Reproductive, Maternal, Newborn, and Child Health: Key Messages of This Volume

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VOLUME SUMMARY

Reproductive, Maternal, Newborn, and Child Health (RMNCH) covers the health concerns and interventions across the life course involving women before and during pregnancy; newborns, that is, the first 28 days of life; and children to their fifth birthday. The volume identifies 61 essential interventions and because of the timing of their delivery in the life course, groups them into three packages: 18 for reproductive health, 30 for maternal and newborn health, and 13 for child health, although some interventions, such as vaccines for immunization, have multiple components. The volume considers the health system needs for implementing these interventions in health service platforms in communities, in primary health centers, and in hospitals and the cost-effectiveness of interventions for which data are available. This chapter summarizes the volume and considers the potential impact and cost of scaling up proven interventions to reduce maternal, newborn, and child deaths and stillbirths.

- The annual number of global maternal and child deaths has dropped markedly in the past 25 years, yet the rate of reduction in many countries has been too slow to achieve Millennium Development Goals 4 and 5 by 2015.

- Progress could be accelerated by scaling up integrated packages of essential interventions across the continuum of care for RMNCH. These interventions are highly cost-effective and result in benefit-cost ratios of 7–11 to 2035 (net present value in U.S. dollars of benefits to costs).
- Scaling up all interventions in the packages of maternal and newborn health, plus folic acid before pregnancy, and child health from the existing rate of coverage to 90 percent would avert 149,000 maternal deaths; 849,000 stillbirths; 1,498,000 neonatal deaths; and 1,515,000 child deaths, representing the impact in 2015 at current rates of pregnancy, birth, and mortality.
- The reproductive health package is particularly important for providing contraceptive services. Addressing 90 percent of unmet need in 2015 would reduce annual births by almost 28 million, which would consequently prevent 67,000 maternal deaths; 440,000 neonatal deaths; 473,000 child deaths; and 564,000 stillbirths from avoided pregnancies.
- Individual interventions that have the highest impact on deaths are provision of contraception; management of labor and delivery; care of preterm births; treatment of severe infectious diseases, including pneumonia, diarrhea, malaria, and neonatal sepsis; and management of severe acute malnutrition.

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- The three packages of reproductive, maternal and newborn, and child health interventions have an annual incremental cost of US$6.2 billion in low-income countries, US$12.4 billion in lower-middle-income countries, and US$8.0 billion in upper-middle-income countries. The average per capita cost of these three packages is US$6.7, US$4.7, and US$3.9 in low-, lower-middle-, and upper-middle-income countries, respectively.
- These packages of interventions are delivered through three key service platforms: community workers and health posts, primary health centers, and hospitals (first level and referral). Community and primary health center platforms could reduce 77 percent of maternal, newborn, and child deaths and stillbirths that are preventable by these essential interventions in the maternal and newborn health and child health packages. Hospitals contribute the remaining averted deaths through more advanced management of complicated pregnancies and deliveries, severe infectious diseases, and malnutrition in these calculations. Contraceptive services are considered to be almost entirely delivered at primary health centers.
- Weaknesses in RMNCH delivery platforms, including limited access to care, poor quality of services, and shortages of health workers or medicines, are a major barrier to improving RMNCH outcomes. To overcome these weaknesses and expand access to RMNCH services, innovative delivery approaches are being deployed, such as task-shifting to other cadres of workers, household visitation, community mobilization and service delivery, financial incentives for households and health workers, and supervision and accreditation.

INTRODUCTION

Reproductive, maternal, newborn, and child health (RMNCH) has been a priority for both governments and civil society in low- and middle-income countries (LMICs). This priority was affirmed by world leaders in the Millennium Development Goals (MDGs) that called for countries to reduce child mortality by 67 percent and maternal mortality by 75 percent between 1990 and 2015. Although substantial progress on these targets has been made, few countries achieved the needed reductions. The United Nations (UN) Secretary-General's Global Strategy for Women's and Children's Health, launched in 2010 and expanded in 2015 to include adolescents, is an indication of the continued global commitment to the survival and well-being of women and children (Ban 2010). Annual official development assistance for maternal, newborn, and child health has increased from US$2.7 billion in 2003 to US$8.3 billion in 2012, when there was an additional US$4.5 billion for reproductive health (Arregoces and others 2015). A continued focus on RMNCH is needed to address the remaining considerable burden of disease in LMICs from unwanted pregnancies; high maternal, newborn, and child mortality and stillbirths; high rates of undernutrition; frequent communicable and non-communicable diseases; and loss of human capacity. Cost-effective interventions are available and can be implemented at high coverage in LMICs to greatly reduce these problems at an affordable cost.

RMNCH encompasses health problems across the life course from adolescent girls and women before and during pregnancy and delivery, to newborns and children. An important conceptual framework is the continuum-of-care approach in two dimensions. One dimension recognizes the links from mother to child and the need for health services across the stages of the life course. The other is the delivery of integrated preventive and therapeutic health interventions through service platforms ranging from the community to the primary health center and the hospital.

This volume presents the levels and trends of RMNCH indicators, proven interventions for prevention of mortality, costs of these interventions and potential health service delivery platforms, and system innovations. Other volumes in the third edition of *Disease Control Priorities* also cover topics of importance to women and children that are related to the RMNCH health services packages (box 1.1). These topics include the following:

- Trauma care; obstetric surgery; obstetric fistula; surgery for family planning, abortion, and postabortion care; and surgery for congenital anomalies (Volume 1, *Essential Surgery*)
- Breast cancer, cervical cancer and precancer, childhood cancer, and cancer pain relief (Volume 3, *Cancer*)
- Childhood mental and developmental disorders (Volume 4, *Mental, Neurological, and Substance Use Disorders*)
- Cardiovascular and respiratory disorders (Volume 5, *Cardiovascular, Respiratory, and Related Disorders*)
- HIV/AIDS and other sexually transmitted infections, tuberculosis, and malaria (Volume 6, *HIV/AIDS, STIs, Tuberculosis, and Malaria*)
- Road traffic injury and interpersonal violence (Volume 7, *Injury Prevention and Environmental Health*)
- Child (older than five years) and adolescent development (the subject of the entire Volume 8, *Child and Adolescent Development*).

From the Series Editors of *Disease Control Priorities*, Third Edition

Budgets constrain choices. Policy analysis helps decision makers achieve the greatest value from limited available resources. In 1993, the World Bank published *Disease Control Priorities in Developing Countries* (*DCP1*), an attempt to systematically assess the cost-effectiveness (value for money) of interventions that would address the major sources of disease burden in low- and middle-income countries (Jamison and others 1993). The World Bank's 1993 *World Development Report* on health drew heavily on *DCP1*'s findings to conclude that specific interventions against noncommunicable diseases were cost-effective, even in environments in which substantial burdens of infection and undernutrition persist (World Bank 1993).

DCP2, published in 2006, updated and extended *DCP1* in several respects, including explicit consideration of the implications for health systems of expanded intervention coverage (Jamison and others 2006). One way that health systems expand intervention coverage is through selected platforms that deliver interventions that require similar logistics but address heterogeneous health problems. Platforms often provide a more natural unit for investment than do individual interventions, and conventional health economics has offered little understanding of how to make choices across platforms. Analysis of the costs of packages and platforms—and of the health improvements they can generate in given epidemiological environments—can help guide health system investments and development.

The third edition is being completed. *DCP3* differs substantively from *DCP1* and *DCP2* by extending and consolidating the concepts of platforms and packages and by offering explicit consideration of the financial-risk-protection objective of health systems. In populations lacking access to health insurance or prepaid care, medical expenses that are high relative to income can be impoverishing. Where incomes are low, seemingly inexpensive medical procedures can have catastrophic financial consequences. *DCP3*

offers an approach that explicitly includes financial protection as well as the distribution across income groups of financial and health outcomes resulting from policies (for example, public finance) to increase intervention uptake (Verguet, Laxminarayan, and Jamison 2015). The task in all the volumes has been to combine the available science about interventions implemented in very specific locales and under very specific conditions with informed judgment to reach reasonable conclusions about the impact of intervention mixes in diverse environments. *DCP3*'s broad aim is to delineate essential intervention packages— such as the essential packages in this volume—and their related delivery platforms. This information will assist decision makers in allocating often tightly constrained budgets so that health system objectives are maximally achieved.

DCP3's nine volumes are being published in 2015 and 2016 in an environment in which serious discussion continues about quantifying the sustainable development goal (SDG) for health (United Nations 2015). *DCP3*'s analyses are well placed to assist in choosing the means to attain the health SDG and assessing the related costs. Only when these volumes, and the analytic efforts on which they are based, are completed will we be able to explore SDG-related and other broad policy conclusions and generalizations. The final *DCP3* volume will report those conclusions. Each individual volume will provide valuable specific policy analyses on the full range of interventions, packages, and policies relevant to its health topic.

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LEVELS AND TRENDS IN RMNCH INDICATORS

Reproductive Health

Poor reproductive health outcomes for women and their children may result from a broad spectrum of morbid conditions and adverse circumstances and risk factors, such as unsafe sex leading to unwanted pregnancies and sexually transmitted infections, as well as violence against women and girls. Because these are sensitive matters and are often related to gender inequality in a cultural and social context, measuring and quantifying the burden of these conditions and risk factors remains a challenge. This *DCP3* volume focuses on four conditions and risk factors that have significant impacts on reproductive health: unwanted pregnancies, unsafe abortions, infertility, and violence against women.

In 2015, 12 percent of married or in-union women of reproductive age worldwide want to delay or avoid pregnancy but are not using any method of contraception. For example, women in Sub-Saharan Africa are twice as likely to have an unmet need for family planning compared with the rest of the world (UN 2015). The total fertility rate remains very high in many countries in Sub-Saharan Africa (map 1.1, panel a).
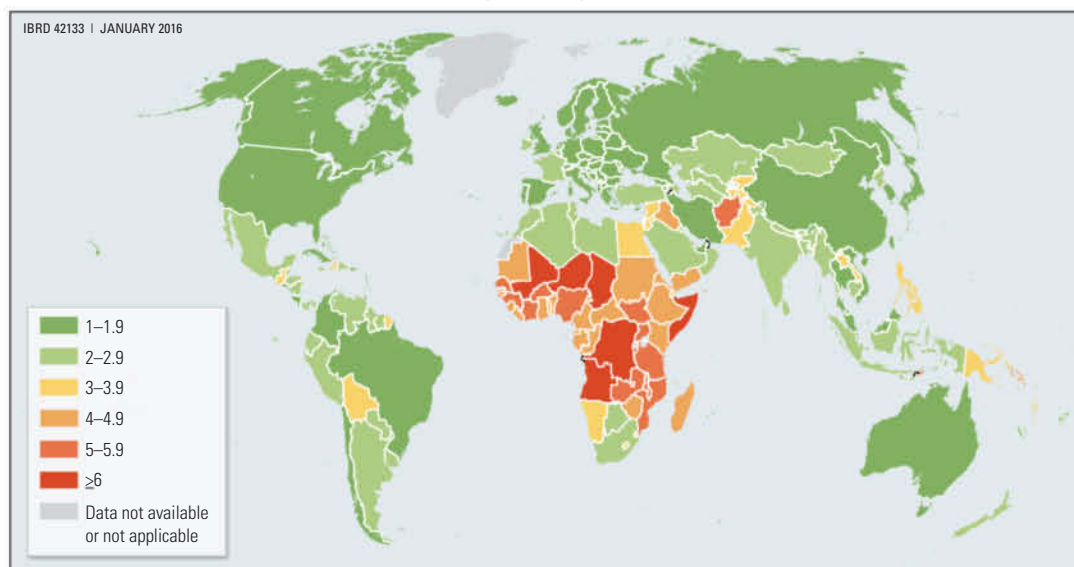
An estimated 74 million unintended pregnancies occurred in LMICs in 2012 (Sedgh, Singh, and Hussain 2014). Some of these ended by unsafe abortion, a major cause of maternal morbidity and mortality (Singh, Sedgh, and Hussain 2010). About 8.5 million women worldwide suffer complications from unsafe abortions annually (Singh, Darroch, and Ashford 2014). Regardless of legal status or policies on abortion, it can be fairly stated that preventing unsafe abortion is critical and that effective programming for reproductive health needs should be uncoupled from laws on the legal status of abortion. The large effects of reducing unwanted pregnancies on maternal, neonatal, and child deaths and stillbirths are estimated in a later section of this chapter.

Another hidden burden of reproductive health is infertility. In 2010, an estimated 48.5 million women were involuntarily childless as a result of male or female infertility, or both. This is especially concerning in LMICs, where infertility can lead to severe stigmatization, economic deprivation and denial of inheritance, divorce, and social isolation (Chachamovich and others 2010; Cui 2010).

As an extreme manifestation of social and gender inequality, violence against women and girls is often a hidden problem, with serious health consequences. Women exposed to intimate partner violence are more likely to have poor pregnancy outcomes; acquire HIV

Map 1.1 Total Fertility, Maternal Mortality Ratios, and Under-Five Mortality Rates by Country, 2015
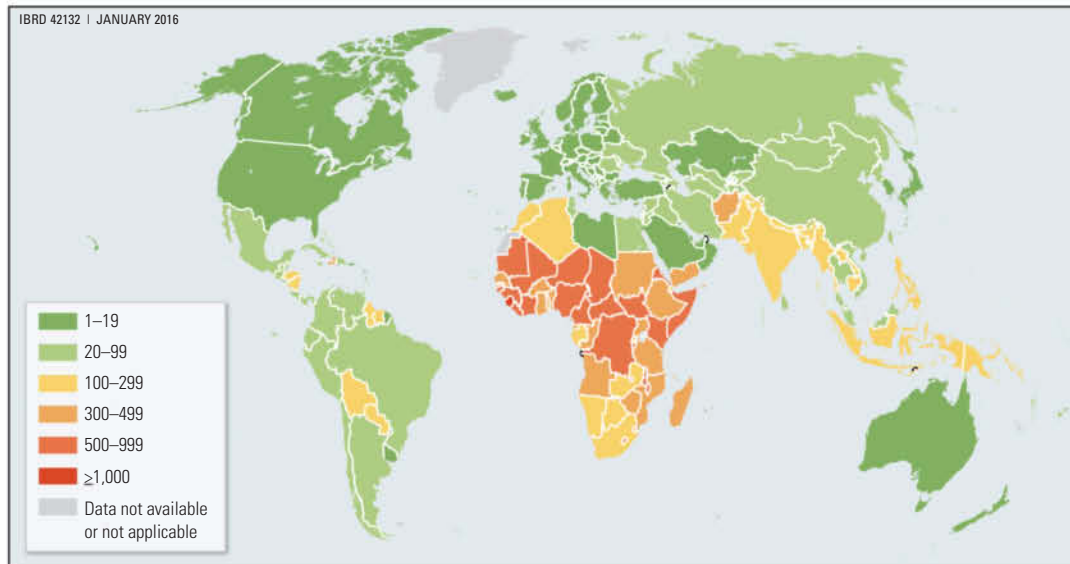
a. Total Fertility (children per woman) 2010–15

IBRD 42133 | JANUARY 2016

Legend:
- 1–1.9
- 2–2.9
- 3–3.9
- 4–4.9
- 5–5.9
- ≥6
- Data not available or not applicable

Source: Based on UNPD 2015 (http://esa.un.org/unpd/wpp); map re-created based on WHO 2015.
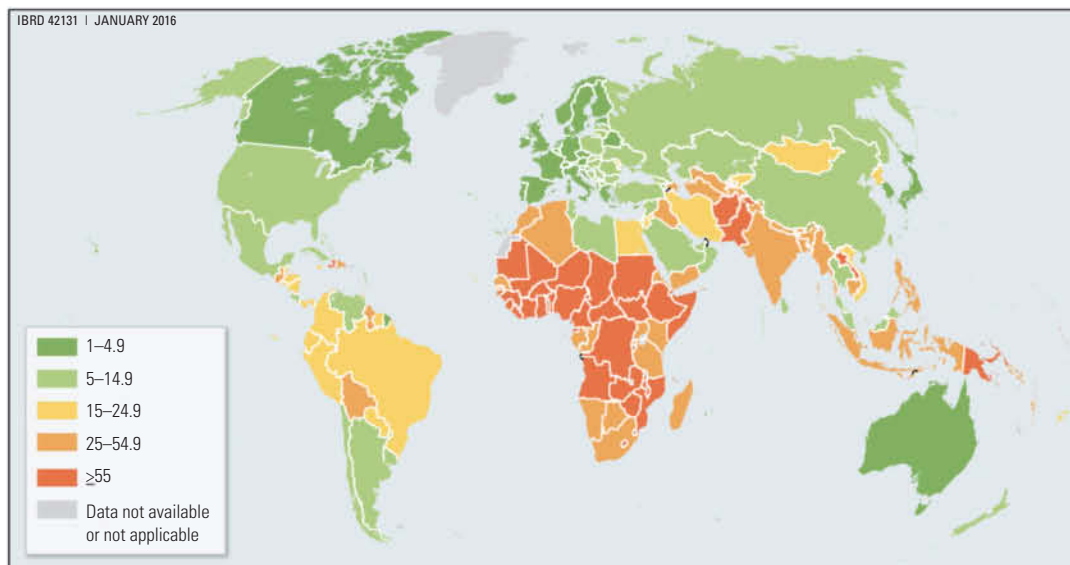
map continues next page

Map 1.1 Total Fertility, Maternal Mortality Ratios, and Under-Five Mortality Rates by Country, 2015 (continued)

b. Maternal Mortality Ratios, 2015

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Legend:
- 1–19
- 20–99
- 100–299
- 300–499
- 500–999
- ≥1,000
- Data not available or not applicable

Source: Based on WHO 2015; map re-created based on WHO 2015.

c. Under-Five Mortality per 1,000 Live Births, 2015

IBRD 42131 | JANUARY 2016

Legend:
- 1–4.9
- 5–14.9
- 15–24.9
- 25–54.9
- ≥55
- Data not available or not applicable

Source: Based on UN IGME 2015; map re-created based on WHO 2015.

(in some regions), syphilis, chlamydia, or gonorrhea; experience depression; or have alcohol abuse disorders (WHO, Department of Reproductive Health and Research, London School of Hygiene and Tropical Medicine, and South African Medical Research Council 2013). Studies have found between 3 percent and 31 percent of women report partner violence during pregnancy (Devries and others 2010). Worldwide, 30 percent of women age 15–49 years in a relationship experience physical or sexual violence by their intimate partner at some point in their lives (WHO, Department of Reproductive Health and Research, London School of Hygiene and Tropical Medicine, and South African Medical Research Council 2013). Tragically, many women do not seek help following these events.

Maternal Mortality and Morbidity

Globally, the total number of maternal deaths decreased by 43 percent, from 532,000 in 1990 to 303,000 in 2015, and the global maternal mortality ratio declined by 44 percent, from 385 maternal deaths per 100,000 live births in 1990 to 216 in 2015 (Alkema and others 2015). LMICs continue to account for 99 percent (302,000 out of 303,000) of global maternal deaths. The highest risks of maternal death are in countries in South Asia and Sub-Saharan Africa (map 1.1, panel b). Thus, while considerable progress has been made, particularly in recent years, the goal of reducing maternal mortality by 75 percent by 2015 was not met.

The risk of maternal death has two components: the risk of getting pregnant, which is a risk related to fertility and its control or lack of control; and the risk of developing a complication and dying while pregnant, in labor, or postpartum. Chapter 3 of this volume, on maternal morbidity and mortality, focuses on the risk during pregnancy, delivery, and postpartum, which is highest at the time of delivery (Filippi and others 2016).

The most important causes of maternal death are obstetric hemorrhage, hypertension, abortion, and sepsis (figure 1.1, panel a). The overall proportion of HIV-related maternal deaths is highest in Sub-Saharan Africa (Say and others 2014). Most maternal deaths do not have well-defined medical causes, and given that many occur in the community rather than health facilities, determining the cause is challenging. Deaths due to abortive outcomes (for example, ectopic pregnancy, induced abortion, and miscarriage), obstructed labor, and indirect causes are of considerable programmatic interest, but are particularly difficult to capture because of poor reporting resulting from lack of knowledge and the sensitive nature of abortion and maternal deaths in facilities. Deaths due to abortion are often not reported to avoid stigma. Despite the availability of proven interventions, the persistence of deaths due to hemorrhage and hypertension are particularly concerning.

The common causes of maternal morbidity in the community vary by region; these causes include anemia, preexisting hypertension or diabetes, depression, and other mental health conditions. Prolonged and obstructed labor is associated with a high burden of morbidity and disability, including that due to obstetric fistula. The true extent of maternal morbidity is not known because of difficulties in definition and measurement. The World Health Organization (WHO) is currently working with partners to develop standard definitions and tools to close this gap.

Perinatal, Neonatal, and Child Mortality

The under-five mortality rate (U5MR), the probability of dying between a live birth and the fifth birthday, is one of the most important measures of the health of a population. Although MDG 4 was not achieved globally, some high-mortality countries in South Asia and Sub-Saharan Africa have achieved this target (Afnan-Holmes and others 2015; Amouzou and others 2012). The U5MR remains very high, especially in many countries in Sub-Saharan Africa (map 1.1, panel c).
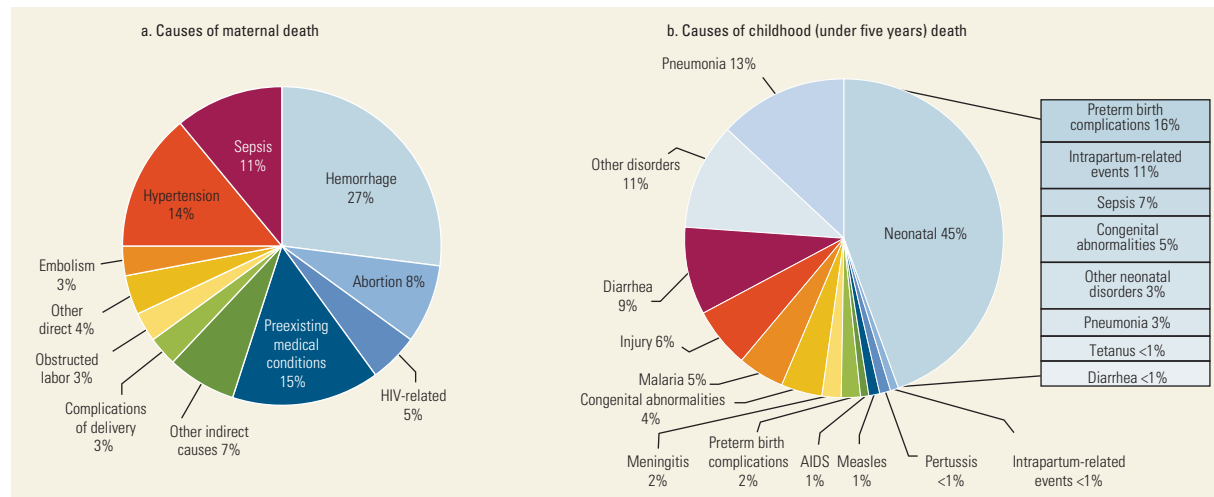
The U5MR in 2015 is 42.5 per 1,000 live births, a decline from 90.6 per 1,000 live births in 1990 (You and others 2015). The U5MR fell by half or more from 1990 to 2015 in all world regions. The UN estimates that only 24 of 82 low- or lower-middle-income countries achieved the MDG 4 target (You and others 2015). However, it is important to note that compared with historical trends, the reduction of U5MR has accelerated since 2000, when the MDGs were approved (You and others 2015).

The neonatal mortality rate is now widely followed as an important population health measure because a large proportion (45 percent in 2015) of the deaths in children under age five years occurs in the first month of life. In addition, the rate of stillbirths has received more attention with the recognition of the large number of viable fetuses (2.6 million in 2015) who die after 28 weeks of gestation, often at the time of delivery (Blencowe and others 2016).

Of the 5.9 million deaths occurring after a live birth before age five years, pneumonia, diarrhea, and neonatal sepsis or meningitis are the leading infectious causes (figure 1.1, panel b). The leading single cause of child deaths was complications from preterm birth, followed by pneumonia and intrapartum-related complications, formerly known as birth asphyxia. In the next 15 years, with further implementation of proven health interventions, it is anticipated that the infectious causes of death will decline more quickly than noninfectious causes (Liu and others 2014).

The proportion of global live births in Sub-Saharan Africa is projected to increase from 24.9 percent currently to 32.6 percent by 2030 because of the region's high fertility rate compared with other regions. If the current regional trends in child mortality are continued to 2030, global child deaths will fall to 4.4 million (Liu and others 2014). However, because of both the high number of births and high U5MR, Sub-Saharan Africa's share of global child deaths is expected to increase from 49.6 percent to 59.8 percent by 2030.

Figure 1.1 Causes of Maternal and Child Deaths

a. Causes of maternal death

Source: Say and others 2014.

b. Causes of childhood (under five years) death

Source: Liu and others 2016.

MATERNAL, FETAL, AND CHILD MALNUTRITION AND EARLY CHILD DEVELOPMENT

Malnutrition includes both undernutrition and the growing problem of overweight, both important problems in women and children under age five years. In women of reproductive age (age 20–49 years), a body mass index (BMI) of less than 18.5 kilograms weight/height in meters squared (kg/m^2) is defined as undernutrition or excessive thinness, and a BMI of greater than or equal to 25 kg/m^2 is considered overweight. The prevalence of maternal undernutrition has fallen from almost 20 percent in Asia and Africa to about 10 percent, which is still too high (Black and others 2013). The prevalence of overweight in women has steadily increased during the same period in all world regions, reaching more than 50 percent in the Americas and in Oceania, 30 percent in Africa, and 20 percent in Asia (Black and others 2013). Deficiencies of iodine, calcium, zinc, iron, and other essential vitamins and minerals are also prevalent and have particular relevance to maternal and fetal health.

Restriction of fetal growth, usually assessed by a low weight for gestational age at birth, is due to poor maternal nutrition and other morbidity, infection, and toxic in-utero exposures (Das and others 2016). Compared to a U.S. birthweight reference, more than a quarter of all live births in LMICs, or 32.4 million babies, were born small-for-gestational age (Black and others 2013). A new international birthweight standard has subsequently been published (Villar and others 2014). Compared with this standard, the estimated global prevalence of small-for-gestational-age births is about one-quarter lower (Kozuki and others 2015). As neonates and infants, these babies have a higher risk of mortality than babies who were appropriate weight for gestational age, and this risk is similar using either the U.S. reference or the new international standard (Kozuki and others 2015). They also have an increased risk of stunted linear growth (Black and others 2013; Christian and others 2013). The risk of mortality with small-for-gestational age birth increases if they are also premature.

Compared with an international growth standard, it was estimated that in 2011 26 percent of children globally had stunted linear growth (height-for-age of less than −2 standard deviations of the growth standard), totaling 165 million children (Black and others 2013). The prevalence of stunting has declined in LMICs since 1990, more in Asia and Latin America than in Africa. Stunting prevalence has declined at similar rates in rural and urban areas but remains higher in rural areas (Stevens, Paciorek, and Finucane 2016). Severe wasting, which was estimated to affect 3 percent, or 19 million, of the world's children in 2011, requires urgent intervention with therapeutic feeding and treatment of concurrent infections (Lenters, Wazny, and Bhutta 2016). Of the micronutrient deficiencies, vitamin A and zinc deficiencies are associated with increased risk of mortality and infectious disease morbidity (Black and others 2013; Das and others 2016). At the same time, overweight (greater than 2 standard deviations of the growth

standard weight for height) has steadily increased since 1990 to 7 percent, an increase of more than 50 percent, affecting 43 million children.

Fetal growth restriction, suboptimal breastfeeding, stunting, wasting, and deficiencies of vitamin A and zinc, usually in combination with infectious diseases, are important underlying causes of neonatal and child deaths. These conditions have been estimated to be the underlying causes of 45 percent of deaths in children under age five years (Black and others 2013).

Grantham-McGregor and International Child Development Committee (2007) estimate that a high proportion of the world's surviving children do not reach their developmental potential, based on rates of stunting and poverty. This poor development outcome has numerous causes, including antenatal and postnatal nutrition, exposure to violence, brain injuries or infections, and environments with insufficient stimulation (Aboud and Yousafzai 2016). Critical periods for brain development are during fetal growth and in the first two years of life. Micronutrient deficiencies in pregnancy have important consequences, such as compromised mental development with iodine deficiency and neural tube defects with folic acid deficiency (Black and others 2013). Inadequate diets and high rates of infectious diseases in the first two years of life lead to short stature (stunting) and permanent deficits in cognitive and social development. Additional important determinants of development in children are the amount and quality of household psychosocial stimulation (Singla, Kumbakumba, and Aboud 2015) and the effects of maternal illness, including depression (Walker and others 2007).

INTERVENTIONS TO REDUCE MATERNAL AND CHILD MORBIDITY AND MORTALITY

The RMNCH volume identifies essential interventions, based on their efficacy and appropriateness, to address important health conditions. Tables 1.1–1.3 list these interventions in the least advanced service platform at which their delivery is possible. The three platforms represent services that can be provided by (1) community health workers or health posts; (2) primary health centers; or (3) hospitals, both first-level and referral. The interventions are grouped by the point at which they are needed in the continuum of care. We also consider the nature of their delivery (urgent, continuing care, or routine care), which has important implications for the organization and responsibilities of the health system.

ESSENTIAL INTERVENTIONS ON STILLBIRTHS AND MATERNAL, NEONATAL, AND CHILD DEATHS

In this volume, we define three packages of interventions across the RMNCH continuum with the greatest potential to reduce deaths and disability: reproductive health, maternal and newborn health, and child (age 1–59 months) health.

We report on estimated morbidity and mortality from 75 countries that include more than 95 percent of the world's maternal and child deaths, the countries that had been monitored in the Countdown to 2015 initiative (Requejo and others 2015). Estimates are derived using the Lives Saved Tool (LiST; box 1.2) by increasing the coverage of each intervention to 90 percent from the current level of coverage in each of these 75 countries (Requejo and others 2015).

The deaths averted by individual interventions in the maternal and newborn health and the child health packages are shown in figure 1.2. The immediate (for 2015) impact on deaths of the individual interventions and their combined effects if implemented together was estimated. For these estimates, the effects of folic acid supplementation in the reproductive health package are considered, and these effects are combined with the maternal and newborn package for presentation.

A separate analysis was undertaken for family planning services in the reproductive health package, in which the provision of contraception is scaled up to cover 90 percent of current unmet need (Walker, Tam, and Friberg 2013). Because this reduces the number of pregnancies, we calculated the number of maternal, neonatal, and child deaths and stillbirths that would be prevented if the rates of mortality in 2015 had applied to these pregnancies and births. Estimates of the effects of other interventions such as human papillomavirus vaccination or targeted health care approaches for adolescents are considered in other volumes (for example, volume 3 *Cancer* and volume 8 *Child and Adolescent Development*).

The impact is also considered for interventions provided by each of three platforms for health services (see tables 1.1–1.3). The community platform includes all interventions that can be delivered by a community-based health worker with appropriate training and support or by outreach services, such as child health days, immunizations, vitamin A, and other interventions. For ill children, the integrated community case management (iCCM) approach is assumed to include diagnosis and treatment of pneumonia, diarrhea, and malaria cases without danger signs that indicate the need for referral (Hamer and others 2012; Young and others 2012).

Lives Saved Tool

The Lives Saved Tool (LiST) has been continually developing since 2003. The initial version of the software was developed as part of the work for the Child Survival Series in *The Lancet* in 2003 (Jones and others 2003). The original purpose of the program was to estimate the impact that scaling up community-based interventions would have on under-five mortality (Jones and others 2003). The Bill & Melinda Gates Foundation provided support for the further development and maintenance of the software as part of the work of the Child Health Epidemiology Reference Group (CHERG). At that point, the software was shifted into the free and publicly available Spectrum software package, to take advantage of the demographic capabilities in that software and to provide links to other models for family planning and AIDS (Stover, McKinnon, and Winfrey 2010). Since that time, LiST has expanded its scope to examine the impact of interventions on birth outcomes and stillbirths (Pattinson and others 2011), maternal mortality, and incidence of pneumonia and diarrhea (Bhutta and others 2013), as well as neonatal and child mortality.

LiST has been characterized as a linear, mathematical model that is deterministic (Garnett and others 2011). It describes fixed relationships between inputs and outputs that will produce the same outputs each time one runs the model. The primary inputs in LiST are coverage of interventions with the condition that the quality of that intervention is sufficient to be effective, what is commonly referred to as *effective coverage*. The outputs are changes in population-level risk factors (such as wasting or stunting rates, birth outcomes such as prematurity,

or size at birth) and cause-specific mortality (neonatal, child mortality for those age 1–59 months, maternal mortality, and stillbirths). The relationship between an input (change in intervention coverage) and one or more outputs is specified as a measure of the effectiveness of the intervention in reducing the probability of that outcome. The outcome can be cause-specific mortality or a risk factor. The overarching assumption in LiST is that mortality rates and cause-of-death structure will not change except in response to changes in coverage of interventions.
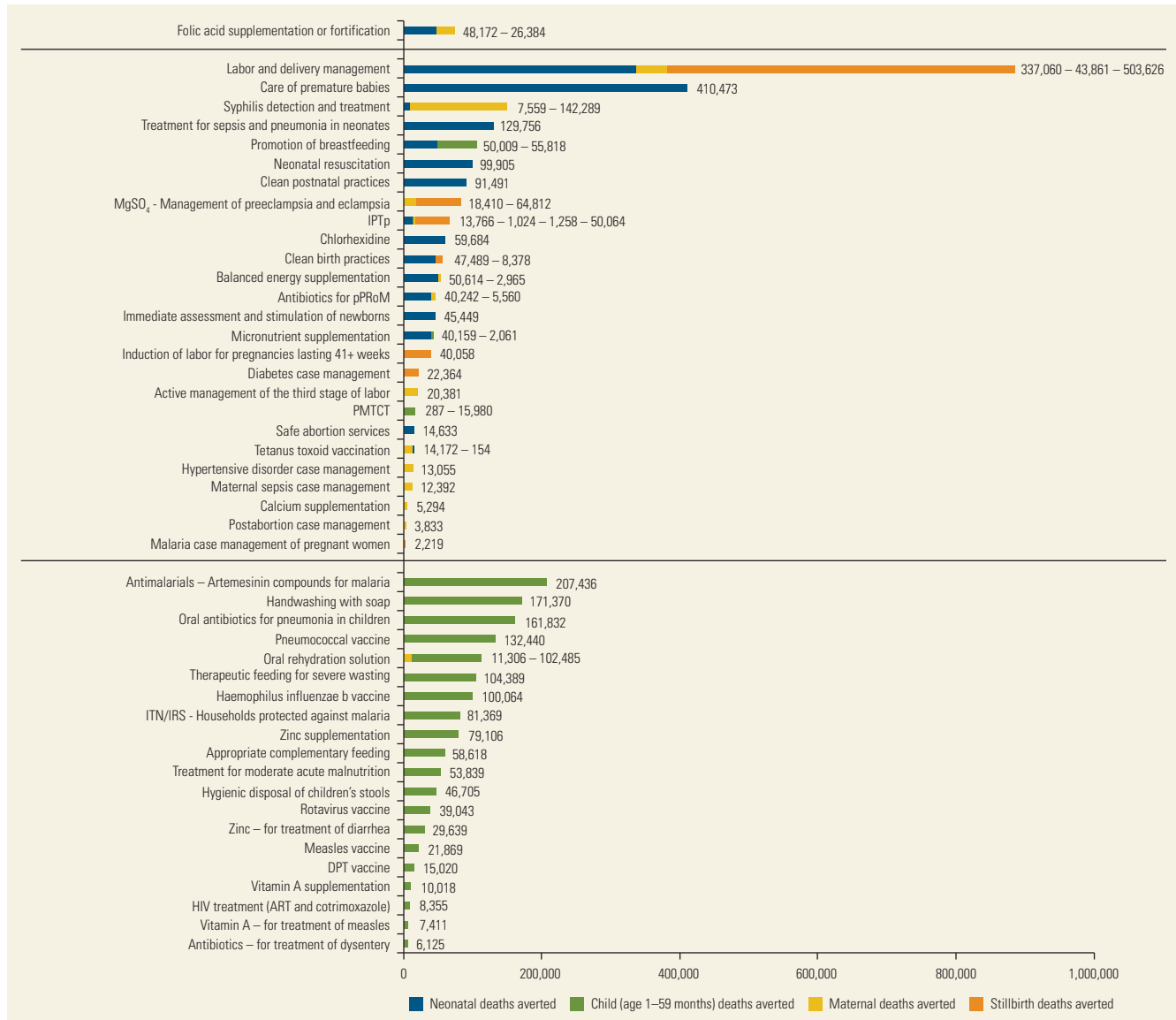
The roughly 70 separate interventions within LiST (see tables 1.1–1.3) target stillbirths, neonatal mortality, mortality in children age 1–59 months, maternal mortality, or risk factors such as stunting and wasting, within the model. In LiST, interventions can be linked to multiple outcomes, with some interventions linked to multiple causes of death and risk factors. LiST allows the impact of scaling up coverage of multiple interventions to be examined simultaneously.

CHERG, along with its institutional sponsors, the WHO and UNICEF, developed rules of evidence to decide what interventions should be included in the model as well as how to develop the estimates of effectiveness (Walker and others 2010). The assumptions used within LiST are drawn from various sources, but most of the evidence about effectiveness of interventions is presented in three journal supplements (Fox and others 2011; Sachdev, Hall, and Walker 2010; Walker 2013). The set of assumptions and their sources can be found at the LiST website (http://www.livessavedtool.org).

The primary health center (PHC) platform is a facility with a doctor or a nurse midwife (or both), nurses and support staff, as well as basic diagnostic and treatment capabilities. The PHC provides facility-based contraceptive services, including long-acting reversible contraceptives (implants, intrauterine devices); surgical sterilization (vasectomy, tubal ligation); care during pregnancy and delivery for uncomplicated pregnancies; provision of medical care for adults and children, such as injectable antibiotics, that cannot be done in the community; and

training and supervision of community-based workers. For LiST modeling, the effects of meeting the unmet need for contraceptives are considered to be delivered by the PHC platform. For young infants and children, the Integrated Management of Childhood Illness approach is assumed to be used at the PHC level (Bryce and others 2004). The hospital platform, consisting of both first-level and referral hospitals, includes more advanced services for management of labor and delivery in high-risk women or those with complications, including operative

Figure 1.2 Deaths Averted by Individual Interventions in the Maternal and Newborn Health and Child Health Packages

Folic acid supplementation or fortification — 48,172 − 26,384

Labor and delivery management — 337,060 − 43,861 − 503,626
Care of premature babies — 410,473
Syphilis detection and treatment — 7,559 − 142,289
Treatment for sepsis and pneumonia in neonates — 129,756
Promotion of breastfeeding — 50,009 − 55,818
Neonatal resuscitation — 99,905
Clean postnatal practices — 91,491
MgSO₄ - Management of preeclampsia and eclampsia — 18,410 − 64,812
IPTp — 13,766 − 1,024 − 1,258 − 50,064
Chlorhexidine — 59,684
Clean birth practices — 47,489 − 8,378
Balanced energy supplementation — 50,614 − 2,965
Antibiotics for pPRoM — 40,242 − 5,560
Immediate assessment and stimulation of newborns — 45,449
Micronutrient supplementation — 40,159 − 2,061
Induction of labor for pregnancies lasting 41+ weeks — 40,058
Diabetes case management — 22,364
Active management of the third stage of labor — 20,381
PMTCT — 287 − 15,980
Safe abortion services — 14,633
Tetanus toxoid vaccination — 14,172 − 154
Hypertensive disorder case management — 13,055
Maternal sepsis case management — 12,392
Calcium supplementation — 5,294
Postabortion case management — 3,833
Malaria case management of pregnant women — 2,219

Antimalarials − Artemesinin compounds for malaria — 207,436
Handwashing with soap — 171,370
Oral antibiotics for pneumonia in children — 161,832
Pneumococcal vaccine — 132,440
Oral rehydration solution — 11,306 − 102,485
Therapeutic feeding for severe wasting — 104,389
Haemophilus influenzae b vaccine — 100,064
ITN/IRS - Households protected against malaria — 81,369
Zinc supplementation — 79,106
Appropriate complementary feeding — 58,618
Treatment for moderate acute malnutrition — 53,839
Hygienic disposal of children's stools — 46,705
Rotavirus vaccine — 39,043
Zinc − for treatment of diarrhea — 29,639
Measles vaccine — 21,869
DPT vaccine — 15,020
Vitamin A supplementation — 10,018
HIV treatment (ART and cotrimoxazole) — 8,355
Vitamin A − for treatment of measles — 7,411
Antibiotics − for treatment of dysentery — 6,125

■ Neonatal deaths averted ■ Child (age 1–59 months) deaths averted ■ Maternal deaths averted ■ Stillbirth deaths averted

Note: ART = antiretroviral therapy; DPT = diphtheria, pertussis, tetanus; HIV = human immunodeficiency virus; IPTp = intermittent preventive treatment in pregnancy; ITN/IRS = insecticide-treated net/indoor residual spraying; MgSO₄ = magnesium sulfate; PMTCT = prevention of mother-to-child transmission; pPRoM = preterm premature rupture of membranes.

delivery, full supportive care for preterm newborns, and children with severe infection or severe acute malnutrition with infection.

The reproductive health package, other than provision of contraceptive services, consists primarily of educational interventions that are not expected to have a direct impact on deaths, but are important to encourage behaviors to prevent infections, ensure proper nutrition of girls before pregnancy, or to seek care for antenatal or delivery services at other levels. The effects of these practices or treatments are included in LiST and are assigned to the level at which the practice or treatment occurs.

Some deaths are averted through provision of folic acid before conception and in early pregnancy, reducing both stillbirths and neonatal deaths by preventing fetal neural tube defects, resulting in a reduction of stillbirths of 26,000 and neonatal deaths of 48,000 at the current rates of fertility. These deaths are included in the maternal and newborn package for presentation in this chapter.

The largest effect of the reproductive health package is from the contraceptive services that prevent unintended pregnancies. It is estimated that if 90 percent of current unmet need for contraceptives had been met, 28 million births would have been prevented in 2015. This level of

Table 1.1 Essential Interventions for Reproductive Health

	Delivery platform[a]		
	Community workers or health post	**Primary health center**	**First-level and referral hospitals**
Information and education	1. Sexuality education		
	2. Nutritional education and food supplementation		
	3. Promotion of care-seeking for antenatal care and delivery		
	4. Prevention of sexual and reproductive tract infections	1. Detection and treatment of sexual and reproductive tract infections	
	5. Prevention of female genital mutilation (may be for daughters of women of reproductive age)	2. Management of complications following female genital mutilation	
	6. Prevention of gender-based violence	3. Post-gender-based violence care (prevention of sexually transmitted infection and HIV, emergency contraception, support and counseling)	
	7. Information about cervical cancer and screening	4. Screening and treatment of precancerous lesions, referral of cancers	1. Management of cervical cancer
Service delivery	8. Folic acid supplementation[b]		
	9. Immunization (human papillomavirus, hepatitis B)		
	10. Contraception: Provision of condoms and hormonal contraceptives[b]	5. Tubal ligation, vasectomy, and insertion and removal of long-lasting contraceptives[b]	2. Management of complicated contraceptive procedures

Note: Red type denotes urgent care, blue type denotes continuing care, and black type denotes routine care. In this table, the community worker or health post consists of a trained and supported health worker based in or near communities working from home or a fixed health post. A primary health center is a health facility staffed by a physician or clinical officer and often a midwife to provide basic medical care, minor surgery, family planning and pregnancy services, and safe childbirth for uncomplicated deliveries. First-level and referral hospitals provide full supportive care for complicated neonatal and medical conditions, deliveries, and surgeries.
HIV = human immunodeficiency virus.
a. All interventions listed for lower-level platforms can be provided at higher levels. Similarly, each facility level represents a spectrum and diversity of capabilities. The column in which an intervention is listed is the lowest level of the health system in which it would usually be provided.
b. The intervention effect was included in the Lives Saved Tool (LiST).

Table 1.2 Essential Interventions for Maternal and Newborn Health

	Delivery platform[a]		
	Community worker or health post	**Primary health center**	**First-level and referral hospitals**
Pregnancy	1. Preparation for safe birth and newborn care; emergency planning		
	2. Micronutrient supplementation[b]		
	3. Nutrition education[b]		

table continues next page

Table 1.2 Essential Interventions for Maternal and Newborn Health (continued)

	Delivery platform[a]		
	Community worker or health post	**Primary health center**	**First-level and referral hospitals**
	4. IPTp[b]		
	5. Food supplementation[b]		
	6. Education on family planning	1. Management of unwanted pregnancy[b]	
	7. Promotion of HIV testing	2. Screening and treatment for HIV and syphilis[b]	
		3. Management of miscarriage or incomplete abortion and postabortion care[b]	
		4. Antibiotics for pPRoM[b]	
		5. Management of chronic medical conditions (hypertension, diabetes mellitus, and others)	
		6. Tetanus toxoid[b]	
		7. Screening for complications of pregnancy[b]	
		8. Initiate antenatal steroids (as long as clinical criteria and standards are met)[b]	1. Antenatal steroids[b]
		9. Initiate magnesium sulfate (loading dose)[b]	2. Magnesium sulfate[b]
		10. Detection of sepsis[b]	3. Treatment of sepsis[b]
			4. Induction of labor postterm[b]
			5. Ectopic pregnancy case management[b]
			6. Detection and management of fetal growth restriction[b]
Delivery (woman)	8. Management of labor and delivery in low-risk women by skilled attendant[b]	11. Management of labor and delivery in low-risk women (BEmNOC) including initial treatment of obstetric and delivery complications prior to transfer[b]	7. Management of labor and delivery in high-risk women, including operative delivery (CEmNOC)[b]
Postpartum (woman)	9. Promotion of breastfeeding[b]		
Postnatal (newborn)	10. Thermal care for preterm newborns[b]	12. Kangaroo mother care[b]	8. Full supportive care for preterm newborns[b]
	11. Neonatal resuscitation[b]		
	12. Oral antibiotics for pneumonia[b]	13. Injectable and oral antibiotics for sepsis, pneumonia, and meningitis[b]	9. Treatment of newborn complications, meningitis, and other very serious infections[b]
		14. Jaundice management[b]	

Note: Red type denotes urgent care, blue type denotes continuing care, black type denotes routine care. In this table, the community worker or health post consists of a trained and supported health worker based in or near communities working from home or a fixed health post. A primary health center is a health facility staffed by a physician or clinical officer and often a midwife to provide basic medical care, minor surgery, family planning and pregnancy services, and safe childbirth for uncomplicated deliveries. First-level and referral hospitals provide full supportive care for complicated neonatal and medical conditions, deliveries, and surgeries.

BEmNOC = basic emergency newborn and obstetric care; CEmNOC = comprehensive emergency newborn and obstetric care; HIV = human immunodeficiency virus; IPTp = intermittent preventive treatment in pregnancy; pPRoM = preterm premature rupture of membranes.

a. All interventions listed for lower-level platforms can be provided at higher levels. Similarly, each facility level represents a spectrum and diversity of capabilities. The column in which an intervention is listed is the lowest level of the health system in which it would usually be provided.

b. The intervention effect was included in the Lives Saved Tool (LiST).

Table 1.3 Essential Interventions for Child Health

Delivery platform[a]		
Community worker or health post	**Primary health center**	**First-level and referral hospitals**
1. Promote breastfeeding and complementary feeding[b]		
2. Provide vitamin A, zinc, and food supplementation[b]		
3. Immunizations[b,c]		
4. Cotrimoxazole for HIV-positive children[b]	1. Antiretroviral therapy for HIV-positive children[b]	
5. Education on safe disposal of children's stools and handwashing[b]		
6. Distribute and promote use of ITNs or IRS[b]		
7. Detect and refer severe acute malnutrition[b]	2. Treat severe acute malnutrition[b]	1. Treat severe acute malnutrition associated with serious infection[b]
8. Detect and treat serious infections without danger signs (iCCM[d]); refer if danger signs[b]	3. Detect and treat serious infections with danger signs (IMCI[d])[b]	2. Detect and treat serious infections with danger signs with full supportive care[b]

Note: Red type denotes urgent care, blue type denotes continuing care, black type denotes routine care. In this table, the community worker or health post consists of a trained and supported health worker based in or near communities working from home or a fixed health post. A primary health center is a health facility staffed by a physician or clinical officer and often a midwife to provide basic medical care, minor surgery, family planning and pregnancy services, and safe childbirth for uncomplicated deliveries. First-level and referral hospitals provide full supportive care for complicated neonatal and medical conditions, deliveries, and surgeries.

HIV = human immunodeficiency virus; iCCM = integrated community case management; IMCI = integrated management of childhood illness; IRS = indoor residual spraying; ITN = insecticide-treated net.

a. All interventions listed for lower-level platforms can be provided at higher levels. Similarly, each facility level represents a spectrum and diversity of capabilities. The column in which an intervention is listed is the lowest level of the health system in which it would usually be provided.

b. The intervention effect was included in the Lives Saved Tool (LiST).

c. Immunizations included in the standard package are those for diphtheria, pertussis, tetanus, polio, bacillus Calmette-Guerin, measles, hepatitis B, Haemophilus influenzae type b, pneumococcus, rotavirus.

d. Components of iCCM are treatments for diarrhea, pneumonia, and malaria; and of IMCI are treatments of diarrhea, pneumonia, malaria, AIDS (acquired immune deficiency syndrome), other infections, and severe acute malnutrition.

contraception, in turn, would reduce maternal deaths by 67,000, neonatal deaths by 440,000, child deaths by 473,000, and stillbirths by 564,000. Because about half of unwanted pregnancies are ended in abortion, preventing these pregnancies would also reduce millions of abortions, more than half of which would have been unsafe (Singh and others 2009). In addition, delayed age of first pregnancy and avoidance of short interpregnancy intervals would reduce adverse birth outcomes such as preterm delivery. It is important to note that these potential deaths averted by preventing unplanned pregnancies cannot be added to the potential lives saved by the maternal and newborn and child health packages (plus folic acid supplementation), which are estimated at the current rates of fertility and mortality.
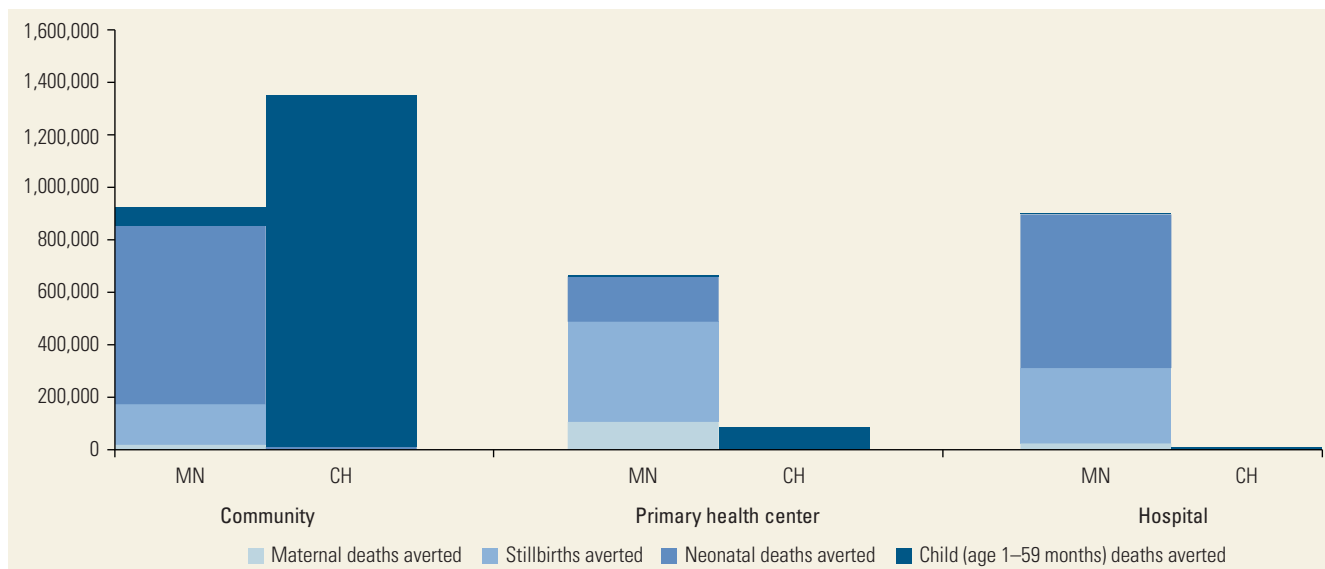
The maternal and newborn package provides many interventions resulting in large effects on all of the mortality outcomes in the current year (figure 1.3). We estimate that 2,574,000 deaths would be averted, including 149,000 maternal deaths, 849,000 stillbirths, 1,498,000 neonatal deaths, and 78,000 child deaths (figure 1.2).

For stillbirths, 19 percent could be averted with the community platform, 46 percent with the PHC platform, and an additional 35 percent in hospitals. For maternal deaths, 13 percent could be averted with the community platform, 71 percent with the PHC platform, and the remaining 16 percent with hospital care. For neonatal deaths, the relative effects on level of services are different from maternal deaths, with a possible 48 percent of newborn deaths averted with the community platform, an additional 12 percent with the PHC platform, and a further 40 percent with hospital care. The interventions with the largest effects are labor and delivery management, care of preterm births, and treatment of neonatal sepsis and pneumonia (figure 1.2).

The child health package includes essential interventions across all three service platforms and together these could avert 1,437,000 child deaths. The largest impact (93 percent of avertable child deaths) can be realized by interventions in the community platform (figure 1.3), especially through immunizations and treatment of infectious diseases (figure 1.2). The PHC platform

Figure 1.3 Deaths Averted by Health Care Packages through Three Service Platforms

Source: Analyses using the Lives Saved Tool (LiST).
Note: CH = child health package; MN = maternal and newborn package.

results in additional effects on child deaths primarily through treatment of severe infectious diseases and of severe acute malnutrition (SAM). SAM can be managed on an outpatient basis with therapeutic feeding but is placed in the PHC platform because of the need for initial assessment and stabilization. The hospital platform averts some additional deaths with full supportive care for very severe infectious diseases and malnutrition.

Scaling up all interventions in the maternal and newborn health and child health packages in 2015 would avert 149,000 maternal deaths, 849,000 stillbirths, 1,498,000 neonatal deaths, and 1,515,000 child deaths, a total of 4,011,000 deaths averted. Then, interventions would result in a reduction in about half of the estimated global 303,000 maternal deaths in 2015 and also about half of the 5,900,000 global newborn and child deaths (Alkema and others 2015; You and others 2015). However, they would result in a reduction of only about one-third of the 2,600,000 stillbirths (Blencowe and others, forthcoming). Well-functioning community and PHC platforms could avert 77 percent of maternal, newborn, and child deaths and stillbirths that are preventable by these essential interventions, with hospitals contributing the remaining averted deaths through more advanced management of complicated pregnancies and deliveries and newborn and child conditions.

An additional consideration for the organization of health services is whether the interventions can be provided as scheduled routine care (shown in black in
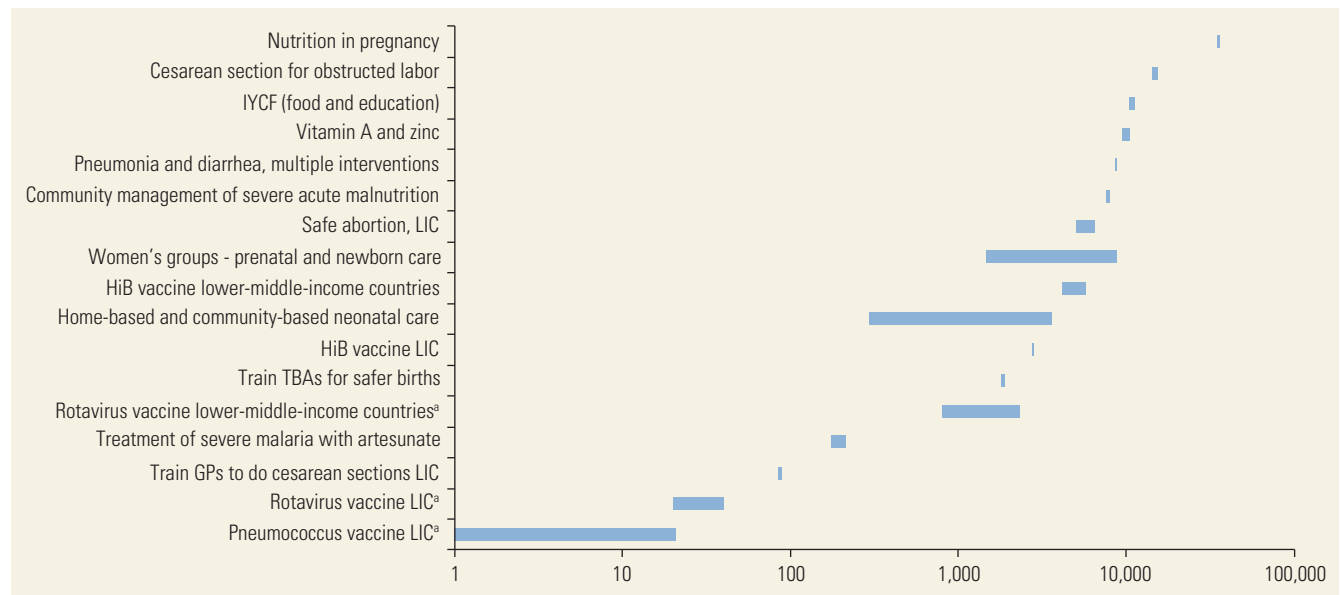
tables 1.1–1.3); provided as continuing care such as for chronic conditions (shown in blue in tables 1.1–1.3); or if the service has to be available at all times and offered as urgent care (shown in red in tables 1.1–1.3). Because of the unpredictable nature of most life-threatening conditions in maternal, newborn, and child health, such as complications of labor and delivery or acute illnesses, most of the essential interventions must be available for urgent care at all times of the day.

COST-EFFECTIVENESS

Individual RMNCH interventions, summarized in figure 1.4, have been shown to be cost-effective (Horton and Levin 2016). This volume explores the cost-effectiveness of packages of interventions that have not yet been scaled up across LMICs. It also reports on new results from extended cost-effectiveness analyses that look at financial-risk-protection outcomes in addition to the health outcomes that are part of traditional cost-effectiveness analyses.

Expansion of coverage of the traditional Expanded Program on Immunization package of bacillus Calmette-Guerin; diphtheria, pertussis, and tetanus; measles; polio; and hepatitis B vaccines remains highly cost-effective, regardless of delivery modality. Introduction of pneumococcal and rotavirus vaccines at Gavi (the Global Vaccine Alliance) prices can avert deaths at a cost of less

Figure 1.4 Cost-Effectiveness Ranges of Selected Interventions for Reproductive, Maternal, Neonatal, and Child Health for Cost per Death Averted (2012 U.S. dollars)

Note: Some vaccine results are for lower-middle-income countries. If country group is not specified, results refer to low and lower-middle-income countries combined.

GP = general practitioner; HiB = Haemophilus influenzae B; IYCF = infant and young child feeding interventions (education combined with food distribution to poorest); LIC = low-income country; TBA = traditional birth attendant.

a. Cost-effectiveness of vaccines is sensitive to vaccine price. Rotavirus and pneumococcus vaccine costs to LICs are a fraction (for example, 5 percent) of the price paid by Gavi, the Vaccine Alliance to procure the vaccines; Gavi, in turn, receives prices that are more favorable than what upper-middle-income countries pay as a result of volume discounts and other factors.

than US$100 per death (Horton and Levin 2016), but these estimates do not include reduced out-of-pocket expenditures, improved financial risk protection for households, or long-term benefits of improved cognition and lifetime productivity (Barnighausen and others 2014). Megiddo and others (2014) find that introduction of a rotavirus vaccine in India was cost-saving and was estimated to avert 34.7 (95 percent uncertainty range [UR], 31.7–37.7) deaths and US$215,569 (95 percent UR, US$207,846–US$223,292) out-of-pocket expenditure per 100,000 children under age five years.

Chapters in this volume have calculated that home-based management of maternal and neonatal care, including interventions to train traditional birth attendants for safer births (Sabin and others 2012), can be cost-effective with lower-end estimates of cost-effectiveness of less than US$1,000 per death averted. Scaling up midwifery services with referral when needed and family planning would cost US$2,200 per death averted (Bartlett and others 2014).

Using extended cost-effectiveness analysis (Verguet and others 2015), it was shown that investing in the provision of universal public finance for pneumonia treatment and for combined treatment with pneumococcal conjugate vaccine provides substantially higher financial risk protection and saves more lives for the poor in Ethiopia than the current situation. Financial risk protection associated with an intervention is measured using the money-metric-equivalent value of insurance, which is simply what an individual would pay as an insurance premium to ensure that they are fully protected against the disease or adverse health condition.

India alone accounts for 28 percent of neonatal deaths globally. In 2011, India introduced a home-based newborn care (HBNC) package to be delivered by community health workers across rural areas of the country. Nandi and others (2015) estimate the disease and economic burdens averted by scaling up the HBNC among households in rural India. Compared with a baseline of no coverage, providing the care package through the existing network of community health workers could avert 48 (95 percent uncertainty range [UR] 34–63) incident cases of severe neonatal morbidity and 5 (95 percent UR 4–7) related deaths, save US$4,411 (95 percent UR US$3,088–US$5,735) in out-of-pocket treatment expenditure, and provide US$285 (95 percent UR US$200–US$371) in insurance value per 1,000 live

births in rural India. Intervention benefits were greater for lower socioeconomic groups.

Investments that increase the supply and demand for RMNCH interventions can have long-lasting effects—for example, the benefits of investments in nutrition can go beyond the immediate improvement in nutritional status by also improving cognitive development, school performance, and future earnings (Victora and others 2008; Walker and others 2007).

The economic and social benefits of a set of integrated RMNCH interventions include health and fertility impacts (Stenberg and others 2014). Some of these benefits are strictly economic, reflected in higher gross domestic product (GDP) from increased workforce participation and higher productivity. Other benefits, denoted as *social benefits*, are not reflected in conventional GDP measures. For example, the value of a child's life saved does not depend only on his or her participation in the labor force when an adult. When taking into consideration the *full-income* approach that goes beyond GDP to also capture these social benefits, including from reducing morbidity and controlling fertility, the benefit-cost ratios indicate high returns on increased investment in RMNCH in most countries, especially when benefits beyond the intervention period are included. For all LMICs considered as a group, the benefit-cost ratio is 8.7 for the intervention period to 2035 at a 3 percent discount rate (Stenberg and others 2014; Stenberg and others 2016).

COST OF SCALING UP ESSENTIAL INTERVENTIONS FOR REPRODUCTIVE, MATERNAL, NEWBORN, AND CHILD HEALTH

This volume estimates the annual cost of scaling up three service packages for reproductive health (family planning costs only), maternal and newborn health, and child health in 74 of the 75 Countdown countries (Sudan is not included because of lack of data). These countries account for more than 95 percent of the world's maternal and child deaths. We estimate the annual incremental costs of scaling up the three packages described in table 1.1, based on per capita cost estimates from a global reproductive, maternal, newborn, and child health investment case (Stenberg and others 2014). Using population estimates for 2015 associated with the health impact shown in figure 1.3, the annual incremental cost is US$6.2 billion in low-income countries, US$12.4 billion in lower-middle-income countries, and US$7.9 billion in upper-middle-countries (table 1.4). Considering a longer time horizon of 2013 to 2035, the annual incremental costs of scaling up the three packages increases slightly depending on the country income groups, reflecting a larger target population, consistent with Stenberg and others (2014) and chapter 16 in this volume (Stenberg and others 2016). These estimates include health system strengthening costs, such as program management, infrastructure needs, improved

Table 1.4 Cost of Essential Reproductive Health (family planning only), Maternal and Newborn Health, and Child Health Packages by Country Income Group for 2015 and 2035 (million 2012 U.S. dollars, except per capita costs)

Package	Low-income countries		Lower-middle-income countries		Upper-middle-income countries		Total cost per package	
	2015	2035	2015	2035	2015	2035	2015	2035
Reproductive health package costs[a]	$562	$603	$520	$630	$151	$164	$1,233	$1,397
Cost per capita	$0.6	$0.5	$0.2	$0.2	$0.1	$0.1	$0.2	$0.2
Maternal and newborn health package costs[a]	$1,183	$1,268	$2,922	$3,542	$1,768	$1,923	$5,872	$6,733
Cost per capita	$1.3	$1.0	$1.1	$1.1	$0.9	$0.9	$1.0	$1.0
Child health package costs[a]	$4,484	$4,810	$8,838	$10,712	$6,060	$6,591	$19,382	$22,113
Cost per capita	$4.8	$3.9	$3.4	$3.3	$2.9	$2.9	$3.5	$3.3
Total costs	$6,229	$6,681	$12,406	$14,884	$7,979	$8,679	$26,614	$30,243
Total per capita costs	$6.7	$5.4	$4.7	$4.6	$3.9	$3.9	$4.7	$4.5

Note: Estimates have been inflated to 2012 U.S. dollars using U.S. consumer price index data (World Bank World Development Indicators).
a. Package costs include commodities, front-line health workers, and additional health system strengthening costs for scaling up services.

governance, and health system information and logistics systems. These costs account for 73 percent of total package costs in low-income countries, 50 percent in lower-middle-income countries, and 41 percent in upper-middle-income countries.[1]

The child health package requires the greatest additional cost to scale up to 2035 with an additional US$22 billion per year. It includes a wide range of commodities and services to prevent and treat childhood illness, including immunization, malaria, and HIV. Scaling up the maternal and newborn package requires an additional US$6.7 billion per year. The reproductive health package is the least costly to scale up and requires an additional US$1.4 billion per year, covering commodities and personnel costs of front-line workers delivering modern family planning methods associated with the greatest reductions in fertility. The estimate does not include the costs of educational interventions in the reproductive health package because these were not available. One reproductive health package service, folic acid, is included in the maternal and newborn health package in this chapter, while human papillomavirus vaccination is included and costed in the package of essential cancer services.

The cost of family planning is low at an average of US$0.20 per capita per year and an annual incremental cost of US$1.4 billion per year. However, because the model only estimates the cost of adding an average 104 million new users for the period, we also estimated the cost of eliminating unmet need for all women who desire to prevent a pregnancy, but do not currently use effective contraceptive methods, by 2035 (Stenberg and others 2014). In this scenario, 208 million additional users are reached during this period at a total cost of US$2.9 billion or US$14.0 per additional user (US$15.8 per additional user for low-, US$10.0 for lower-middle-, and US$24.4 for upper-middle-income countries) (table 1.5).

For comparison, a recent study by the Guttmacher Institute (Singh, Darroch, and Ashford 2014) estimates that meeting all women's needs for modern contraceptives will cost US$5.3 billion per year more than current spending. Although the services included are very similar to those included in our reproductive health package, the Guttmacher estimate covers all LMICs rather than the 74 Countdown countries, includes the costs of improving the quality of care for current family planning users, and includes costs of scaling up services for an estimated 225 million women with unmet need (Singh, Darroch, and Ashford 2014). In sum, differences between this and our estimate reflect differences in scope (all LMICs compared with only Countdown countries), methods, and underlying

Table 1.5 Average Additional Modern Contraceptive Users, Cost per Additional User, and Incremental Costs over the Period 2013–35 (2012 U.S. dollars)

	Low-income countries	Lower-middle-income countries	Upper-middle-income countries	Total
Additional modern contraceptive users (million)	75	106	27	208
Cost per additional user	$15.8	$10.0	$24.4	$14
Incremental costs (US$ million)	$1,188	$1,065	$663	$2,916

assumptions regarding the rate of scaling up and the methods mix of modern family planning among the target population.

Scaling up the three essential packages will require an average additional investment of US$4.7 per person per year in the 74 countries with 95 percent of the global maternal and child mortality burden. It provides rates of return based on economic and social benefit that are up to nine times the investment by 2035 (Stenberg and others 2016). The current (2015) cost of the three packages, inclusive of health system costs, ranges from US$6.70 per capita in low-income settings to US$4.80 and US$3.90 in lower-middle-income and upper-middle-income country settings. These estimates may be higher or lower depending on the country context and current levels of investment and commitment to health system strengthening.

Results from the RMNCH investment case (Stenberg and others 2014) are complemented by new evidence on individual interventions in reproductive, maternal and newborn, and child health interventions also presented in this volume. Although information on empirical costs has grown substantially in the past decade, it remains imperfect and lacks up-to-date data on relatively well-established interventions, such as vitamin A capsule distribution and family planning where modern contraceptive coverage is low in spite of high expressed unmet need. In emerging areas, such as maternal depression and intimate partner violence, few published studies are available. However, the literature does support trends in relative costs across the essential packages and provides a wealth of information especially for child illness and for a variety of platforms. For example, average unit costs (cost per beneficiary) are lower for family planning interventions, antenatal

care visits, and normal deliveries at home or health centers with trained birth attendants. Costs per beneficiary tend to increase with the complexity of the service (that is, treatment of obstetric or abortion complications, treatment of severe acute child malnutrition, and a range of community-based nutrition interventions). For example, breastfeeding support and prevention of micronutrient deficiencies are inexpensive compared with facility-based treatment of severe acute malnutrition. Within packages, costs are also likely to vary depending on the context and condition—the prevention and treatment of malaria and diarrheal disease are less expensive per child (US$20 to US$100) than treating pneumonia and meningitis, which more often require inpatient admission (US$150 per visit, or US$800 per child treated for pneumonia; US$300 to US$500 for inpatient care treatment of meningitis and pneumonia).

IMPROVING INTERVENTION UPTAKE AND QUALITY

Supply- and demand-side interventions to improve intervention uptake and quality are increasingly used to ensure that essential RMNCH services are delivered with quality and used appropriately.

Supply-Side Interventions

On the supply side, interest has been growing in the use of pay-for-performance, which rewards providers or health care organizations for achieving coverage or quality targets. One study in Rwanda shows a 23 percent increase in facility delivery and larger increases in preventive care visits by young children in facilities enrolled in a payment plan compared with randomly selected controls (Basinga and others 2011).

A study of performance-based financing in Rwanda in which the government implemented an incentive program in several districts to motivate providers to improve the quality of care and increase service output found no significant differences in the use of maternal health services between intervention and control sites (Priedeman Skiles and others 2013). Only facility birth deliveries (p = 0.014) were 10 percentage points higher for the intervention sites compared with controls. Performance-based financing may be useful if targeted at specific services, such as facility deliveries, but only if service use was consistently low. Peabody and others (2014) considered payment-for-performance incentives and child health outcomes in the Philippines using clinical performance vignettes among randomly

chosen physicians every six months during a three-year period to assess physicians' quality indicators. Bonus payments were awarded if qualifying scores were met. Outcomes of interest—including age-adjusted wasting, C-reactive protein, hemoglobin level, parental self-reported health of children, and children under age five years hospitalized for diarrhea or pneumonia—were not improved in intervention sites. Only two indicators improved. Parental self-reported health of children increased by 7 percentage points and wasting declined by 9 percentage points. A Cochrane review suggests that the quality of evidence is too poor to draw general conclusions about the effectiveness of pay for performance and notes that several studies arrive at contradictory results (Witter and others 2012).

Safe childbirth (intrapartum care) checklists have been proposed as a way of reducing newborn deaths, but there are gaps in the evidence base. The WHO childbirth safety checklist was developed to help reduce the major causes of these deaths (hemorrhage, infection, obstructed labor, and others) (Spector and others 2013; Temmerman, Khosla, Bhutta, and Bustreo 2015; Temmerman, Khosla, Laski, and others 2015). Since most deaths associated with childbirth occur within a 24-hour window and the major causes are well described, checklists have promise for improving healthy delivery. Follow-up studies are currently underway that focus directly on health outcomes attributable to the increase in these practices. The quality of RMNCH services can also be improved using supportive supervision for front-line health workers, which is associated with small benefits for provider practice and knowledge (Bosch-Capblanch, Liaqat, and Garner 2011).

Recent efforts have been made in task-shifting—an innovative approach to increase the delivery of RMNCH services by reassigning certain tasks to community workers. Lay community health workers are increasingly being deployed to classify and treat childhood infectious diseases, such as pneumonia, diarrhea, and malaria, and approaches such as iCCM for their management are expanding widely (Young and others 2012). A recent WHO Guidance Panel on Task Shifting suggested that health workers could carry out many tasks related to maternal and newborn health, provided they received adequate training and support (WHO 2012). These personnel include lay workers (for example, for promotion of appropriate care-seeking behavior and antenatal care during pregnancy, administration of misoprostol to prevent postpartum hemorrhage, and promotion and support of breastfeeding), auxiliary nurses (for example, for administration of injectable contraceptives), auxiliary nurse midwives (for example, for neonatal resuscitation

and insertion and removal of intrauterine devices), nurses (for example, for administration of a loading dose of magnesium sulfate to prevent or treat eclampsia), midwives (for example, for vacuum extraction during childbirth), and associate clinicians (for example, for manual removal of the placenta).

Demand-Side Interventions

Countries are increasingly relying on demand-side interventions to expand coverage. Brazil's Bolsa Família, launched in 2003, transfers payments to families on the condition that beneficiaries obtain health services (such as vaccinations and prenatal care for pregnant women) and that children maintain a minimum daily attendance rate at school. The program was associated with a 9.3 percent ($p < 0.01$) decline in the infant mortality rate and a 24.3 percent ($p < 0.01$) decrease in the postneonatal mortality rate (Shei 2013).

Lagarde, Haines, and Palmer (2009) conducted a systematic review of conditional cash transfers (CCTs) in low- and middle-income countries to see whether CCTs improve access to and use of health care services as well as health outcomes. Of the 11 CCT studies reviewed, 10 find significant positive effects on the outcome variable being examined. Only the Janani Suraksha Yojana program in India had no significant benefit, but its failure to lower the maternal mortality rate likely stems from beneficiaries' lack of access to quality health care facilities (Lim and others 2010). A 2009 Cochrane review finds that CCTs were associated with higher service use and may be an effective approach to promoting use of frequently undervalued preventive interventions, such as immunization (Lagarde, Haines, and Palmer 2009). Removal of user fees can result in increased use of the targeted RMNCH service, sometimes by a large margin (Lagarde and Palmer 2008; Ponsar and others 2011). Although few rigorous evaluations have been conducted, vouchers have been linked to increases in use of facility delivery and family planning (Bellows and others 2013; Bellows, Bellows, and Warren 2011). A meta-analysis of women's participatory learning and action groups finds that vouchers could potentially reduce maternal mortality by 37 percent and newborn mortality by 23 percent (Prost and others 2013).

CONCLUSIONS

Despite sizable recent reductions in child and maternal deaths, the rate of mortality decline has been too slow to achieve MDGs 4 and 5 globally. Particular regions, especially Sub-Saharan Africa, have high rates of fertility,

maternal mortality, and under-five mortality, providing a compelling case for integrated RMNCH interventions. Most deaths from RMNCH conditions could be greatly reduced by scaling up integrated packages of interventions across the continuum of care. Many of these interventions, especially family planning, labor and delivery management, promotion of breastfeeding, immunizations, improved childhood nutrition, and treatment of severe infectious diseases, are among the most cost-effective of all health interventions. Nevertheless, implementation research is still needed to adapt these interventions to the local health service context and achieve the greatest effects. The benefits of scaling up packages extend beyond health to also include substantial economic and social outcomes. Improved access and quality of care around childbirth can generate a quadruple return on investment by saving maternal and newborn lives and preventing stillbirths and disability. Furthermore, these benefits extend beyond survival—for example, investing in early childhood nutrition and stimulation can reduce losses in cognitive development and adult capacity. Strengthening health systems and improving data for decision making are, among others, key strategies to drive improvement, equity, and accountability.

The 2015 UN Global Strategy for Women's, Children's, and Adolescents' Health builds on evidence presented in this volume, as well as the need to focus on critical population groups such as adolescents and those living in fragile and conflict settings; build the resilience of health systems; improve the quality of health services and equity in their coverage; and work with health-enhancing sectors on issues such as women's empowerment, education, nutrition, water, sanitation, and hygiene (Temmerman, Khosla, Bhutta, and Bustreo 2015). The objectives of universal health coverage, including public health interventions and preventive as well as curative services (Schmidt, Gostin, and Emanuel 2015), and ensuring financial security and health equity are critical if the Sustainable Development Goals are to be achieved. A new vision and commitment to realize good health and human rights for all women, adolescents, and children needs to be articulated.

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NOTES

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
  Middle-income countries (MICs) are subdivided:
  - Lower-middle-income = US$1,046 to US$4,125
  - Upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

1. For the maternal and newborn health package, health system costs are assumed to constitute 19 percent, 23 percent, and 22 percent of the total package for low-, lower-middle, and upper-middle-income groups, respectively. For the child health package, they are 72 percent, 71 percent, and 76 percent of the total for low-, lower-middle, and upper-middle-income groups, respectively.

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