had to take place in district hospitals to ensure that there would be enough patients to conduct training in the first place.

Because of these and other factors, the MOH would not begin training health providers in the program until 2006.⁷ By 2007, only 23 percent of health centers had two or more IMCI-trained providers on staff.⁸ Yet despite this early disappointment, Rwanda's development of effective systems to fight childhood illness was already well underway—and would accelerate in the years to come.

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CONTEXT

KEY POINTS

- » In 2000, Rwanda faced a severe shortage of trained health care providers and facilities, resulting in limited access to treatment and services in the face of urgent public health needs.
- » At the time, Rwanda trailed both its East African neighbors and its low-income peers in such vital measures as health expenditure per capita and in the number of births attended by skilled health staff.
- » Of greatest concern were the five leading causes of under-five mortality: lower respiratory infections; malaria; diarrhea; malnutrition; and neonatal disorders.
- » To address these, in addition to the evidence-based interventions and implementation strategies discussed in the previous sections, three main contextual factors were key to Rwanda's success: an institutional culture of accountability, a commitment to decentralization, and high levels of national health expenditure and donor financing

BACKGROUND

In 2000, Rwanda was still grappling with the aftermath of the 1994 genocide that killed nearly one million people, displaced another two million, and devastated the nation's health care system.

President Paul Kagame's administration—which began in April 2000—faced the daunting task of reinstating the rule of law and creating a viable path to development in a land where few civic structures remained in place.

The country faced a severe shortage of trained health care providers and facilities, resulting in limited geographic access and poor coverage in the face of urgent public health needs.¹ At the time, Rwanda trailed the averages of both its East African neighbors and its Countdown to 2030 low-income peers in health expenditure per capita and in the number of births attended by skilled health staff.²

The doctors and nurses who were available were highly centralized, with three-quarters of the physicians and half of the nurses located in Kigali.³ In an overwhelmingly rural country, this meant that large portions of the nation were chronically underserved.

In Gikongoro province, for example, only 30 percent of the population lived within five kilometers of a health center.⁴ The nation's Ministry of Health (MOH) recognized that the low density of health facilities—many of which were understaffed—was a significant contributor to Rwanda's high U5M rate.

Of greatest concern were the five leading causes of under-five mortality: lower respiratory disorders; malaria; diarrhea; malnutrition; and neonatal disorders. Along with measles—which was still a significant public health concern at the time—these conditions accounted for approximately three-quarters of all deaths of children under

CONTEXTUAL FACTORS CONTRIBUTING TO SUCCESS

How is it possible that a nation as poor, as small, and as ravaged as Rwanda was in the mid-1990s could go on to achieve impressive gains against under-five mortality (U5M) within a mere decade and a half?

In addition to the evidence-based interventions and implementation strategies discussed in previous chapters, three main contextual factors are commonly cited by Rwandans and by outside observers as reasons for the nation's notable successes in this area.

- » An institutional culture of accountability
- » A commitment to decentralization
- » High levels of national health expenditure and donor financing

An institutional culture of accountability

The government invoked the pre-colonial imihigo concept of accountability, and infused it into the health care system. What made this more than an empty bromide was the government's willingness to give personnel the training, the tools, and the data they needed to hit their goals—and a no less notable willingness to decentralize implementation in order to swiftly identify successes and address failures.

Several of the Rwandan interviewees drew attention to the importance of imihigo, an indigenous concept that is broadly synonymous with accountability; the word is a plural form of umuhigo, which means “to vow to deliver.” The national government has invoked imihigo in setting performance goals and holding districts responsible for meeting them. Every year, ministers and all district mayors sign imihigo performance contracts with the president himself. These contracts include up to 100 indicators, including several—typically over a dozen—that are health-related. Districts are then ranked according to their achievements.

Interviewees noted that imihigo fosters not only a healthy competition among districts, but also a sense that health outcomes are the responsibility of local leaders nationwide—not just of MOH bureaucrats. The imihigo principle has been at the heart of some of the most important elements of Rwanda's U5M campaign, such as decentralization and performance-based financing. In addition, the emphasis on accountability was an important factor in guiding and assessing evidence-based interventions (also known as EBIs; for more on these interventions, see the chapters on “What did Rwanda do” and “How did Rwanda Implement”.)

A commitment to decentralization

The emphasis on local accountability has been accompanied by a commensurate expansion of local implementation authority. The national Ministry of Health (MOH) sets national policy, gathers and evaluates data, and provides overall supervision, while the districts and localities carry out Kigali's directives.⁵

In 2006, to foster greater efficiency, Rwanda consolidated its 106 administrative districts into 30, and 12 provinces into five. Under the old territorial system, the nation's health districts were organized around hospitals and often cut across administrative districts, blurring political accountability for health outcomes.⁶ In the new districting format, health districts were eventually incorporated into the administrative districts, and placed under the authority of the mayor (the elected head of a district).

The national government also reduced its staff, sending some positions out to the districts.⁷ Indeed, in 2008, Rwanda granted full autonomy to the districts for health decisions, including the right to hire and fire health workers (with some exceptions for doctors and nurses in remote rural areas to ensure adequate levels of clinical service).⁸ The new levels of district autonomy created challenges at first, but over time decentralization has come to be seen as a crucial component in Rwanda’s U5M gains, enabling local personnel to implement national initiatives more rapidly and equitably than might have otherwise been the case. At the same time, these districts are still held accountable to the national government through the aforementioned performance contracts and imihigo system.

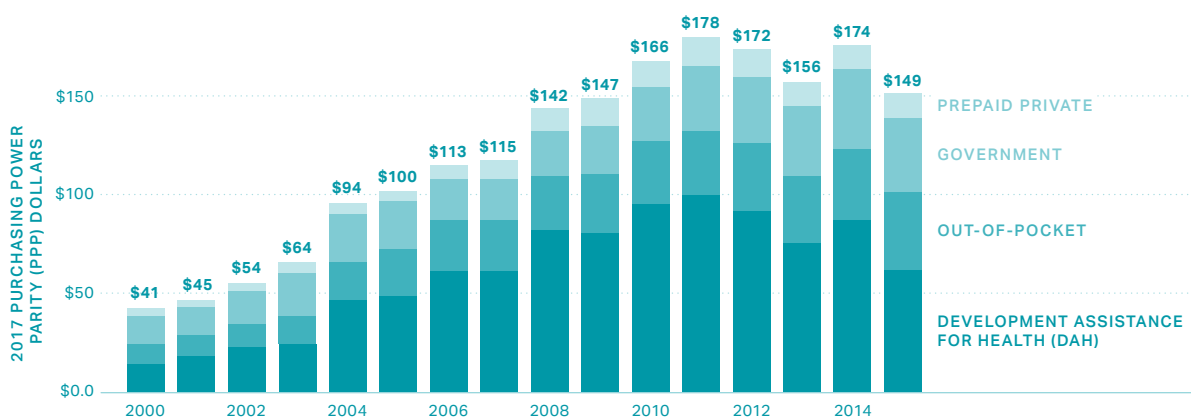
High levels of national health expenditure and donor financing

Over the last 15 years, Rwanda’s health sector has benefited from a strong national commitment to health care, as well as a steady increase in both external and internal funding. Between 2000 and 2015, Rwanda’s total expenditure on health increased from \$327 million to \$1.8 billion.¹⁰ This has corresponded with an increase in per capita health spending from \$41 in 2000 to \$149 in 2015 (2017 PPP dollars).⁹

Regarding external funding, Rwanda has been very successful in securing foreign aid to help fund its health programs, receiving higher per capita health assistance than its immediate neighbors (although it is not the largest regional recipient of such aid, as several sub-Saharan African nations exceed Rwanda’s receipts in both absolute and per capita terms).

Over time however, health-related aid as a percentage of total health spending dropped from nearly 60 percent of the nation’s total health expenditure in 2000 to about 40 percent in 2015.¹⁰ The fact that total health spending has generally remained on an upward trajectory is due in part to the national government’s increasing contribution to total health expenditure, from \$109 million in 2000 to \$430 million in 2015.⁹ This increase in government contributions shows the emphasis placed on improving health outcomes.

Health expenditure profile in Rwanda



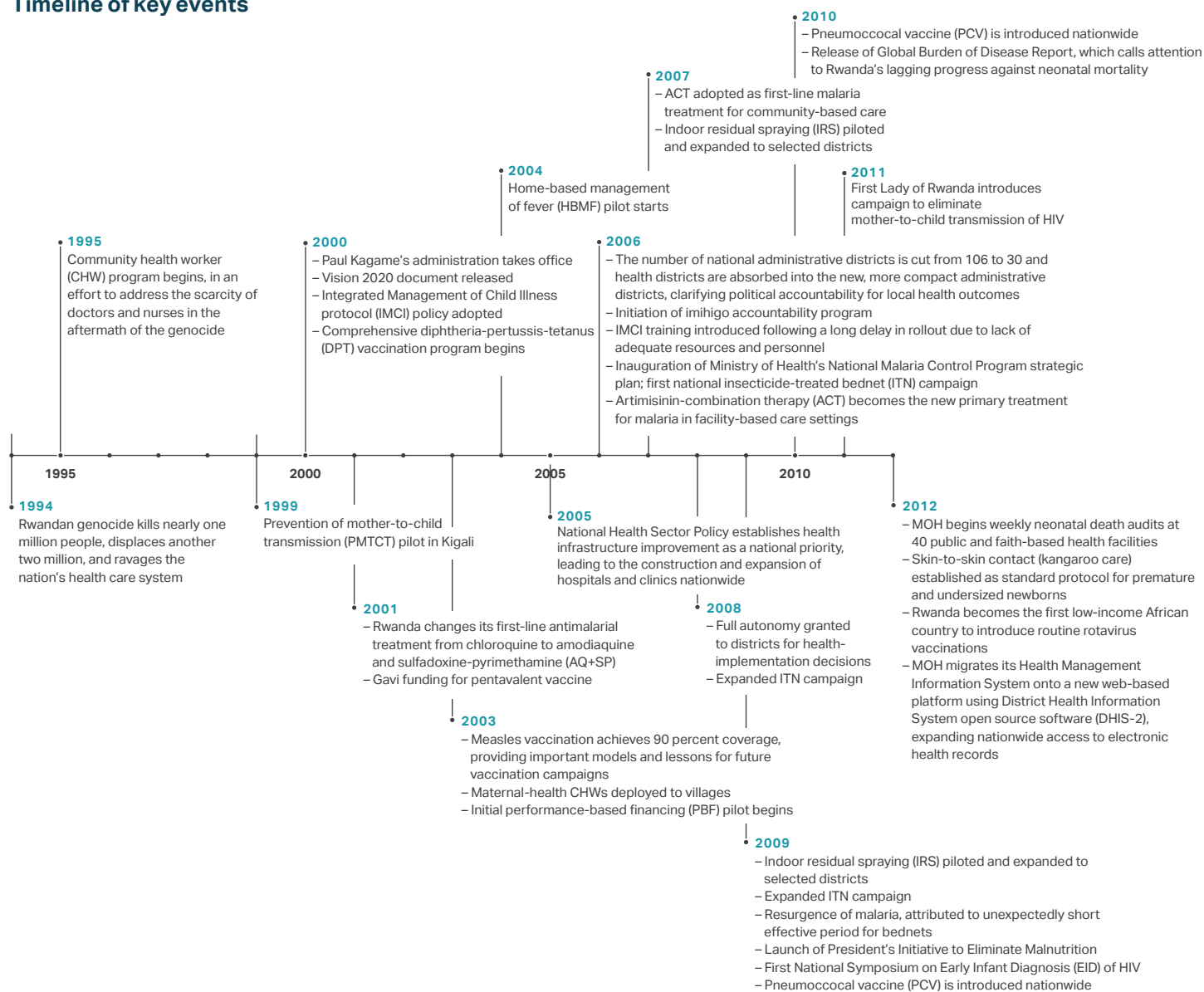
Data Source: IHME Health Financing, World Bank

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MILESTONES

Timeline of key events

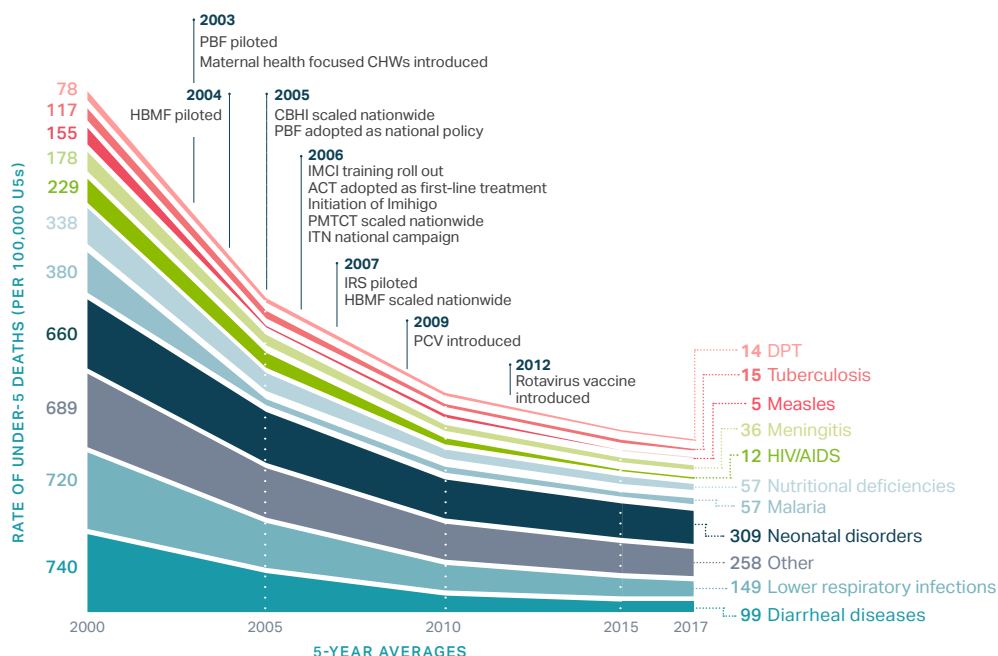


QUANTITATIVE MODELING RESULTS

BURDEN OF DISEASE

The largest contributors to under-five mortality in Rwanda in 2000 and 2015 are shown below.

Under-five mortality in Rwanda over time, death rates per 100,000 children under five



Data Source: Institute for Health Metrics and Evaluation (IHME) GBD 2017

QUANTITATIVE MODELING APPROACH

The research team collaborated with IHME to look at quantitative modeling results using a decomposition method, and also collaborated with the Johns Hopkins Bloomberg School of Public Health to model results using the Lives Saved Tool (LiST). These analyses complement the primary research by looking at what the models suggest about the likely contribution of specific interventions in reducing child mortality. A summary of the results is presented in the following sections.

MODELING RESULTS

The *decomposition method* estimates the percentage decline in U5M attributed to changes in risk factors and intervention coverage, based on efficacy assumptions derived from published literature.

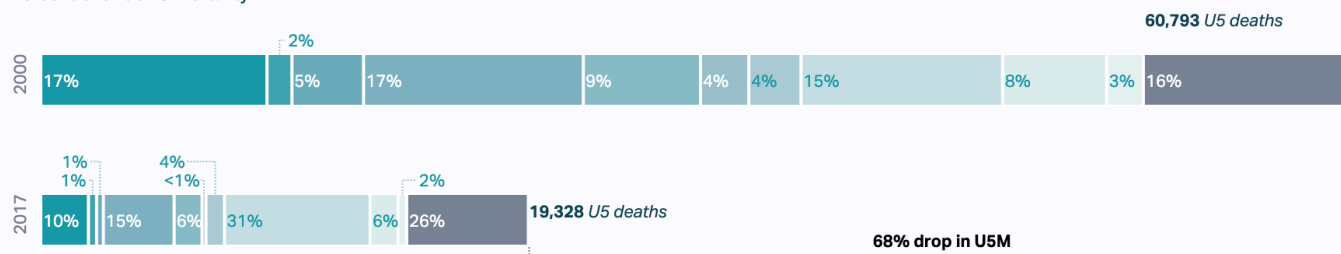
From this method, the most significant contributor to the decline in Rwanda’s U5M rate is health interventions, which includes preventive measures like vaccines and curative treatments. Another significant contributor is program-related risk factors, which includes child growth failure, low birth weight, suboptimal breastfeeding, and vitamin A & zinc deficiency.

The decomposition analysis found an additional 18 percent reduction in child mortality (26 percent of the total reduction during this period) was attributed to risk factors corresponding to other communicable diseases, other non-communicable diseases, and other injuries. This reflects the portion of reduction in each of these causes of death (CoD) that is not accounted for by health systems interventions (bottom row).¹

Decomposition analysis

TOP COD CONTRIBUTING TO U5M REDUCTION

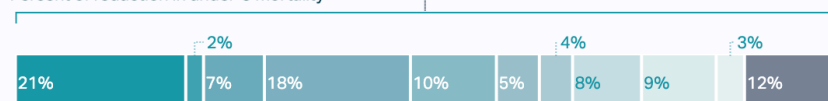
Percent of under-5 mortality



- Diarrheal diseases
- DPT
- HIV/AIDS
- Lower respiratory infections
- Malaria
- Measles
- Meningitis
- Neonatal disorders
- Nutritional deficiencies
- Tuberculosis
- Other

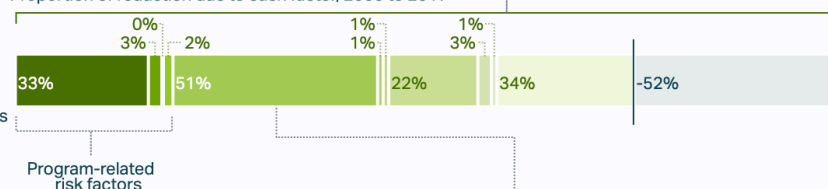
REDUCTION IN CAUSE OF DEATH

Percent of reduction in under-5 mortality



REDUCTION DECOMPOSITION

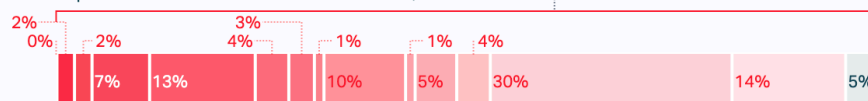
Proportion of reduction due to each factor, 2000 to 2017



- Child growth failure
- LBW
- Suboptimal breastfeeding
- Vitamin A and Zinc deficiency
- Health systems
- Air quality
- WASH
- Reductions in other communicable disease risk factors
- Reductions in other non-communicable disease risk factors
- Reductions in other injuries risk factors
- Population age structure
- Population growth

HEALTH SYSTEMS INTERVENTION BREAKDOWN

Proportion of intervention-attributed reduction, 2000 to 2017



- ACT
- Antibiotics for LRI
- ART
- DTP3 vaccine
- Hib vaccine
- ITN and IRS
- Measles first dose vaccine
- ORS and Zinc
- PCV
- PMTCT
- Rotavirus vaccine
- Skilled birth attendance
- Other communicable disease interventions
- Other non-communicable disease interventions
- Other injuries interventions

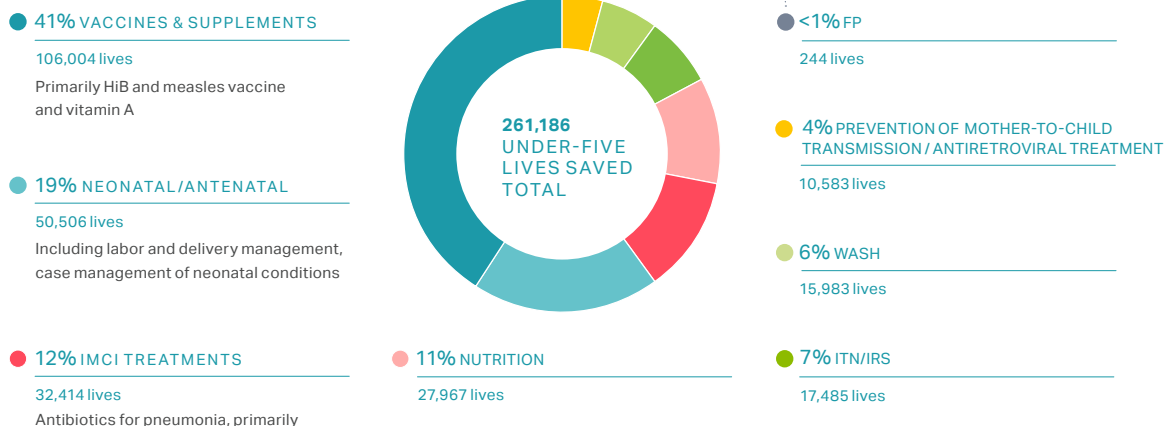
Data Source: Analysis from GBD Risk Factors Collaborators, GBD 2017, IHME

We checked these results against LiST estimates of the number of lives saved attributed to each intervention based on estimates of disease incidence and deaths from the United Nations Inter-Agency Group for Child Mortality Estimation (IGME), as well as assumptions about effectiveness of interventions from published literature.

This model attributes a total of 261,186 lives saved between 2000 and 2016 to specific health interventions, with the largest contributors being vaccines and supplements (especially Hib vaccine, measles vaccine, and vitamin A), neonatal and antenatal interventions (particularly labor and delivery management and case management of neonatal sepsis and pneumonia), and Integrated Management of Childhood Illness (IMCI) treatments (especially oral antibiotics for pneumonia).²

Lives Saved tool results for Rwanda, 2000–2016

Lives saved attributed to interventions



Data source: Lives Saved Tool - Johns Hopkins Bloomberg School of Public Health

SUMMARY

Across both modeling methods, neonatal and antenatal interventions and vaccines are estimated to have had a significant impact on reducing under-five deaths in Rwanda. The results of the primary research findings on implementation outcomes for each intervention are presented in the next section. A description of the quantitative modeling methods can be found in the Methodology section.

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DETAILED FINDINGS

INTERVENTION COVERAGE BY CAUSE OF DEATH (COD) IN RWANDA

REDUCTION IN U5MR FROM COD, 2000–2015	EVIDENCE BASED INTERVENTION	ACCEPTABILITY	FEASIBILITY	FIDELITY	EFFECTIVENESS/REACH
Malaria 88% decline in U5MR	ITNs	N/A	Over 3 million ITNs distributed during 2006–2007 and 6.1 million distributed during 2008–2009. ⁴	ITN utilization is approximately 10% less than ITN possession (KI).	Percent of children under-5 sleeping under ITNs increased to 68% by 2015. ⁵
	IRS	General acceptability came about after seeing the lack of mosquitoes following the first round of spraying.	In the districts chosen, 87–99% of targeted buildings are sprayed. ⁶	N/A	Seven districts covered by IRS represent 70% of the malaria burden for the country. ⁷
Lower Respiratory Infections 76% decline in U5MR	PCV	The communities generally accepted the benefits of the vaccination because “[Rwanda’s] population trusts very much their government and what they are doing and that [the MOH’s] main interest is our beneficiaries” (KI).	No stockouts occurred during the vaccine rollout. ⁸	20.8%	After introduction, PCV coverage quickly increased up to 97% by 2010 with a concurrent reduction in child hospitalization due to pneumonia of 53% between the periods of 2007–2009 (prior to introduction of PCV7) and 2010–2013 (after introduction of PCV7). ⁹
Diarrheal Diseases 86% decline in U5MR	Rota Vx	High coverage rates reflecting community acceptance “it was very easy to administer the vaccine because mothers were not afraid of it.”	Rotavirus vaccine was delivered nationally.	Three doses of rotavirus vaccine are being given at 6, 10 and 14 weeks as recommended ¹⁰ with the rollout completed as planned (partner engagement and coordination, community sensitization, integrated strengthening of supply and M and E systems).	Rotavirus vaccination in children under 1-year of age increased from 50% in 2012 and to 99% in 2013. ¹¹ Hospital admissions for diarrhea in children under-5 fell by 49% between 2011 and 2013. ¹²
HIV 93% decline in U5MR	PMTCT	N/A	Increased ANC services available led to increased availability of PMTCT (KI). The number of health facilities offering PMTCT increased from 53 in 2003 to 382 in 2010.	N/A	98% of women coming in for antenatal care are tested for HIV and 99% of HIV-positive pregnant women receive ART to reduce MTCT (KI). MTCT rates have dropped from 9.7% in 2006 to 2.4% in 2010 and 1.8% in 2015. ¹³ Adoption of improved treatments often prior to international recommendations by WHO and other bodies—most notably, Option B+. In 2015, 92.2% of pregnant women received HIV testing during ANC, and less than 1% were HIV-positive. ¹⁴ All Health Centers by 2009 offered ART including PMTCT.

REDUCTION IN U5MR FROM COD, 2000–2015	EVIDENCE BASED INTERVENTION	ACCEPTABILITY	FEASIBILITY	FIDELITY	EFFECTIVENESS/REACH
HIV 93% decline in U5MR	ART		Turnaround time from collection of sample to receipt of results by the provider decreased from 144 days to 20 days. ¹⁵		Health facilities offering ART increased from 4 in 2002 to 465 in 2013. ¹⁶ EID for infants born to HIV-positive mothers in 2011 was 72–94%. ¹⁷ In 2013, 60% of HIV-positive children ages 0–14 years were receiving ART. ¹⁸
Measles 97% decline in U5MR	Measles vaccination	Coverage with the MR vaccine estimated at 95% in 2015. ¹⁸	Regular response to new needs and cases possible through leveraging of existing platforms.	N/A	Measles vaccine coverage was maintained above 80% from 2003 to 2009. ¹⁹ In 2010, there was a vaccine coverage rate of 95% and 121 identified cases of measles nationwide. ²⁰ No extended outbreaks identified despite influx of new unvaccinated populations.
Nutritional deficiencies 81% decline in U5MR	Severe acute malnutrition identification and monitoring				82% of children under-5 were screened for malnutrition in 2014. ²¹ Wasting (low weight-for-height and therefore a marker for acute malnutrition) decreased from 6.8% of children under-5 in 2000, to 5% in 2005, 3% in 2010, and 2% in 2015. ¹⁴ Note that similar success was not seen in markers of more chronic malnutrition including stunting.
Neonatal disorders 51% decline in U5MR	Neonatal interventions			Partographs, while available were not widely used completely. ²² Only 7% of women getting active management of the third stage of labor (AMSTL) received all components. ²²	Rates of C-section increased from 2.1% of deliveries in 2000, to 2.9% in 2005, 7.1% in 2010 and 13.0% in 2015. ²³ Women having a post-partum checkup within the first 2 days following delivery increased from 2.9% in 2000 to 43% in 2015. ²⁴

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- 1 This analysis uses the Das Gupta decomposition method, which averages across the multiple ways in which each of the factors could combine to result in the realized changes in under-five mortality.
- 2 The inputs to the decomposition are cause-specific mortality rate, age-specific population estimates, intervention coverage rates, and intervention effectiveness estimates. Cause-specific mortality and population estimates come from the Global Burden of Disease study and intervention coverage rates were estimated using multiple sources of survey data, including but not exclusive to DHS surveys. A literature review and synthesis were conducted to establish intervention effectiveness.
- 3 The under-five mortality decomposition analysis breaks down changes over time for a series of factors that directly influence child-mortality levels. This figure assesses five-year intervals, presenting changes as percentages relative to the number of deaths in the first year of the time interval. Some factors contribute to increases (bars that are on the right side of the dotted line) in the number of deaths, while others contribute to declines (bars to the left of the dotted line)—the net of the two corresponds to the total change in deaths over the time period (represented by the black dot).

Interventions and Risk Factors: Interventions and risk factors influence mortality rates through changes in the proportion of the population exposed to each, and through changes in the corresponding relative risk of mortality. Increased coverage of specific interventions is known to reduce mortality rates, whereas increased exposure to certain risk factors increases mortality rates.

Health Care Access and Quality: The Healthcare Access and Quality index captures changes in 32 separate causes of death amenable to personal health care interventions. The impact of HAQ on under-five mortality rates was determined by regressing HAQ on risk-deleted mortality rates across locations and years. The bar representing HAQ can be interpreted as the effect of improved HAQ on mortality rates after accounting for risk factors and interventions.

Population Change: The total number of deaths in a given year is a product of both age-specific mortality rates and the population size in each age group, so changes in population are factored into the decomposition. For example, if mortality rates are cut in half while the population size doubles, total deaths will remain the same.

- Other factors:* After capturing all of the explainable changes in under-five deaths, there is often some remaining change that is unexplained by the factors included in the analysis. These can be thought of as indirect factors that ultimately affect child mortality through means other than the factors included in the analysis. For example, improvements in infrastructure may contribute to decreased mortality rates, but we were unable to incorporate a measurement of improved infrastructure - or the effect of any such improvement— into this analysis.
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METHODOLOGY

THE RWANDA UNDER-FIVE MORTALITY (U5M) STUDY IS A COLLABORATION BETWEEN THE

University of Global Health Equity (UGHE), the Bill & Melinda Gates Foundation, and Gates Ventures, as part of the Exemplars in Global Health project.

This has two broad aims: First, developing and testing an implementation framework and mixed-methods approach to understand the success of exemplar countries; second, identifying implementation strategies and contextual factors that other nations could adapt and adopt to reduce U5M within their own borders.

PROJECT FRAMEWORK

The UGHE and Gates Ventures teams proceeded with primary and desk research, informed by an implementation-science framework designed specifically for this project.

Because the same policies and interventions brought different results in different countries, implementation science offers important tools for how to think more holistically about how and why countries were able to reduce U5M, and from where lessons in replication can be drawn.

The Rwanda U5M project's initial work included identifying evidence-based interventions (EBIs) that had been found to directly reduce U5M, dividing the interventions between those targeting the neonatal period (birth to 28 days) and post-neonatal early childhood (28 days to 4 years). For a full listing of the EBIs considered, see the tables at the end of this document.

While we are often able to identify policies and evidence-based interventions chosen by a country to reduce U5M, the key lessons in how these were chosen, adapted, implemented, and sustained are often missing from available published or gray literature.

To advance our research, we developed a framework to understand the contribution of contextual factors and the different levels of actors involved: global, national, ministry, subnational, facility, and community.

That framework emerged from an exhaustive consideration of current models, and incorporates elements from several of them, along with vital insights from primary investigators on approaches to the interpretation of evidence and the design of primary-research tools.

The primary frameworks and implementation science resources we drew from include:

Exploration, Preparation, Implementation, Sustainment (EPIS)¹

This framework walks through four key steps of the implementation process needed to achieve long-term change: exploration; adoption decision/preparation; active implementation; and sustainment.

Re-AIM²

This evaluation framework breaks down implementation outcomes into the four elements of its acronym: reach (coverage); effectiveness; adoption (range and proportion of individuals and organizations willing to participate); implementation (fidelity, time, cost and adaptations made); and maintenance (institutionalization into routine care and policies and long-term impact). It is designed to demonstrate the range of factors that influence success or failure at the individual and broader levels.

Consolidated Framework for Implementation Research (CFIR)³

This framework serves as a guide to understand the contextual factors that influenced the success or failure of implementation of a specific intervention. These include the outer context; the inner (organizational) context; the characteristics of the intervention; the implementation approach; and the individual actors responsible for implementation.

Implementation Outcomes (Proctor et al)⁴

This approach distinguishes implementation outcomes from the more traditionally measured intervention and system outcomes.

None of the above frameworks could, by themselves, account for the full range of implementation strategies that Rwanda and its partners undertook at the national, subnational, and care-delivery levels.

That said, the final framework certainly incorporated elements from established approaches. This included the choice of and implementation of EBIs (drawing from EPIS), as well as facilitators and barriers at the local, national and global levels (drawing from CFIR).

By combining all of these frameworks, and adding some new elements, we developed an approach that could guide us in prioritizing areas for primary research, interpreting the secondary research, and synthesizing our findings. A graphical illustration of the team's final framework may be found at the end of this document.

DESK REVIEW

The UGHE/Gates Ventures team undertook an extensive review of available information and published data on the current state of U5M in Rwanda and worldwide. It assessed the policies, strategies, and specific evidence-based interventions available to potential exemplar countries, as well as the implementation of these EBIs in five exemplar countries, including Rwanda. All five nations had succeeded in reducing U5M mortality beyond those experienced by other nations in the same region or at similar levels of wealth.

The team conducted its initial secondary research through MEDLINE (PubMed) and Google Scholar, using the search terms "child mortality" or "under-5 mortality" and the country's name. Further searches included specific EBIs, causes of death, or contextual factors as search terms (e.g. "insecticide-treated nets," "malaria," or "community health workers").

The UGHE team reviewed this initial secondary research for accuracy and completeness. This desk review was an iterative process, with ongoing additions throughout the concurrent primary-research process as additional sources (published articles, reports, case studies) were identified.

The team purposely did not include in-depth reviews of important broad interventions that contributed to U5M reduction—including education, poverty reduction, improved sanitation, and nutrition programs—but did include some evidence of increased coverage where available.

PRIMARY RESEARCH

Informed by the framework and review of relevant literature on contextual factors and implementation outcomes, the team organized primary-research interviews with key informants who had direct experience in supervising or carrying out Rwanda's U5M interventions during the time period covered in this report.

The purpose of these interviews was to gain an explanatory evaluation of the results from the desk review, identify additional areas of research, and fill identified gaps in understanding.

The team developed interview templates for three categories of informants: Ministry of Health officials and staff; project managers and implementers for specific causes of death or EBIs; and other partners at the national or global level.

The informants included current and former MOH employees, along with representatives of non-government organizations (NGOs); institutional donors, and multinational agencies. We focused on individuals active in the time period between 2000 and 2015, but were able to also capture some experiences from the formative post-genocide period of 1995-2000 as well as insights on developments since 2015.

Key informants were chosen based on the topics identified in the desk review and the close collaboration of in-country collaborators. In selecting interviewees, the research team placed a priority on finding individuals who could shed light on those EBIs which were reported as most successful, as well as on those for which no evidence of implementation could be found.

The interviews themselves were designed to address the entire intervention-implementation process, from conception through sustainment.

Interviewees were informed about the goals and structure of the project, and consent for participation and recording was obtained separately from the interview. The sole purpose of recording was to review the accuracy of notes.

ANALYSIS AND SYNTHESIS

The UGHE team used a mixed-methods explanatory approach, applying the framework to understand the progress (or lack thereof) for each cause of death and the coverage of chosen evidence-based interventions, as well as facilitators and barriers at the local, national, and global levels.

This approach was designed to understand how and why Peru was able to achieve success in decreasing U5M, and the primary obstacles it faced. The analyses were also informed by other projects, including Countdown 2015, equity analyses from the International Center for Equity in Health, and geospatial mapping from IHME, among others.

In addition, the research team collaborated with IHME to look at quantitative modeling results using a decomposition method, and also collaborated with the Johns Hopkins Bloomberg School of Public Health to model results using the Lives Saved Tool (LiST). These quantitative analyses complement the primary research by looking at what the models suggest about the likely contribution of specific interventions in reducing child mortality.

The *decomposition* analysis conducted by IHME breaks down changes over time for a series of factors that directly influence child mortality levels using the Das Gupta method. The overall change in mortality between years is divided into contributions from:

- » *Interventions and risk factors:* Interventions and risk factors influence mortality rates through changes in the proportion of the population exposed to each, and through changes in their corresponding relative risks of mortality. Increased coverage of specific interventions is known to reduce mortality rates, whereas increased exposure to certain risk factors increases mortality rates. The relative risk for each specific disease outcome is established through a literature review.
- » *Population changes:* The total number of deaths in a given year is a product of both age-specific mortality rates and the population size in each age group, so changes in both population growth and population age structure are factored into the decomposition. One example of the effect of population changes is if mortality rates are cut in half while the population size doubles in each age group, total deaths remain the same.

The *Lives Saved Tool* (LiST), developed by the Johns Hopkins Bloomberg School of Public Health, calculates changes in cause-specific mortality based on intervention coverage change, intervention effectiveness for that cause, and the percentage of cause-specific mortality sensitive to that intervention. Coverage data come from large-scale household surveys – typically Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS), as well as WHO/UNICEF and the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP).

Default effectiveness values come from systematic reviews, meta-analyses, Delphi estimations, and randomized control trials based upon the Child Health Epidemiology Reference Group guidelines. Baseline mortality is drawn from country-level estimates from DHS, WHO, UNICEF, UNFPA, World Bank Group, and the United Nations Population Division and the UN Inter-Agency Group for Child Mortality Estimation (IGME). Additionally, users who have more recent or alternative data sources can easily replace default data with their own.

HUMAN SUBJECTS REVIEW

The UGHE/Gates Ventures team's work was approved by—and conducted with the support of—the Ministry of Health (MOH), the National Health Research Committee, and the Rwanda Biomedical Center's Division of Maternal, Child and Community Health. A waiver was obtained from the Rwanda National Ethics Committee on the grounds that this research was to be conducted entirely retrospectively, using de-identified data and desk reviews of existing reports, with informed consent obtained from all interview participants.

No quotes or specific viewpoints identifiable to the source have been included without explicit permission. All recordings and interviews were kept in password-protected computers, and stored on a limited-access Google Drive with all identifications of interviewees removed. All recordings will be destroyed once the interview coding has been completed.

INTERVENTION COVERAGE BY CAUSE OF DEATH IN RWANDA

CAUSE OF DEATH	EVIDENCE-BASED INTERVENTION
Lower respiratory infections	Antibiotic treatment
	Vaccination: PCV
	Vaccination: Hib
	Community-based management
	Facility-based management
Diarrheal diseases	Oral rehydration therapy
	Zinc supplementation
	Vaccination: Rotavirus
	Community-based management
	Facility-based management
Malaria	Antimalarial combination therapy
	Rapid diagnostic testing
	Insecticide-treated nets
	Indoor residual spray
	Intermittent preventative therapy for high-risk groups
	Community-based management
	Facility-based management
Measles	Vaccination: Measles
	Vitamin A supplementation (prior to vaccination)
Malnutrition	Exclusive breastfeeding for 6 months
	Continued breastfeeding and complementary feeding after 6 months
	Vitamin A supplementation
	Management of severe acute malnutrition (ready-to-use food, rehydration, antibiotics)

CAUSE OF DEATH	EVIDENCE-BASED INTERVENTION	
HIV	Antiretroviral treatment for infants and children	
	HIV testing of children born to HIV+ mothers	
	Prevention of mother-to-child transmission	<ul style="list-style-type: none"> » Early diagnosis of pregnant women (or pre-pregnancy) » PMTCT treatment for mothers* and post-partum to exposed infants » Elective C-section for untreated HIV+ mothers**; replacement feeding** » Antiretroviral treatment for mother for life as prevention (started in 2012) » Exclusive breast feeding
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Meningitis	Vaccination: PCV meningococcal	
	Vaccination: Hib	
	Vaccination: Meningococcal	
	Antibiotic treatment	
	Chemoprophylaxis during acute outbreaks	
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Other vaccine preventable diseases	Vaccination: Tetanus	
	Vaccination: Diphtheria	
	Vaccination: Pertussis	
	Vaccination: Polio	

* No longer recommended (PMTCT versus ART for life)

** No longer recommended for women on ART with suppressed VL

NEONATAL MORTALITY EVIDENCE-BASED INTERVENTIONS (EBIS)

PERIOD OF RISK	EBI	
Preconception	Folic acid supplementation	
Antenatal	Tetanus vaccination	
	Malaria prevention and treatment	<ul style="list-style-type: none"> » Intermittent presumptive treatment » ITNs
	Iodine supplementation (in endemic iodine deficient settings) 4 or more antenatal visits (ANC4)	
	Prevention and treatment of preeclampsia and eclampsia	<ul style="list-style-type: none"> » Calcium supplementation* » Low-dose aspirin for high-risk women* » Antihypertensive treatment for severe hypertension » Magnesium sulfate » Early delivery
Intrapartum	Antibiotics for PPRM	
	Corticosteroids for preterm labor	
	C-section for breech or obstructed labor	
	Active management of delivery (including partograph)	
	Clean delivery practices (incl. clean cord-cutting)	
	Trained birth attendant	
	Facility-based delivery	
	Basic emergency obstetric and newborn care (BEmONC)	
	Comprehensive emergency obstetric and newborn care (CEmONC)	
	Timely transport for higher level care for mother	
Postnatal	Newborn resuscitation	
	Immediate breastfeeding	
	Prevention and management of hypothermia	<ul style="list-style-type: none"> » Immediate drying and wrapping » Delayed bathing » Skin-to-skin » Baby warming
	Kangaroo care for LBW/prematurity	
	Timely transport for higher level care for mother	
	Post-partum visits to identify danger signs and provide active referral	
	Antibiotics for suspected or confirmed infection	
	Surfactant therapy for RDS and prematurity	
	Neonatal intensive care units (equipped, trained staff, standards and protocols established and followed)	
	Basic emergency obstetric and newborn care (BEmONC)	

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