Chapter 3

Levels and Causes of Maternal Mortality and Morbidity

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INTRODUCTION

In September 2000, 189 world leaders signed a declaration on eight Millennium Development Goals (MDGs) to improve the lives of women, men, and children in their respective countries (United Nations General Assembly 2000). Goal 5a calls for the reduction of maternal mortality by 75 percent between 1990 and 2015. Goal 5a was supplemented by MDG 5b on universal access to contraception. MDGs 5a and 5b have been important catalysts for the reductions in maternal mortality levels that have been achieved in many settings.[1]

Despite substantial progress, challenges remain. The majority of low-income countries (LICs), particularly in Sub-Saharan Africa and postconflict settings, have not made sufficient progress to meet MDG 5a. The post-2015 agenda on sustainable development is broader than the MDG agenda, with a greater number of nonhealth goals and a strong focus on inequity reduction; the new agenda includes an absolute reduction in maternal mortality as a marker of progress.[2] This new indicator is expected to be framed as targets for preventable maternal deaths (Bustreo and others 2013; Gilmore and Camhe Gebreyesus 2012).

The International Classification of Diseases (ICD-10) defines maternal death as "[The] death of a woman while pregnant or within 42 days of the end of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes" (WHO 2010, 156). Subsequent guidance on the classification of causes includes nine groups of underlying causes (box 3.1) (WHO 2012).

Despite the increased global focus on maternal mortality as a public health issue, little detailed knowledge is available on the levels of maternal mortality and morbidity and the causes of their occurrence. A large proportion of maternal deaths occur in settings in which vital registration is deficient and many sick women do not access services. To obtain data on population levels of maternal mortality in these settings, special surveys are needed, including the following (Abouzahr 1999):

- Reproductive Age Mortality Studies, which investigate all reproductive age deaths
- Demographic and Health Surveys, which interview women and men about their siblings' survival in adulthood to identify deaths of sisters during or following pregnancy (the siblings are from the same mother) (Ahmed and others 2014)
- Smaller studies, which use the indirect sisterhood method
- National investigations, which add questions to censuses
- Verbal autopsy studies, which provide information on causes and circumstances of deaths.

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Maternal death studies require large sample sizes; recent national-level data are often nonexistent, and maternal mortality tracking relies principally on mathematical models. This lack of data has led to a repeated call for countries to improve their vital registration systems and to strengthen other mechanisms for informing intervention strategies, such as the maternal death surveillance and response system proposed within the new accountability framework (WHO 2013). Accountability remains a central part of United Nations Secretary General Ban Ki-Moon's updated global strategy to accelerate progress for women's, children's, and adolescent's health (http://www.everywomaneverychild.org/global-strategy-2). The accountability framework, developed under the 2010 global strategy to accelerate women's and children's health, included recommendations for improvements in resource tracking; international and national oversight; and data monitoring, including maternal mortality (Commission on Information and Accountability for Women's and Children's Health 2011).

Information on maternal morbidity is frequently collected in hospital studies, which are only representative of patients who seek care. Community-based studies are rare in LICs and suffer from methodological limitations, particularly when they rely on self-reporting of obstetric complications. Self-reporting is known not to agree sufficiently with medical diagnoses to estimate prevalence. In particular, studies validating retrospective interview surveys find that women without medical diagnoses of complications during labor frequently reported symptoms of morbidity during surveys, a phenomenon that can lead to an overestimation of prevalence (Ronsmans and others 1997; Souza and others 2008). In addition, community-based studies have focused on direct obstetric complications; little is known about the nature and incidence of many indirect complications that are aggravated by pregnancy. For example, reliable population-based estimates of the occurrence of asthma during pregnancy do not exist in LICs.

This chapter addresses the extent and nature of maternal mortality and morbidity and serves as a backdrop to subsequent chapters on obstetric interventions in LICs. It introduces the determinants of maternal mortality and morbidity and their strategic implications. The next section uses the most recent estimates from the World Health Organization (WHO) to show that women face a higher risk of maternal death in Sub-Saharan Africa. It discusses the recent findings of a WHO meta-analysis that show that the most important direct causes are hemorrhage, hypertension, abortion, and sepsis; however, the proportion of deaths due to indirect causes is increasing in most parts of the world. The chapter then focuses on pregnancy-related complications, including nonfatal illnesses such as antenatal and postpartum depression, using the findings from systematic reviews conducted by the Child Health Epidemiology Reference Group. The most common contributors to maternal morbidity are probably anemia and depression at the community level, but prolonged and obstructed labor results in the highest burden of disease because of fistulas (IHME 2013). The chapter discusses the broader determinants of maternal morbidity and mortality, and then concludes by making the links with the interventions highlighted in chapter 7 in this volume (Gülmezoglu and others 2016).

MATERNAL MORTALITY LEVELS AND TRENDS

The WHO, in collaboration with the United Nations Children's Fund, the United Nations Population Fund, the World Bank Group, and the United Nations Population Division, publishes global estimates of maternal mortality, which are excerpted in this chapter (WHO 2015). A complete description of the methodology and underlying data and statistical model can be found in the publication and online.[3] In this chapter, the latest estimate is for 2015. Whenever an estimate includes trend data between two points, updates of those estimates typically supersede previously published figures. Readers are directed to the WHO's Reproductive Health and Research web page on maternal mortality to access the latest published data.[4]

Maternal Mortality Ratio Levels and Trends, 1990–2015

Globally, the total number of maternal deaths decreased by 43 percent from 532,000 in 1990 to 303,000 in 2015. The global maternal mortality ratio (MMR)

declined by 44 percent, from 385 maternal deaths per 100,000 live births in 1990 to 216 in 2015—an average annual decline of 2.3 percent (WHO 2015).

All MDG regions experienced a decline in the MMR between 1990 and 2015. The highest reduction was in Eastern Asia (72 percent), followed by Southern Asia (67 percent), South-Eastern Asia (66 percent), Northern Africa (59 percent), Oceania (52 percent), Caucasus and Central Asia (52 percent), Latin America and the Caribbean (50 percent), Sub-Saharan Africa (45 percent), and Western Asia (43 percent). Although the Caucasus and Central Asia experienced a relatively low level of decline, its already low MMR of 69 maternal deaths per 100,000 live births in 1990 suggests that a different set of more finely tuned strategies might be required to respond to the challenge of achieving the same rate of decline as other regions with higher 1990 MMRs, with possibly a stronger focus on improved fertility control (Shelburne and Trentini 2010).

Despite an initial increase in maternal mortality in regions highly affected by human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), evidence suggests that maternal mortality due to HIV/AIDS peaked in 2005 and showed signs of decline in 2010 and 2015, most likely because of the increased availability of antiretroviral medication. Of the 183 countries included in this exercise, 9 countries that had high levels of maternal mortality in 1990 are categorized as having met the MDG goal of having reduced maternal mortality by 75 percent. They are Maldives (90 percent reduction in MMR); Bhutan (84 percent); Cambodia (84 percent); Cabo Verde (84 percent); the Islamic Republic of Iran (80 percent); Timor-Leste (80 percent); Lao People's Democratic Republic (78 percent); Rwanda (78 percent); and Mongolia (76 percent).

An additional 39 countries are characterized as having made a 50 percent reduction in maternal mortality; 21 countries have made insufficient progress; and 26 made no progress.

These estimates should be viewed in context; accurate data on maternal mortality are lacking for the majority of countries. The range of uncertainty indicates that the true total number of maternal deaths in 2015 could plausibly be as low as 291,000 and as high as 349,000. Similarly, the global MMR plausibly ranges from 207 to 249 maternal deaths per 100,000 live births.

Disproportionate Burden in Low- and Middle-Income Countries

Low- and middle-income countries (LMICs, as defined by the World Bank) account for 99 percent (300,000) of global maternal deaths. The MMR in these regions

(242 per 100,000) is 14 times higher than that in high-income countries (HICs, as defined by the World Bank (17 per 100,000). Most maternal deaths occur in MDG regions Sub-Saharan Africa (201,000) and South Asia (66,000). Sub-Saharan Africa alone accounts for 66 percent of maternal deaths and has the highest MMR, at 546 maternal deaths per 100,000 live births. By MDG region, Eastern Asia has the lowest rate among developing regions, at 27 maternal deaths per 100,000 live births. Of the remaining developing regions, four had low MMRs: Caucasus and Central Asia (33), Northern Africa (70), Western Asia (91), and Latin America and the Caribbean (67). Three had moderate MMRs: South-Eastern Asia (110), Southern Asia (176), and Oceania (187). The adult lifetime risk of maternal mortality—the probability that a 15-year-old woman will die eventually from a maternal cause—in Sub-Saharan Africa is the highest at 1 in 36; this number is in contrast to 1 in 150 in Oceania; 1 in 210 in Southern Asia; 1 in 380 in South-Eastern Asia; and 1 in 4,900 in developed regions. The global adult lifetime risk of maternal mortality is 1 in 180.

At the country level, two countries, Nigeria and India, account for more than one-third of all global maternal deaths in 2015, with an approximate 58,000 (uncertainty interval [UI] 42,000 to 84,000) maternal deaths (19 percent) and 45,000 (UI 36,000 to 56,000) maternal deaths (15 percent), respectively. Ten countries account for nearly 59 percent of global maternal deaths. In addition to Nigeria and India, they are the Democratic Republic of Congo (22,000; UI 16,000 to 33,000), Ethiopia (11,000; UI 7,900 to 18,000), Pakistan (9,700; UI 6,100 to 15,000), Tanzania (8,200; UI 5,800 to 12,000), Kenya (8,000; UI 5,400 to 12,000), Indonesia (6,400; UI 4,700 to 9,000), Uganda (5,700; UI 4,100 to 8,200), and Bangladesh (5,500; UI 3,900 to 8,800). Of the 183 countries and territories in this analysis, Sierre Leone and Chad have the highest adult lifetime risk of maternal mortality, 1 in 17 and 1 in 18, respectively.

MEDICAL CAUSES OF MATERNAL DEATHS

Most maternal deaths do not have well-defined causes. Nevertheless, using the available data, nearly 73.0 percent of all maternal deaths between 2003 and 2009 were attributable to direct obstetric causes; deaths due to indirect causes accounted for 27.5 percent (95 percent confidence interval 19.7–37.5) of all deaths. The major causes of maternal mortality are as follows (Say and others 2014):

- Hemorrhage, 27.1 percent (95 percent confidence interval 19.9–36.2); more than 72.6 percent of deaths

from hemorrhage were classified as postpartum hemorrhage

- Hypertension, 14.0 percent (95 percent confidence interval 11.1–17. 4)
- Sepsis, 10.7 percent (95 percent confidence interval 5.9–18.6)
- Abortive outcomes, 7.9 percent (95 percent confidence interval 4.7–13.2)
- Embolism and other direct causes, 12.8 percent.

Three causes of death—unsafe abortions, obstructed labor, and indirect causes—are of considerable programmatic interest but are particularly difficult to capture. The first case, unsafe abortions, is discussed further in chapter 2 of this volume (Ezeh and others 2016).

Deaths from Abortions

Say and others (2014) estimate that 7.9 percent (95 percent confidence interval 4.7–13.2) of all maternal deaths were due to abortive outcomes, including spontaneous or induced abortions and ectopic pregnancies. This share is lower than in previous assessments, which estimated mortality due to unsafe abortion at 13 percent (WHO 2011b).

Ectopic Pregnancy

Although ectopic pregnancy can have very serious mortality consequences, and there have been reports of increased incidence, it remains a rare event at less than 2 per 100 deliveries (Stulberg and others 2013). This condition has a high case fatality rate where urgent surgical care is not available. However, no systematic review of its global prevalence has been published since the 1980s.

Induced Abortions

In classifying maternal deaths due to abortion, and more specifically to unsafe abortion, which is defined as the termination of an unintended pregnancy "performed by persons lacking the necessary skills or in an environment not in conformity with minimal clinical standards, or both" (WHO 1993; Ganatra and others 2014, 155), there is a particular risk for misclassification that may lead to underreporting. ICD-10 does not have a specific code for unsafe abortion; accordingly, deaths attributed to unsafe abortion are often documented within special studies. Even where induced abortion is legal, the religious and cultural values in many countries can mean that women do not disclose abortion attempts, and relatives or health care professionals do not report these deaths as such. Underregistration of deaths may be the result of the stigmatization of abortion, which may result in intentional misclassification by providers where abortion is restricted.

Deaths from Obstructed Labor

Obstructed labor is commonly considered to be or diagnosed as a clinical cause of maternal death. However, as a death classification, it may be hard to capture because deaths occurring after obstructed labor and its consequences may be coded under hemorrhage or sepsis. This practice is especially an issue in settings in which verbal autopsies are used to determine cause of death, because verbal autopsy methods vary; lack of consistent case definitions and confusion regarding hierarchical assignment of causes affect the validity of the study data. In total, complications of delivery accounted for 2.8 percent (95 percent confidence interval 1.6–4.9), and obstructed labor accounted for 2.8 percent (95 percent confidence interval 1.4–5.5) of all maternal deaths globally, both reported within the "other direct" category, which totals to 9.6 percent (95 percent confidence interval 6.5–14.3).

Deaths from Indirect Causes

The review found that the indirect causes of maternal death, when combined, are the most common cause of maternal death. A breakdown of deaths due to indirect causes suggests that more than 70 percent are from preexisting medical conditions, including HIV/AIDS, exacerbated by pregnancy. Information on the number and proportion of maternal deaths related to HIV/AIDS alone is presented in box 3.2. However, these estimates should be considered with caution, given the phenomenon of misattribution of indirect maternal causes of death. Underestimation of 20 percent to 90 percent of maternal deaths has been described in a number of settings. In Austria, misclassification was significantly higher for indirect deaths (81 percent, 95 percent confidence interval 64–91 percent) than for direct deaths (28 percent, 95 percent confidence interval 21 percent to 36 percent); in the United Kingdom, indirect deaths may account for up to 74 percent of underreported maternal deaths from 2003 to 2005 (Karimian-Teherani and others 2002; Lewis 2007).

Global Distribution of Maternal Deaths

The global distribution of maternal deaths is influenced by the two regions, Sub-Saharan Africa and Southern Asia, that account for the majority of all maternal deaths (WHO 2014b). Although estimated regional cause-of-death distributions are uncertain for many

Proportions of Considered AIDS-Related Indirect Maternal Deaths

Assessing maternal deaths among human immuno-deficiency virus (HIV)–infected women is a separate but related estimation process. Worldwide in 2015, 4,700 maternal deaths were attributed to HIV (an indirect cause of maternal deaths because the condition usually preexists pregnancy, and this cause of death is not specific to pregnant women); 4,000 (85 percent) of these deaths were in Sub-Saharan Africa. The MDG region of Southern Asia was a distant second, with 310 deaths. The proportion of maternal deaths attributed to HIV was highest in Sub-Saharan Africa (2.0 percent) and Latin America and the Caribbean (1.5 percent). Without HIV, the MMR for Sub-Saharan Africa would be 535 maternal deaths per 100,000 live births, rather than 510.

The proportion of HIV-attributable maternal deaths is 10 percent or more in five countries: South Africa (32 percent), Swaziland (19 percent), Botswana (18 percent), Lesotho (13 percent), and Mozambique (11 percent).

AIDS-related indirect maternal deaths accounted for 1.6 percent of global maternal deaths. Underreporting and misclassification of indirect maternal deaths due to HIV/AIDS are a particular issue in death certificate coding and when countries rely on verbal autopsies to ascertain cause of death. This imprecision highlights the need for review of deaths of HIV-infected women temporal to pregnancy; the women may die from HIV or with HIV while pregnant. As methods for global maternal death estimation evolve, the evidence for the parameters needed to estimate indirect maternal HIV deaths and further clarification on the use of ICD-10 codes will standardize and improve our understanding of maternal and HIV death tallies.

causes, point estimates show substantial differences across regions. Hemorrhage accounted for 36.9 percent (95 percent confidence interval 24.1 percent to 51.6 percent) of deaths in northern Africa, compared with 16.3 percent (95 percent confidence interval 11.1 percent to 24.6 percent) in developed regions. Hypertensive disorders were a significant cause of death in Latin American and the Caribbean, accounting for 22.1 percent (95 percent confidence interval 19.9 percent to 24.6 percent) of all maternal deaths in the region.

Almost all sepsis deaths occurred in developing regions, and the percentage of deaths was highest at 13.7 percent (95 percent confidence interval 3.3 percent to 35.9 percent) in Southern Asia. Only a small proportion of deaths are estimated to result from abortion in Eastern Asia, 0.8 percent (95 percent confidence interval 0.2 percent to 2.0 percent), where access to abortion is generally less restricted. Latin America and the Caribbean and Sub-Saharan Africa have higher proportions of deaths in this category than the global average, 9.9 percent (95 percent confidence interval 8.1 percent to 13.0 percent) and 9.6 percent (95 percent confidence interval 5.1 percent to 17.2 percent), respectively. Another direct cause, embolism, accounted for more deaths than the global average in South-Eastern Asia and Eastern Asia, 12.1 percent (95 percent confidence interval 3.2 percent to 33.4 percent) and 11.5 percent (95 percent confidence interval 1.6 percent to 40.6 percent), respectively.

The proportion of deaths due to indirect causes was highest in Southern Asia, 29.3 percent (95 percent confidence interval 12.2 percent to 55.1 percent), followed by Sub-Saharan Africa, 28.6 percent (95 percent confidence interval 19.9 percent to 40.3 percent); indirect causes also accounted for nearly 25.0 percent of the deaths in the developed regions. The overall proportion of HIV/AIDS maternal deaths is highest in Sub-Saharan Africa, 6.4 percent (95 percent confidence interval 4.6 percent to 8.8 percent).

Trends in Maternal Death Causes

The continued dearth of basic information in most countries of the developing region, where most of the deaths occur, impedes the ability to address the question of changes in causes of maternal deaths over time. In determining trends in causes of maternal deaths, it is reasonable to conclude that the proportion of indirect deaths is increasing in all regions. The actual indirect causes differ in that HIV/AIDS deaths are highest in Sub-Saharan Africa; other medical causes are highest in developed regions and Eastern Asia.

MEDICAL CAUSES OF MATERNAL MORBIDITY

Definition of Maternal Morbidity

The WHO Maternal Morbidity Working Group defines maternal morbidity as "any health condition attributed to and/or aggravated by pregnancy and childbirth that has a negative impact on the woman's wellbeing" (Firoz and others 2013, 795). The working group emphasizes the wide range of indirect conditions in the morbidity that women experience during pregnancy, delivery, or postpregnancy by listing more than 180 diagnoses and dividing them into 14 organ dysfunction categories, ranging from obstetric to cardiorespiratory and rheumatology conditions.

The negative impact of pregnancy-related ill health is highlighted on the basis of subsequent disabilities, including how severely the woman's functional status is affected and for how long. The origins of maternal morbidity occur during pregnancy, but the sequelae might take several months to manifest themselves. Capturing the negative impact of morbidities requires a longer reference period than used for the death definition.

Perceived Morbidity

Where women are not able to access services easily, surveys are conducted to measure their health status. Accurate diagnoses are difficult to make in survey conditions without confirmation from a clinical examination, laboratory reports, or medical records (Ronsmans and others 1997). However, surveys provide evidence of women's experience of health and morbidity during pregnancy. Overall, many women complain about ill health in pregnancy and the puerperium. Studies of self-reports in low-income settings typically find that more than 70 percent of women report signs or symptoms of pregnancy-related complications (Lagro and others 2003). In a Nepal study, women reported, on average, three to four days per week with symptoms of illness during pregnancy (Christian and others 2000). The type of symptoms reported varied according to gestational age, with nausea and vomiting more common in early pregnancy, and swelling of the hands and face more common toward the end of pregnancy. Counterintuitive changes in self-reported ill health have been described for the postpartum period, with anticipated declines in symptoms over time sometimes followed by increases (Filippi and others 2007; Saurel-Cubizolles and others 2000); self-perceived ill health is not simply a result of biological changes but also of social support and influences.

Severity of Conditions

Maternal health specialists have tried since the 1990s to distinguish between women with severe and less severe conditions in the measurement of morbidity (Stones and others 1991). Maternal deaths are relatively rare events, and these specialists believe that cases at the very severe end of the maternal morbidity spectrum have two useful characteristics: they are more frequent than maternal deaths, and they share similar characteristics to maternal deaths, including some common risk factors. Women who nearly died during pregnancy, labor, or postpregnancy, but survived, usually because of chance or good hospital care, are maternal "near-misses" (WHO 2011a). Depending on the definitions used and on the country and hospital settings, maternal near-misses occur for 0.05 percent to 15.0 percent of hospitalized women (Tuncalp and others 2012). The WHO has developed operational definitions of near-misses to facilitate comparisons between settings (WHO 2011a).

Nevertheless, it is worth noting that the cause patterns of maternal mortality, near-misses, and less severe morbidity differ, depending on the case fatality of certain conditions and the ease of halting the progression of disease (Pattinson and others 2003).

Principal Morbidity Diagnoses

The principal medical causes of mortality are also important morbidity diagnoses, but they are not the only ones to consider. To this list must be added other contributing factors, such as depression and anemia, because of their frequency or severity. We must also add the sequelae of difficult labor, such as incontinence, fistulas, and prolapse. A further consideration is the presence of comorbidities, such as obstructed labor followed by infection, that complicate management, diagnosis, and classification.

Figure 3.1 illustrates a conceptual framework of the ways in which different maternal conditions interact. Long-term health sequelae are associated with certain diagnoses in pregnancy. For example, neglected obstructed and prolonged labors are associated with obstetric fistulas. The conceptual framework also includes medical risk factors. One of these, obesity, has become a global epidemic and has been linked with increasing levels of hypertension and diabetes. The management of pregnancy and childbirth, including cesarean section, is also a risk factor for future problems, for example, placenta previa. Female genital mutilation, particularly in its most severe form, is associated with adverse maternal and perinatal outcomes, including postpartum hemorrhage and emergency cesarean (WHO 2006).

Figure 3.1 Conceptual Framework of Maternal Health
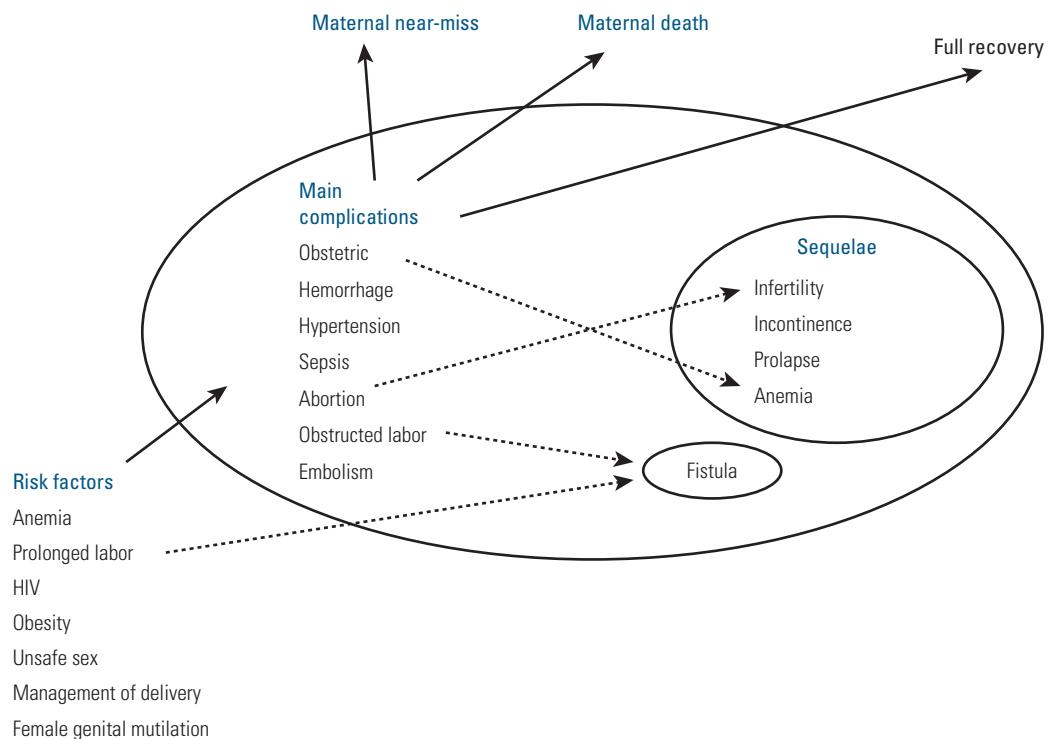
This section focuses on 11 groups of diagnoses that can lead to direct obstetric deaths or associated long-term ill health: abortion, hypertensive disease, obstetric hemorrhage, infection, prolonged and obstructed labor, anemia, postpartum depression, postpartum incontinence, fistula, postpartum prolapse, and HIV/AIDS. Other important indirect conditions that we do not consider are discussed in other *DCP3* volumes, including volume 6 on *HIV/AIDS, STIs, Tuberculosis, and Malaria*. Figures 3.2 and 3.3 summarize the prevalence of the considered conditions.

Abortion

Morbidity with abortive outcomes comprises several diagnoses, including ectopic pregnancy, abortion, and miscarriage, as well as other abortive conditions (WHO 2013) (box 3.3).

Induced abortion is a safe procedure, safer than childbirth when performed in a suitable environment and with the right method. Among unsafe abortions, the morbidity burden is large. Information on the incidence of unsafe abortion and subsequent outcomes at the population level is particularly challenging to obtain because of fear of disclosure. On the basis of estimates derived from hospital data (adjusted for bias), an estimated 22 million unsafe abortions occur each year

worldwide (WHO 2011b); of these, 5 million women are subsequently hospitalized (Singh 2006), most because of hemorrhage (44 percent of admitted cases) or infections (24 percent) (Adler and others 2012a). On average, 237 women experience a severe maternal morbidity associated with induced abortion for every 100,000 live births in countries where abortion is unsafe (Adler and others 2012b). Evidence indicates that the morbidity patterns associated with unsafe abortion are being transformed by the rapid growth of the medical abortion market, with the incidence of severe morbidity episodes declining more rapidly than the incidence of less severe episodes (Singh, Monteiro, and Levin 2012).

Hypertensive Disease

Women in pregnancy or the puerperium can suffer from preeclampsia, eclampsia, and chronic hypertension. Eclampsia and preeclampsia tend to occur more frequently in the second half of pregnancy; less commonly, they can occur up to six weeks after delivery. Medication can alleviate the symptoms and their negative effects, but the only cure is expedited delivery. The etiology of the condition remains unclear.

One systematic review reported that the global prevalence of preeclampsia is 4.6 percent (95 percent confidence interval 2.7 percent to 8.2 percent), and

Figure 3.2 Prevalence of Direct Obstetric Complications
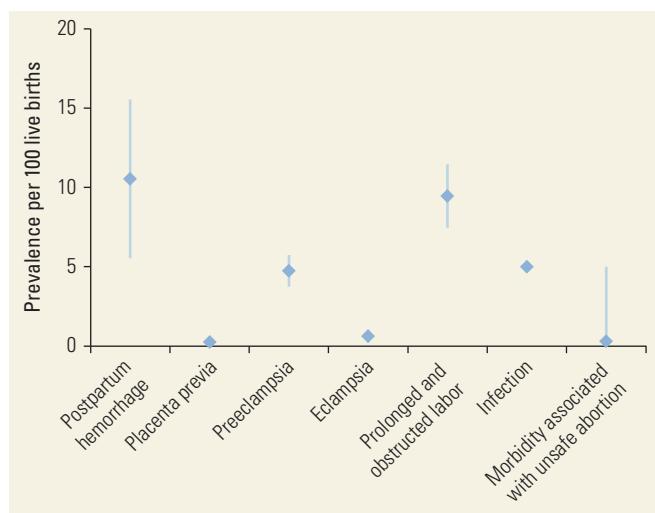
Sources: Based on Abalos and others 2013; Adler and Filippi, unpublished; Calvert and others 2012; Cresswell and others 2013; Dolea and Stein 2003.

Figure 3.3 Prevalence of Severe Direct Obstetric Complications
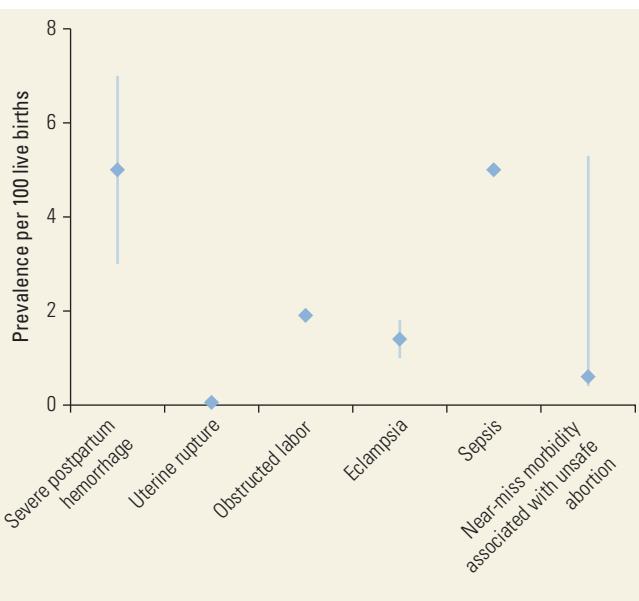
Sources: Based on Abalos and others 2013; Adler and others 2012a; Adler and Filippi, unpublished; Calvert and others 2012; Hofmeyr and others 2005.

the prevalence of eclampsia is 1.4 percent (95 percent confidence interval 1.0 percent to 2.0 percent) (Abalos and others 2013). The review finds evidence of regional variations, with Sub-Saharan Africa having the highest incidence of both conditions. Preeclampsia and eclampsia are more common among women in their first pregnancy, women who are obese, women with preexisting hypertension, and women with diabetes. All of these characteristics are increasingly more common in pregnant populations. Preeclampsia and eclampsia

are associated with perinatal deaths, placental abruption, and cardiovascular disease in later life in the mother.

Obstetric Hemorrhage

Women can experience anomalous or excessive bleeding because of an early pregnancy loss, a placental implantation abnormality, or an abnormality in the process of childbirth. The systematic review by Cresswell and others (2013) finds a global prevalence of 0.5 percent for placenta previa (95 percent confidence interval 0.4 percent to 0.6 percent). An equivalent systematic review for placental abruption has not been published, but most papers on this condition suggest an approximate prevalence of 1 percent (Ananth and others 1999).

Postpartum hemorrhage is a major cause of maternal morbidity worldwide. A systematic review finds a global prevalence of blood loss equal to or greater than 500 milliliters in 10.8 percent of vaginal deliveries (95 percent confidence interval 9.6 percent to 12.1 percent) (Calvert and others 2012); the prevalence of severe hemorrhage (equal to or greater than 1,000 milliliters) was 2.8 percent (95 percent confidence interval 2.4 percent to 3.2 percent). The review includes many study settings in which active management of the third stage of labor is practiced. The prevalence of postpartum hemorrhage in home deliveries is probably higher. Postpartum hemorrhage is associated with anemia, which can persist for several months after birth (Wagner and others 2012).

The incidence of hemorrhage has increased in HICs in recent years (Mehrabadi and others 2013). This trend has been linked to changes in risk factors, such as pregnancies at older ages, obesity, and previous cesarean delivery, as well as to better data capture systems (Kamara and others 2013). These risk factors are increasingly more common in LICs as well.

Pregnancy-Related Infection

Puerperal sepsis causes the greatest concern of all pregnancy-related infections because of its severity. No review of the prevalence of sepsis has been published since the work in the early 2000s for the Global Burden of Diseases (Dolea and Stein 2003). In this review, Dolea and Stein calculate that the incidence of sepsis ranged from 2.7 to 5.2 per 100 live births according to world region. A community-based study in India finds that the incidence of puerperal sepsis in the first week postpartum was 1.2 percent after home delivery and 1.4 percent after facility-based delivery. The incidence of fever was higher at 4 percent overall in the same Indian study (Iyengar 2012). Another study in India finds a high incidence of puerperal infections at home (10 percent) and of fever (12 percent), but the study uses broader

Definitions of Obstetric Causes of Maternal Morbidities and Deaths

Abortive outcomes include abortion, miscarriage, ectopic pregnancy, and other abortive conditions (WHO 2013). Abortive outcomes take place before 28 weeks during pregnancy, but this time definition varies among countries, with lower cut-offs of 24 weeks also used.

Preeclampsia is characterized by high blood pressure and protein in the urine; women are diagnosed with **eclampsia** when the preeclampsia syndrome is associated with convulsions.

Obstetric hemorrhage refers to anomalous or excessive bleeding because of an early pregnancy loss, a placental implantation abnormality (including placenta previa or placental abruption), or because of an abnormality in the process of childbirth.

Pregnancy-related infections include puerperal sepsis, infections of the genitourinary tract in pregnancy, other puerperal infections, and infections of the breast associated with childbirth (WHO 2013).

Prolonged labor is labor lasting more than 12 hours, in spite of good uterine contractions and good cervix dilation. In **obstructed labor**, the fetal descent is impaired by a mechanical barrier in the birth canal, despite good contractions (WHO 2008). Causes of obstructed labor include cephalopelvic disproportion, abnormal presentation, fetal abnormality, and abnormality of the reproductive tract.

Sources: WHO 2008, 2013.

definitions and followed women for only 28 days (Bang and others 2004). Risk factors for infections include HIV/AIDS and cesarean section.

Prolonged and Obstructed Labor

An unpublished systematic review by Adler and others located only 16 published population-based studies of obstructed and prolonged labor worldwide since 2000. The studies could not be combined through meta-analysis to obtain a global prevalence because of high heterogeneity, which was largely attributed to differences in case definitions. However, the median prevalence was estimated to be 1.9 per 100 deliveries for obstructed labor, and 8.7 per 100 deliveries for combined obstructed and prolonged labor. A systematic review of articles from 1997 to 2002 reporting on uterine rupture finds extremely low prevalence in the community setting (median 0.053, range 0.016 to 0.30 per hundred pregnant women), but it included a study with self-reporting, which tends to overestimate the prevalence of rare conditions (Hofmeyr, Say, and Gülmezoglu 2005).

Anemia

Anemia—which occurs when the number of red cells or hemoglobin (Hb) concentration has reached too low a level in the blood—is a commonly diagnosed condition during pregnancy or the postpartum period.

Its main symptoms include excessive fatigue; it can contribute to or lead directly to a maternal death when Hb concentration has reached particularly low levels. Anemia has many different causes, including blood loss; infection-related blood cell destruction; and deficient red blood cell production because of sickle cell disease, parasitic diseases such as hookworm or malaria, or nutritional deficiency, including iron deficiency.

During pregnancy, anemia is diagnosed when Hb levels are below the threshold of 11 grams/deciliter. Anemia is classified as severe when the levels reach 7 grams/deciliter. Anemia is well-documented in low-income settings thanks to the ease with which lay fieldworkers can collect hemoglobin levels in survey conditions. Using 257 population-based data sets for 107 countries, Stevens and others (2013) estimate that globally 38.0 percent (95 percent confidence interval 34 percent to 43 percent) of pregnant women have anemia, and 0.9 percent (95 percent confidence interval 0.6 percent to 1.3 percent) have severe anemia. Pregnant women in Central and West Africa appear particularly affected (56.0 percent are anemic, and 1.8 percent are severely so). However, global prevalence trends have improved since 1995 (Stevens and others 2013). The review by Wagner and others (2012) demonstrates that women who suffer severe blood loss during childbirth may remain anemic for several months during the postpartum period.

Postpartum Depression

Mental health disorders during pregnancy and the postpartum period include conditions of various severity and etiology, ranging from baby blues to postpartum depression and puerperal psychosis, as well as posttraumatic stress disorders linked, for example, to the death of a baby. The most common of these disorders is depression, which is associated with pregnancy-related deaths by suicide and with developmental delays in children.

Most studies detect depression through screening questionnaires for psychological distress; the most widely used tool is the Edinburgh Postnatal Depression Scale, which has been translated into many languages and used in many different cultures. These screening questionnaires are not equivalent to clinical diagnoses by medical providers; rather, they indicate a high probability of depression among those who have high scores.

Depression is a well-studied area, with a number of systematic reviews and meta-analyses, supported by large numbers of papers, although only a small proportion of these articles are from LMICs. Fisher and others (2012) calculate that in LMICs, the prevalence of depression and anxiety was 16 percent (95 percent confidence interval 15 percent to 17 percent) during pregnancy and 20 percent (95 percent confidence interval 19 percent to 21 percent) during the postpartum period. Halbreich and Karkun (2006), who conducted the most comprehensive systematic review to date from a geographical perspective, find a broader range of prevalence of depression (0 percent to 60 percent). They attribute this wide range to cultural differences in the reporting and in the understanding of depression, as well as differences in tools and other methodological approaches. They also conclude, in view of the wide ranges in the estimates, that the prevalence of depression is high and that the widely cited prevalence of 10 percent to 15 percent is not representative of the actual global prevalence.

Incontinence

Incontinence is any involuntary loss of urine. The most common form of urinary incontinence during and after childbirth is stress urinary incontinence, which consists of involuntary leakages on exertion or effort.

Little information is available on the incidence of incontinence in the postpartum period in LMICs. Walker and Gunasekera (2011) find four studies of reproductive-age women published between 1985 and 2010, in which the prevalence ranged from 5 percent to 32 percent. Another systematic review calculates the mean pooled estimates for all types of incontinence during the first three months postpartum to be 33 percent for parous women and 29 percent for primiparous women (Thom and Rortveit 2010). In addition, they find that

the risk was higher for vaginal birth (31 percent) than for cesarean birth (15 percent), as reported in several case control studies. Although the authors of this paper attempted to obtain information for all countries, no papers from LICs were included.

Obstetric Fistula

Obstetric fistula results in the continuous loss of urine or fecal matter, occurring both day and night (Polan and others 2015). It has been described as a condition worse than death in view of its medical manifestation, treatment difficulties, and social consequences (Lewis Wall 2006). It occurs when labor is obstructed, and contractions continue with the baby's head stuck in the pelvis or vagina; cesarean section is usually required to deliver the baby (Lewis Wall 2012). As a result of the severe delay in delivery and continuous pressure of the fetal head on maternal tissues, blood flow is blocked, resulting in necrosis. This condition leaves abnormal gaps (or communications) between the vagina and bladder or rectum, allowing urine or stool to pass continuously through the vagina. The meta-analysis by Adler and others (2013) of the incidence of fistula in LMICs finds a pooled incidence of 0.09 (95 percent confidence interval 0.01–0.25) per 1,000 recently pregnant women. Another recent meta-analysis of Demographic and Health Survey data finds a lifetime prevalence of 3 cases per 1,000 women of reproductive age (95 percent credible intervals 1.3–5.5) in Sub-Saharan Africa (Maheu-Giroux and others 2015). The condition is extremely rare in HICs, where there are few delays in obtaining good quality maternity care.

Postpartum Vaginal or Uterine Prolapse

Pelvic organ prolapse is defined as the symptomatic "descent of one or more of: the anterior vaginal wall, the posterior vaginal wall, and the apex of the vagina or vault" (Haylen and others 2010, 8). In lay terms, it is when a "descent of the pelvic organs results in the protrusion of the vagina, uterus, or both" (Jelovsek, Maher, and Barber 2007, 1027). Incidence increases with age, parity, and body mass index; hard physical labor is also a risk factor. Prolapse is among the Global Burden of Disease's most common sequelae, with a prevalence of about 9.28 percent. Few population-based incidence studies measure prolapse after childbirth. There is a lack of agreement as to what constitutes a significant prolapse; a grading system exists, but it requires clinical interpretation. In Burkina Faso, 26 percent of women with uncomplicated facility-based deliveries received a diagnosis of prolapse in the postpartum period (Filippi and others 2007). In The Gambia, a population-based study with physical examinations finds that 46 percent

of women ages 15–54 years had prolapse, and 14 percent had moderate or severe prolapse (Scherf and others 2002). Severe prolapse affects quality of life and is associated with depression (Zekele and others 2013).

HIV/AIDS

A positive HIV status is linked to an increased risk of death in pregnant and nonpregnant women (Zaba and others 2013). A recent systematic review suggests that HIV-infected women had eight times the risk of a pregnancy-related death, compared with uninfected women; the excess mortality attributable to HIV/AIDS among HIV-infected pregnant and postpartum women was close to 1,000 deaths per 100,000 pregnant women. The excess mortality attributable to HIV in pregnant women is much smaller than in nonpregnant women, however, probably because women who become pregnant tend to be healthier. A review that investigates the interaction between HIV/AIDS status and direct obstetric complications shows that women who are HIV-positive are 3.4 times more likely to develop sepsis (Calvert and Ronsmans 2013). The evidence of positive links for hypertensive diseases of pregnancy, dystocia, and hemorrhage was variable.

Global Burden of Diseases

The prevalence of conditions, as well as the prevalence, severity or disability weight, and the duration of their respective sequelae, are key factors in establishing the burden of various conditions in a population and in prioritizing them. Some conditions are noteworthy, for example, uterine rupture, because they are very severe and are associated with high risk of death in the mother or the baby. A few severe conditions, for example, fistula, despite being rare, can last a very long time and severely affect women's quality of life.

The WHO Global Health Estimates and IHME Global Burden of Disease estimates suggest that the absolute number of disability-adjusted life years associated with maternal conditions have decreased, owing to lower maternal mortality rates, but the number of years lived with disabilities has increased (Vos and others 2012; WHO 2014a). The increase in disabilities is mostly due to obstructed labor, hypertension, and indirect conditions (Vos and others 2012); it is also due to the high population growth rate, which means that the total number of women of reproductive age is rising.

Major Pregnancy-Related Complications

A longitudinal study shows that women who initially survived severe complications were more likely to die within the next five years than other women (Storeng and others 2012). Many of these deaths occur in subsequent pregnancies, indicating that a small number of women, often those with chronic illnesses, accumulate pregnancy-related risks. What proportion of women suffer a major complication during pregnancy, taking into account various comorbidities? Researchers at Columbia University has suggested 15 percent prevalence as a benchmark for their indicators of met need for complications (Paxton, Maine, and Hijab 2003). This number has not been validated, except possibly by a study in India (Bang and others 2004). If all of the acute direct complications with nonabortive outcomes mentioned in this chapter (Ronsmans and others 2002) were mutually exclusive, the total prevalence could be as high as 31 percent.

BROADER DETERMINANTS OF MATERNAL MORTALITY AND MORBIDITY

This section presents an overview of the broader determinants of maternal mortality and morbidity and highlights the specificities of maternal health by introducing an established conceptual framework and other classification approaches. Determinants include individual risk factors, such as age and parity; characteristics of the social, legal, and economic contexts; and the physical environment, for example, water sources and geographical accessibility.

Significant Individual Risk Factors

Descriptive studies have demonstrated that women face the highest risk of pregnancy-related death and severe morbidity (Hurt and others 2008) when they are very young or older (Blanc, Winfrey, and Ross 2013) when they are expecting their first baby or when they have had many pregnancies, when they live far away from health facilities, or when they do not benefit from support from their families and friends (Mbizvo and others 1993). Table 3.1 illustrates some of the main determinants of maternal mortality and how they influence women's chances of survival during pregnancy or childbirth.

We consider two additional important facets of maternal mortality when discussing determinants and interventions to reduce deaths.

- The risk of maternal deaths has two components: the risk of getting pregnant, which is a risk related to fertility and its control or lack of control; and the obstetric risk of developing a complication and dying while pregnant or in labor. The obstetric risk is highest

Table 3.1 Examples of Risk Factors and Pathways of Influence

Individual nonmedical risk factors

Age	Women at the extreme ends of the reproductive age range (younger than age 20 years and older than age 35 years) have a higher risk of death for both physiological and sociocultural reasons; the largest number of deaths might be in the middle group, because this is when most births occurs.
Parity	Higher risks of complications and death are associated with first pregnancy and more than three to five pregnancies. Women in their first pregnancies have longer duration of labor; women with multiple pregnancies are more likely to suffer postpartum hemorrhage.
Unintended pregnancies	Unwanted pregnancy is a risk factor for unsafe abortion, lack of social support, and domestic violence. Women who continue with their pregnancies are less likely to plan for childbirth and more likely to commit suicide (Ahmed and others 2004).
Marital status	Single women who are pregnant often lack support from their partners or their families and are more likely to try to induce an abortion or to run into financial and other logistical difficulties when seeking care for labor.
Women's education	Women who are educated know where to obtain effective services and are more likely to request these services.
Husbands' education	The husband's educational level is often a more important determinant of maternal mortality than the woman's education (Evjen-Olsen and others 2008).
Ethnicity and religion	In high-income countries, women from black or migrant communities are more likely to die during pregnancy for cultural and medical reasons, including chronic ill health. Women from certain religious groups may seek medical advice from their religious leaders or deliver in places of worship.
Poverty	Money is often required to travel or to deliver safely. Emergency cesarean section is a very expensive procedure, which can lead to delays in seeking care and in catastrophic expenditures.
Obesity and other nutritional factors	Obese or anemic women are more likely to die in childbirth. Obese women face increased risk due to comorbid conditions, such as diabetes, hypertension, or cardiac problems; it is also technically more difficult to provide them with clinical care. Severely anemic women cannot tolerate hemorrhage to the same degree as women with higher hemoglobin levels.
Past obstetric history	Past stillbirths and emergency cesarean are predictors of complications and deaths.

Social and economic context

Women's status	Often measured using education as a proxy, women's status indicators help to assess the extent to which women can make decisions on their own and the extent to which women and their decisions are valued. Many proxy variables have been used to measure women's status, including age at marriage, financial decision-making power, and women's opinions on domestic violence (Gabrysch and Campbell 2009).
Legality of reproductive health services	Where abortion laws are restrictive, women are more likely to have unsafe abortions. The current focus is on delegating certain procedures to midlevel providers to ensure that more women have access to safe and effective services.
Conflict	Extremely high levels of maternal mortality have been reported where infrastructure and communication systems have been destroyed, for example, in Afghanistan and Somalia.

Physical environment and health systems characteristics

Staff and facilities	The number, quality, and distribution of staff members are important risk factors for mortality; it is difficult to predict which women will have complications, and women are more likely to die in home births. Skilled birth attendance is often the most significant risk factor in maternal mortality models. Women who live at a distance from facilities are much more likely to delay seeking care and to experience multiple referrals.
Transportation network	Patient access to transportation and problematic topography are risk factors for long duration of the second tier of delays. (See section on "Three Delays Model.")
Water and sanitation	The availability and quality of water and sanitation (WATSAN) are key factors at the community level; they influence direct risks of diarrheal diseases and other water-borne infections in pregnant and parturient women, as does personal hygiene before and after delivery (Shordt, Smet, and Herschderfer 2012). WATSAN can indirectly pose risks to women's health if they carry heavy water receptacles or are subjected to violence at public water collection points or latrines. In health care facilities, WATSAN affects the hygiene practices of providers during childbirth, such as hand washing and environmental cleaning, with attendant increased risks of maternal and newborn nosocomial infections (Hussein and others 2011).
Quality of care and accountability	As more women deliver with skilled providers, the quality of care in facilities becomes increasingly important. The accountability of the health sector is a new focus of interventions to improve the quality of care. The availability of blood is one of the most important determinants of the quality of care received by women who are severely ill (Graham, McCaw-Binns, and Munjanja 2013).

Note: See Gabrysch and Campbell (2009) for further examples of risk factors.

at the time of delivery. The determinants of these risks share many similarities, but also have specific characteristics.

- Although the overall risks of maternal death are highest among young adolescents and older women of reproductive age, the highest number of deaths is in the middle group of women around age 25 years.

Three Delays Model

Conceptual models guide research and practice and help in the determination of how best to reduce adverse outcomes, by grouping determinants and highlighting their linkages with events in the pathway from health to death. The three delays model (Thaddeus and Maine 1994), attractive because of its simplicity and action-oriented presentation, is based on the following premises:

- Maternal complications are mostly emergencies.
- Maternal complications cannot be predicted with sufficient accuracy.
- Maternal deaths are largely preventable through tertiary prevention (preventing deaths among women who have been diagnosed with a complication).

At the 1987 launch of the Safe Motherhood Initiative, maternal health experts discussed how long a woman would have to have a particular complication before she would die, if untreated. They agreed that for the most frequent complications, women with postpartum hemorrhage had less than 2 hours before death; for antepartum hemorrhage, eclampsia, obstructed labor, and sepsis, the times would be 12 hours, 2 days, 3 days, and 6 days, respectively.

The model has three levels of delay:

- The first delay is the elapsed time between the onset of a complication and the recognition of the need to transport the patient to a facility.
- The second delay is the elapsed time between leaving the home and reaching the facility.
- The third delay is the elapsed time from presentation at the facility to the provision of appropriate treatment.

Each delay has a distinctive set of determinants. The determinants of the first delay are related to the individual circumstances of the women and their families, who must first recognize that care is needed and then be able to access transport or money to travel to facilities. The determinants of the second delay concern the physical environment, the type of transport, and the quality of the

roads, as well as the performance of the referral system between facilities. The determinants of the third delay are related to quality of care, such as the number and training of staff members and the availability of blood supplies and essential equipment. Although the actions and characteristics of women and families can influence the length of the third delay, for example, by helping to mobilize elements of the surgical kits for cesarean delivery by purchasing missing supplies in pharmacies (Gohou and others 2004), most of the determinants of the third delay are related to service provision.

The three delays model has weaknesses. It does not include the concept of primary prevention (avoid pregnancy) and secondary prevention (avoid complications once pregnant). It ignores family planning, noncommunicable chronic diseases, antenatal care, and postpartum care. Implicitly, it also assumes that complications arise at home, where women intend to give birth, whereas increasing numbers of women deliver in facilities (Filippi and others 2009). In addition, it does not consider the newly identified "fourth delay," which arises when women are discharged unwell or chronically ill from facilities and die at home during the postpregnancy period or in the next pregnancy (Pacagnella and others 2012; Storeng and others 2012).

Rights-Based Approach

The rights-based approach to understanding the determinants of maternal health is primarily concerned with the legal, cultural, and social context of service accessibility and delivery; it has been gaining a higher profile with the introduction of MDG 5b in 2007. It began with the observation that most maternal deaths are avoidable, as illustrated by the wide divergence in lifetime risks of maternal death (the probability that a 15-year-old woman will die of a pregnancy related cause) between HICs (one in 3,700) and LMICs (one in 160) (WHO 2014a), and between rich and poor women; that a considerable evidence-based literature exists with respect to effective clinical interventions; and that the reduction of maternal mortality is firmly embedded in women's ability to control the occurrence and timing of pregnancy (Freedman 2001).

Most maternal deaths are not simply biological phenomena; many are in part explained by the lack of freedom and entitlements experienced by women and service providers, as well as by the lack of accountability of providers, health systems, and countries toward women and their families (Freedman 2001; PMNCH 2013). The concept of *freedom* refers to the right of women to control their bodies, including their reproductive options, and to have access to acceptable and effective family

planning services, including safe abortions. *Entitlements* are concerned with access to good quality services, which must be evidence based and respectful and emphasize equity in access for all women who need care, whether they are rich or poor, married or single.

The accessibility and availability of good quality family planning and legal abortion services are key determinants of maternal mortality in many LICs. Quantitative models suggest that preventing pregnancy with contraception has a bigger role to play in reducing maternal mortality than does inducing abortion when pregnant with an unintended pregnancy (Singh and Darroch 2012). However, although access to safe abortion techniques has become easier with the availability of medical abortion, including on the black market from drug sellers or the Internet in countries where abortion is illegal, many women still die because they cannot access safe abortion services (Ganatra and others 2014). The distal determinants of fertility and unwanted pregnancy are broadly similar to the distal determinants of maternal health, with their emphasis on culture, poverty, and education, but their proximate determinants are somewhat different, with a focus on fecundability and marriage patterns (Bongaarts 1978) and, in the case of unwanted pregnancies, an emphasis on the needs of younger and unattached women.

Several studies, mostly qualitative, highlight episodes of rampant disrespect and abuse of pregnant women or women in labor in some maternity units (Hassan-Bitar and Wick 2007; Silal and others 2012). Groundbreaking research is taking place with the TRAction Project in Kenya and Tanzania to delineate the different forms of disrespect and abuse, understand their origins, and quantitatively document their frequency.[5] Lack of respectful care could mean that women do not seek care when they need it, or do not seek it as quickly as they should, and could contribute to deaths of mothers and babies.

Finally, it is important to be aware that in HICs and LMICs, violence is sometimes one of the most frequent causes of death during pregnancy and childbirth (Ganatra, Coyaji, and Rao 1998; Glazier and others 2006).

Health System Factors

The maternal mortality level is one of the best criteria for assessing the relative performance of health systems. One example of a coverage indicator of the continuum of care is skilled birth attendance, which is particularly inequitable. While women rely on a functioning health system to access and use professional care, this indicator has shown large differences between the richest and the poorest women (WHO and UNICEF 2012). Health system classifications are helpful in highlighting the barriers or in facilitating the factors that many women meet when they seek care during pregnancy, childbirth, or emergency situations. These classifications complement the three delays model because they go beyond emergency obstetric care. The WHO health system building blocks offer a starting point for classifying health system determinants and include the following:

- Quality of service delivery and referral system
- Number, distribution, and training of the types of providers required, including midwives and obstetrician-gynecologists
- Completeness and responsiveness of the health information system, including the adequacy of the Maternal Death Surveillance and Response (WHO 2013)
- Ease of access to essential medications, such as magnesium sulfate, misoprostol, and oxytocin, and the supplies necessary for blood transfusions
- Leadership and financing, a particularly relevant issue in several Sub-Saharan African countries that have ended user fees
- Governance, including the capacity of authorities at various levels of the health system to put policies and management systems in place so that women's health can improve.

All of these building blocks are determinants of the coverage and quality of care that women receive across the continuum of care. Country case studies describe the relative importance of these building blocks or equivalent groupings in understanding progress in maternal health (McPake and Koblinsky 2009). The equitable distribution of staff and the adequacy of blood supplies appear to be issues in most settings in LICs. Coverage of one visit for antenatal care is very high; the median coverage level is 88 percent among the Countdown Countries for which data are available (Countdown Countries comprise 75 countries where 95 percent of the world's maternal and child deaths occur). Progress has also been made for skilled birth attendance since 1990 (median coverage of 57 percent), emergency obstetric care (as measured, for example, by the cesarean section rate, and by the density of emergency obstetric care facilities per birth or population), and postnatal care for mothers (median coverage of 41 percent). However, large urban-rural and wealth inequities remain, particularly in countries that have made the least progress since the 1990s (Cavallaro and others 2013; WHO and UNICEF 2012).

Intersectoral Issues

The health sector does not exist in isolation; in developing and implementing effective policies, its interactions with other sectors, such as education, finance, water, and transport, must be considered. For example, the well-documented decline in maternal mortality in Bangladesh may be related to the availability of emergency obstetric care interventions and fertility decline, but it is also likely to be linked to the increased participation of women in the labor force. Several ecological studies of maternal mortality have shown the relationship between maternal mortality and skilled birth attendance, as well as to gross national product, health care expenditures, female literacy, population density, and access to clean water (Buor and Bream 2004; Montoya, Calvert, and Filippi 2014).

Observational studies have shown inadequate levels of hygiene in many maternity facilities (Benova, Cumming, and Campbell 2014), with direct health impacts on mothers, newborns, and care providers (Mehta and others 2011). The reasons are multifactorial and include poor infrastructure; inadequate equipment and supplies; and poor practices by care providers and cleaners as a result of inadequate knowledge, attitudes, motivation, and supervision (Campbell and others 2015). Interventions to address these constraints go beyond the health sector, particularly for water and sanitation (Shordt, Smet, and Herschderfer 2012). Timely access to care and the difficulties in obtaining motorized transport, as well as challenging topography and inadequate and poorly maintained roads, are important barriers to care. Gabrysch and others (2011) demonstrate that in Zambia, the odds of women being able or choosing to deliver in a health facility decreased by 29 percent with every doubling of distance between their home and the closest facility. They conclude that if all Zambian women lived within 5 kilometers of health facilities, 16 percent of home deliveries could be averted.

A Lifecycle Perspective

Safe motherhood programs traditionally consider each pregnancy to be a separate event. Emerging evidence from cohort studies of near-miss patients suggests that women who have suffered severe obstetric complications have increased mortality risks for several years and have a higher risk of complications in subsequent pregnancies. It is important to be able to identify these women and offer them medical support for an extended postpartum period and in subsequent pregnancies (Assarag and others 2015; Storeng and others 2012).

CONCLUSIONS

This chapter summarizes available data on the levels and trends of maternal mortality and morbidity and their main determinants. Mathematical modeling indicates that maternal mortality is declining in most countries, that women face the highest risk of death in the MDG region of Oceania and Sub-Saharan Africa, and that deaths due to direct causes—such as hemorrhage and hypertension—continue to be the main causes in Latin America and the Caribbean and in Sub-Saharan Africa. The proportion of hemorrhage and hypertension deaths found globally remains high despite established interventions to prevent and treat direct causes of maternal death (see chapter 7), such as active management of the third stage of labor. With the data available, it is not possible to determine if this high proportion is the result of a failure to implement policies and therefore quality of care, if there is a shift toward antepartum hemorrhage, or if misclassifications of abortion and obstructed labor are erroneously increasing the hemorrhage category.

Role of Indirect Causes

The data presented in this chapter also suggest that the proportion of maternal deaths due to indirect causes is increasing in most parts of the world. In addition, although the proportion of women who have a serious morbidity remains a hotly debated topic by epidemiologists, we estimate that approximately 30 percent of women may have a serious condition during pregnancy, childbirth, or the postpartum period. The main strategies used to date to reduce maternal mortality are based on the understanding that most complications are emergencies and that most deaths occur during a very short period around childbirth. Accordingly, the focus has been on reducing delays for emergency care, as well as on preventive measures, such as facilitating access to skilled birth attendance and reproductive rights. Complementary strategies are needed to address the indirect causes of death and the broader burden of maternal morbidity, in particular, given that the sequelae of maternal morbidity can last a long time.

Health program managers and policy makers need to continue to encourage women to deliver in health facilities, where complications can be prevented by appropriate care and where women can receive life-saving interventions. At the same time, the gaps in coverage of effective interventions for indirect causes of death according to their distribution in various settings have significant implications for the complexity of service delivery in light of the urgent need to accelerate the rate of decline in maternal mortality and, ultimately,

to stop all preventable deaths. Primary health care may have a greater role in the future in improving the health outcomes of pregnant and recently delivered women.

Quality of Health Care Services

In addition, if the post-2015 agenda is to emphasize universal access to essential interventions, the perceived and technical quality of the health care services provided becomes even more crucial in the fight against maternal mortality and morbidity, given their consequences for both demand for and supply of services. Thus, the international community emphasizes the development and implementation of a palette of quality-of-care interventions, including clinical audits, childbirth checklists, maternal deaths surveillance and response, and interventions to increase awareness around respectful care.

Need for Better Data

Finally, we conclude with a call for action for better data. Although the global attention to maternal mortality has engendered more studies and attempts to measure it, the quality, regularity, and ability of the results to robustly show differentials have not improved dramatically, especially routine sources of information such as vital registration. We remain largely dependent on research and mathematical modeling. The paucity of information on maternal morbidity is an even greater issue. At the community level, data on direct obstetric complications are almost nonexistent; the burden of ill health associated with some conditions, such as sepsis and ectopic pregnancies, has not been reviewed for many years. Better population-based sources for local-level decision making are essential to achieving improved outcomes.

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:
  a) lower-middle-income = US$1,046–US$4,125
  b) upper-middle-income (UMICs) = US$4,126–US$12,745
- High-income countries (HICs) = US$12,746 or more.

For consistency and ease of comparison, DCP3 is using the World Health Organization's Global Health Estimates (GHE) for data on diseases burden, except in cases where a relevant data point is not available from GHE. In those instances, an alternative data source is noted.

1. This chapter uses World Bank regions in discussions based on income level, and Milllennium Development Goal (MDG) regions otherwise. See http://mdgs.un.org/unsd /mdg/Host.aspx?Content=Data/REgionalGroupings .htm for the MDG regional groupings.
2. See website of the Open Working Group on Sustainable Development Goals at http://sustainabledevelopment .un.org/owg.html.
3. See http://www.who.int/reproductivehealth/publications /monitoring/maternal-mortality-2015/en/.
4. This data can be found at http://www.who.int /reproductivehealth/publications/monitoring/maternal -mortality-2015/en/.
5. http://www.urc-chs.com/news?newsItemID=324.

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