Maternal Survival 1

Maternal mortality: who, when, where, and why

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The risk of a woman dying as a result of pregnancy or childbirth during her lifetime is about one in six in the poorest parts of the world compared with about one in 30 000 in Northern Europe. Such a discrepancy poses a huge challenge to meeting the fifth Millennium Development Goal to reduce maternal mortality by 75% between 1990 and 2015. Some developed and transitional countries have managed to reduce their maternal mortality during the past 25 years. Few of these, however, began with the very high rates that are now estimated for the poorest countries—in which further progress is jeopardised by weak health systems, continuing high fertility, and poor availability of data. Maternal deaths are clustered around labour, delivery, and the immediate postpartum period, with obstetric haemorrhage being the main medical cause of death. Local variation can be important, with unsafe abortion carrying huge risk in some populations, and HIV/AIDS becoming a leading cause of death where HIV-related mortaliy rates are high. Inequalities in the risk of maternal death exist everywhere. Targeting of interventions to the most vulnerable—rural populations and poor people—is essential if substantial progress is to be achieved by 2015.

This is the first in a **Series** of five articles about maternal survival

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See **Online** for webpanel

At the turn of this century, 189 countries endorsed the Millennium Declaration and signed up to meeting eight goals. One of these (Millennium Development Goal [MDG] 5) is to "improve maternal health".[1] Maternal death was, however, chosen as the outcome with which to judge progress towards this goal, thus bringing renewed attention to what is a 21st century problem essentially only for the poor, and one virtually eliminated for people with the means and status to access health care. Such a marker of global inequity is shocking and is an indication of wider development issues targeted in some of the other MDGs, especially on poverty, education, and gender. The Millennium Declaration is, however, the first time that maternal mortality has featured so prominently in the high ranks of a global pronouncement, providing an opportunity to galvanise action and so help ensure that the risk of maternal death is minimised for all women. Such action needs to be informed by an understanding of who is dying, when, where, and why. In this first paper in *The Lancet* Maternal Survival Series we provide an overview of maternal mortality.

Maternal mortality is not the only outcome with which progress towards MDG-5 should be judged; the wider continuum of non-fatal results of pregnancy and childbirth are also important, and are discussed in the last paper in this series. Here we focus on maternal mortality explicitly because it has been selected by 189 countries as the target for substantial reduction by 2015.

Like many other areas of international public health, substantial constraints exist on the availability and quality of information to confidently describe the problem, and interpretation of the evidence must be informed by awareness of these constraints. For maternal mortality, some of these limitations can seem overwhelming and to dwell on them can rapidly give the false impression that nothing is known. Clearly, enough is known to act. Our

concerns as measurement scientists have thus been contained but are summarised later. We do this so as not to distract from the seven key messages we seek to convey (panel 1).

We have drawn mainly on published papers reporting primary data; the search terms we used are provided in the webpanel. We also include some unpublished findings for time of death and poverty differentials.

How big is the problem of maternal mortality?

Each year, an estimated 529 000 maternal deaths occur. This number is based on calculations for the year 2000, the most recent date for such crude data.[2] Other measures of the burden of mortality besides the total count are available (panel 2[3]), all of which tell a slightly different story. The global ratio of maternal deaths to livebirths (or maternal mortality ratio)—the most commonly used in-

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Panel 1: Key messages

- Enough is known to inform global action, but the poorest countries have the poorest data
- The burden of maternal mortality is greatest in sub-Saharan Africa and south Asia
- Some countries have managed to reduce maternal mortality during 25 years
- Timing of maternal deaths is clustered around labour, delivery, and the immediate postpartum period
- Obstetric haemorrhage is the main medical cause of maternal death. Local variation can be important, with unsafe abortion carrying a huge risk in some populations, and indirect causes, such as malaria or HIV/AIDS, featuring prominently where background prevalence is high
- A substantial proportion of maternal deaths take place in hospital
- Inequalities in the risk of maternal death exist everywhere, both between and within countries

Panel 2: Definition and measures of maternal mortality[2]

Maternal death
The death of a woman while pregnant or within 42 days of termination 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 (ICD-10).[3]

Maternal mortality ratio
Number of maternal deaths during given time period per 100 000 livebirths during same time period

Maternal mortality rate
Number of maternal deaths in given time period per 100 000 women of reproductive age, or woman-years of risk exposure, in same time period.

Lifetime risk of maternal death
Probability of maternal death during a woman's reproductive life, usually expressed in terms of odds

Proportionate mortality ratio
Maternal deaths as proportion of all female deaths of those of reproductive age—usually defined as 15–49 years—in a given time period

dicator of maternal mortality—is 400 per 100 000 livebirths for the same period. This measure captures the probability of dying once a woman is pregnant, and so is also referred to as the obstetric risk. A more complex indicator is lifetime risk, which accumulates the chances of dying from the complications of pregnancy and childbirth during a woman's reproductive life, and so accounts for fertility as well as obstetric risk. The global estimate for the lifetime risk is one in 74—for every 74 women, one will die of maternal causes.

Maternal deaths are not uniformly distributed throughout the world, and obstetric risk is highest by far in sub-Saharan Africa (figure 1[2]). In 2000, the maternal mortality ratio for sub-Saharan Africa was estimated to be nearly 1000 per 100 000 livebirths: almost twice that of south Asia, four times as high as in Latin America and the Caribbean, and nearly 50 times higher than in industrialised countries. Figure 1 shows the wide margins of uncertainty for these estimates, but also re-emphasises the regional clustering of the burden. The enormity of these differences persists when maternal mortality is measured by absolute numbers or by lifetime risk, although the pattern shifts somewhat. Most maternal deaths occur in sub-Saharan Africa, with a staggering lifetime risk of one in 16, and in south Asia with a lifetime risk of one in 43 (figure 1). These data come into perspective when the extremes are compared: the lowest estimate of lifetime risk is nearly one in 30 000 for Sweden, and the highest is one in six for Afghanistan and Sierra Leone. This comparison between the burden of maternal mortality in developed and developing countries has long been cited as the "largest discrepancy of all public-health statistics",[4] and is substantially greater than that for child or neonatal mortality.
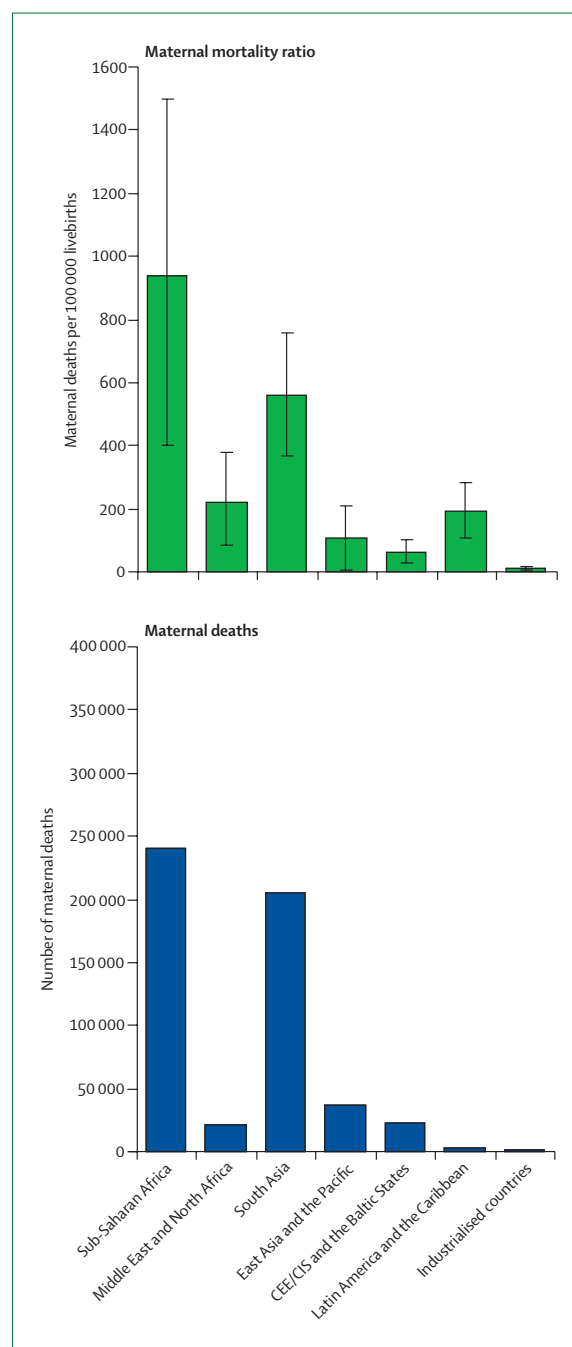

Figure 1: Regional variation in maternal mortality ratio and number of maternal deaths
Data from reference 2. Black bars on upper panel show range of uncertainty.

Are there any signs of progress?

The target set for MDG-5 is a 75% reduction in the maternal mortality ratio between 1990 and 2015. As with other health outcomes, judging progress for maternal mortality is sensitive to the indicator chosen. The maternal mortality ratio does not capture well reductions in risk owing to declining fertility, but such progress
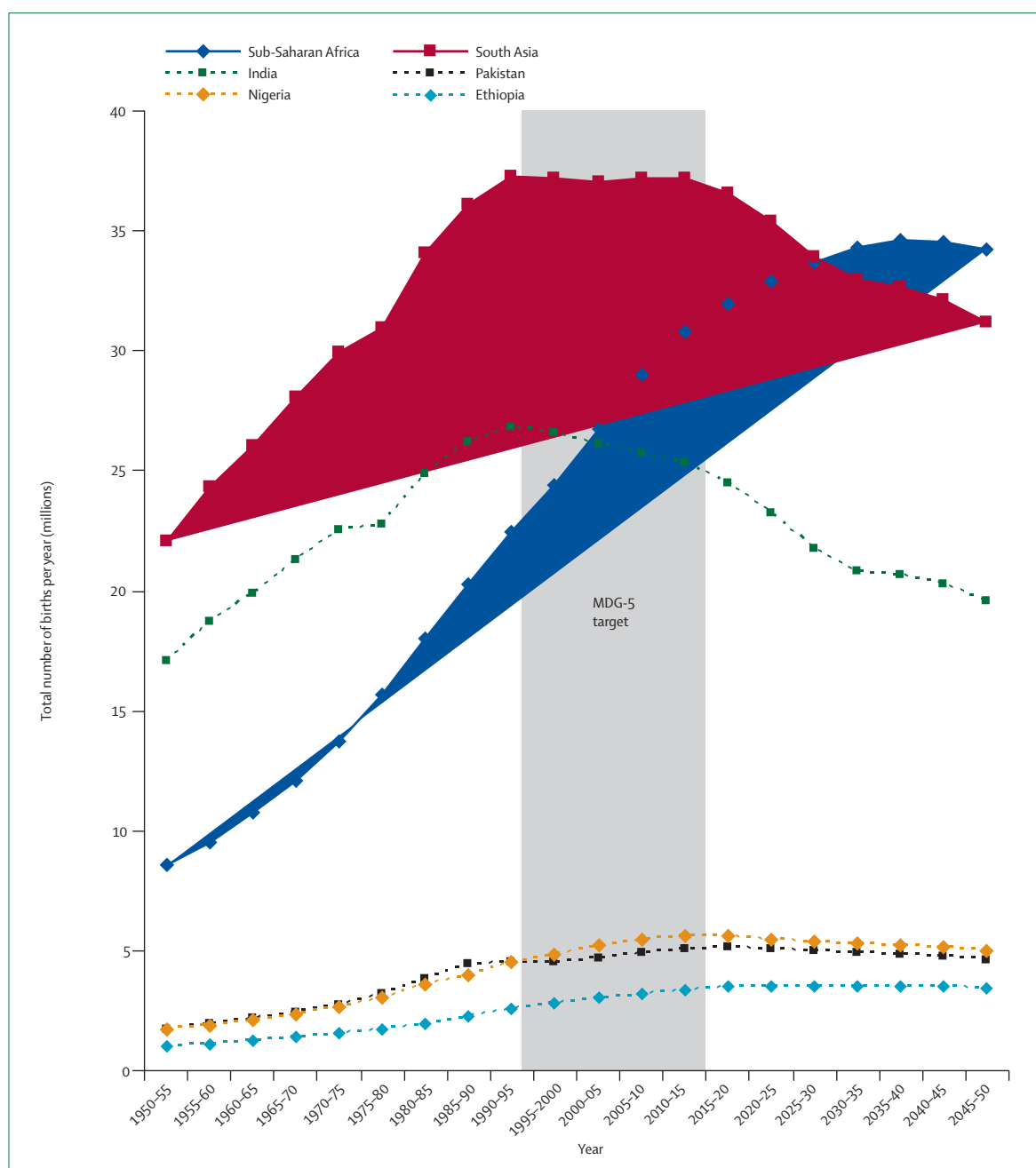
Figure 2: Trends in total number of births in sub-Saharan Africa, south Asia, India, Pakistan, Nigeria, and Ethiopia
Data from reference 5. MDG=Millennium Development Goal.

could emerge from tracking of trends in the number of maternal deaths. In 2000–05, the global total fertility rate was 2·65 children, about half that in 1950–55.[5] As a result, the number of births has fallen in some countries (figure 2). In south Asia, births are projected to remain at almost 40 million per year between 1990 and 2015, though there is huge variation between countries. In India, for example, births are expected to fall from 27 million to 24 million, directly contributing to a 9% fall in maternal

deaths. In sub-Saharan Africa, on the other hand, births will continue to increase by a projected 43% during the same period. Not only will this high fertility add an extra burden to overstretched maternity services, thus potentially increasing obstetric risk, it will also result automatically in increases in the number of maternal deaths.

In terms of the maternal mortality ratio, evidence suggests that a reduction of 75% is achievable within a 25 year timeframe. Some industrialised countries halved
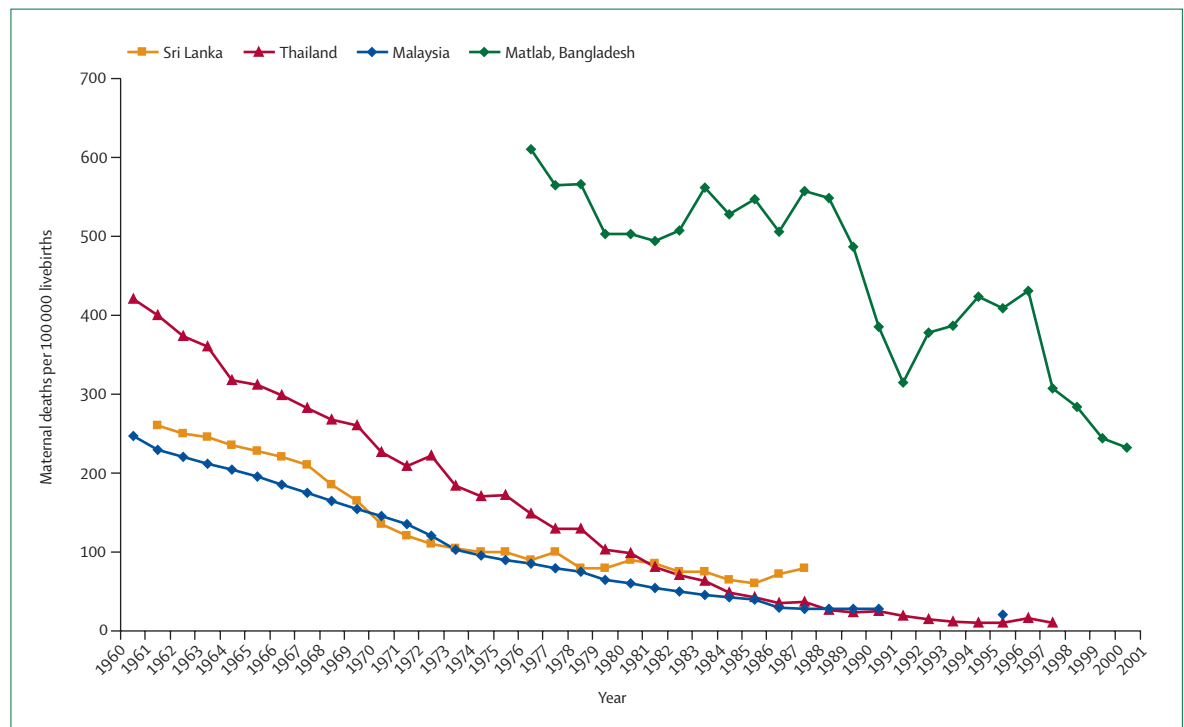
Figure 3: Trends in maternal mortality in Thailand, Malaysia, Sri Lanka, and Matlab, Bangladesh
Data from references 6 and 10.

their maternal mortality ratio in the late 19th century, mostly through the provision of professional midwifery care at birth.[6] Further striking falls occurred during and after World War II, when access to hospital care improved. The enormous difference between, for example, Sweden with a maternal mortality ratio of 300 deaths per 100 000 livebirths in 1935 and the USA with 600 deaths per 100 000 livebirths was essentially eliminated by 1960, when all industrialised countries reached ratios of 20 to 30 deaths per 100 000 livebirths.[7] Such a pronounced fall in maternal mortality is unparalleled, and is largely attributed to a decrease in the virulence of pathogens linked with puerperal sepsis, improved surgical techniques, and universal access to care.[6–8] A more recent fall in maternal mortality occurred in Romania, declining from an exceptionally high ratio for modern-day Europe of 159 deaths per 100 000 livebirths in 1989, attributed to restrictive abortion law. After this law was revoked, the abortion rate increased sharply and the maternal mortality ratio declined substantially to 83 deaths per 100 000 livebirths by 1991.[9]

Evidence from several transitional countries also suggests that a 75% decline can be achieved (figure 3[6,10]). During the past 40 years, Thailand has substantially reduced its maternal mortality ratio from more than 400 deaths per 100 000 livebirths in 1960, to 50 per 100 000 livebirths in 1984. Malaysia and Sri Lanka have also seen declines in the maternal mortality ratio of more than 50% during this period. These substantial achievements are thought to be due to a combination of factors including: long-term investment in midwifery training and referral hospitals; free care and a supportive system with regulation, control, and supervision of the medical and midwifery profession; and information to confirm progress.[11,12] More recent evidence from Egypt and Honduras lends support to the role of professional training networks and of international policy in stimulating declines in maternal mortality.[13,14] Both countries halved their maternal mortality ratio in less than 7 years, although baseline ratios were already less than 200 deaths per 100 000 livebirths. Finally, substantial declines also took place in Matlab, Bangladesh, a rural area receiving intense health and family planning services. The maternal mortality ratio declined from around 600 deaths per 100 000 livebirths in 1976 to 200 per 100 000 livebirths in 2001.[10] This fall was unexpected, since most women still deliver at home without a professional attendant. However, access to surgical obstetric care has increased substantially, and this together with a reduction in deaths from abortion, lower fertility, and general improvements in health (as indicated by lower all-cause death rates for women) are thought to explain part of the decline.[10]

Reliable trend data are not available for countries with high levels of maternal mortality nowadays, and some investigators believe there is little to suggest any progress, especially in sub-Saharan Africa.[15] The only

country with a documented fall in maternal mortality from very high rates is Sri Lanka, where the ratio fell from more than 1500 deaths per 100 000 livebirths to 300 per 100 000 livebirths in 25 years during the first half of the 20th century.[11,12] The eradication of malaria as well as universal access to midwifery care could have contributed to this decline.

These country case studies tell an important and encouraging story. First, they show that substantial falls in maternal mortality are feasible. Second, these successes give rise to some optimism about achieving the MDG-5 target of a 75% reduction over 25 years. Thailand took 18 years to reduce its maternal mortality ratio by three-quarters, and a reduction of two-thirds has taken 21 years in Matlab, Bangladesh. Finally, case studies show considerable diversity in the mechanisms that contribute to the decline in maternal mortality; these encompass policies such as liberalisation of abortion laws, control of infectious diseases, ensuring access to hospital care, and the provision of midwifery care. These intervention strategies all have a different effect on the timing and causes of maternal deaths. Understanding the epidemiology of maternal mortality can thus help inform strategic choices, as discussed in the second paper in this series.

## At what point during pregnancy and childbirth do women die?

Most maternal deaths seem to occur between the third trimester and the first week after the end of pregnancy.[16,17] Mortality can be extremely high on the first and second days after birth. In Matlab, Bangladesh, for example, new data show that the maternal mortality rate (expressed as deaths per 1000 woman-years of risk exposure) was more than 100 times higher on the first day after birth and 30 times higher on the second day after birth than in the second year postpartum (figure 4[3]). These findings provide strong support for prioritisation of strategies that focus on professional intrapartum care.

Women remain at increased risk of death for some time after childbirth. Maternal deaths have conventionally been defined as those occurring up to 42 days postpartum,[18] although recently a new category has been proposed to include late deaths up to 1 year postpartum. This change in definition is important since there is evidence that risk of death is increased for up to 6 months postpartum.[3,19,20] Mortality rates can be especially high after an abortion or stillbirth.[3,20] In Bangladesh, for example, pregnancies ending as abortions or stillbirths accounted for more than half of maternal deaths within the first week after the end of the pregnancy, and 50% within the first 6 weeks.[3] These data have implications for the timing of postpartum care and the duration that women should routinely have access to skilled care after birth.
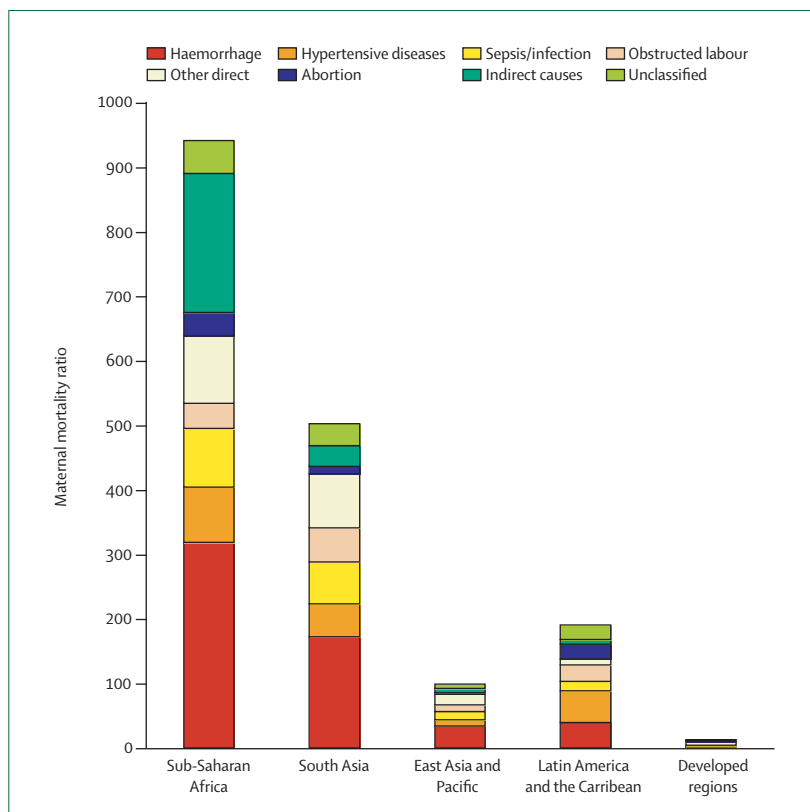
Why do women die?
Direct causes
Evidence suggests that the direct consequences of pregnancy and childbirth continue to account for most
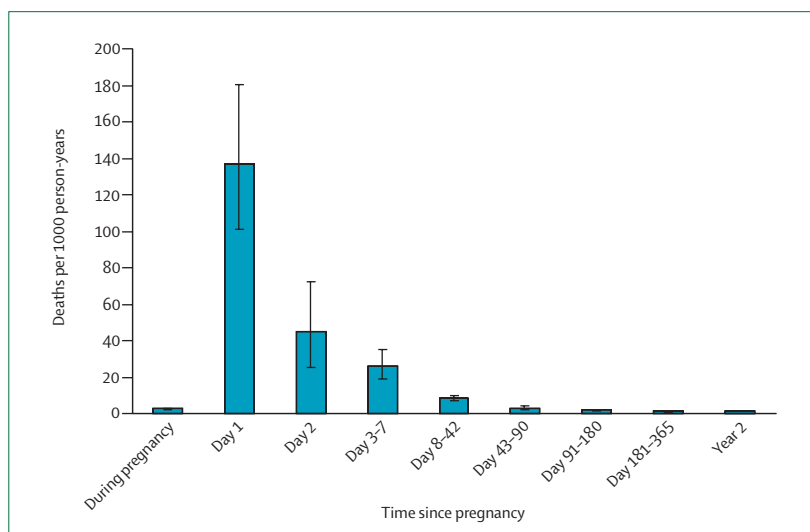
Figure 4: **Mortality during pregnancy and by time since end of pregnancy in Matlab, Bangladesh**
Data from reference 3. Black lines show 95% CI.

Figure 5: **Maternal mortality ratios for 2000 by medical cause and world region**
Ratios were obtained by applying proportional mortality from reference 22 to regional estimates of maternal mortality in 2000 (reference 2).

maternal deaths in developing countries. To obtain reliable information on the individual medical causes of maternal mortality is, however, extremely difficult, especially for deaths that occur at home.[21] In a systematic review of studies of maternal mortality by WHO, severe bleeding, hypertensive diseases, and infections were the dominant causes.[22] Although this pattern is common, the under-representation owing to data constraints of some causes—eg, complications of induced abortion or HIV/AIDS—cannot be ruled out. The systematic review also recognised a paucity of data from sub-Saharan Africa; we bring attention to the need for better country-level data for cause of death in the fifth paper in this series.

With the findings of the WHO review, estimates of cause-specific maternal mortality ratios can be derived (figure 5[2,22]). In sub-Saharan Africa, the combined maternal mortality ratio for severe bleeding, hypertensive diseases, and infections is staggering at almost 500 deaths per 100 000 livebirths, compared with fewer than 300 per 100 000 in south Asia, just over 100 in Latin America and the Caribbean, and four per 100 000 in developed nations. Of an estimated 166 000 deaths from haemorrhage globally each year, an estimated half occur in sub-Saharan Africa and more than a third in south Asia. Haemorrhage has long been known to be the "one major cause of maternal mortality in which women were dying needlessly for want of common skills that every midwife and practitioner should possess".[7] Whether or not a woman dies from bleeding during or after childbirth depends largely on access to timely and competent obstetric care.

The precise proportion of deaths attributable to unsafe abortion is not known. The WHO systematic review estimates maternal mortality ratios from induced abortion of 37 deaths per 100 000 livebirths in sub-Saharan Africa, 12 per 100 000 in south Asia, and 23 per 100 000 in Latin America and the Caribbean[22] (figure 5). However, much higher estimates have been reported globally[23] and in individual studies, especially in countries where abortion is illegal or restricted. For example, in a study of 12 hospitals in Benin, Côte d'Ivoire, and Senegal,[24] almost all deaths in early pregnancy were due to induced abortion, and a third of all maternal deaths were due to unsafe abortion. At the population level, reported results vary substantially. Abortion was rarely given as a cause of death in studies in Afghanistan,[25] Egypt,[13] or Senegal.[26] Conversely, induced abortion was the leading cause of maternal death in rural areas in Tanzania and Bangladesh in the 1980s, with maternal mortality ratios as high as 80 and 100 deaths per 100 000 livebirths, respectively.[27,28]

Indirect causes
The contribution to maternal deaths of diseases that are not unique to pregnancy is largely unknown in developing countries, partly owing to poor diagnostic capability and partly because pregnancies are often not reported for such causes. The inclusion or exclusion of causes that are not unique to the pregnancy (eg, HIV infection) can substantially affect the magnitude of maternal mortality.

Many maternal deaths take place in regions where HIV is prevalent, but the exact contribution of HIV/AIDS to maternal mortality is not known. Although programmes to prevent mother-to-child transmission of HIV have expanded substantially, most pregnant women in high prevalence areas still do not have access to HIV testing, and the HIV status of many pregnant women—let alone those who died—is not known. Nevertheless, HIV/AIDS has become a leading cause of pregnancy-related death in some hospitals[29,30] and there is growing evidence of its importance as a cause of death in populations with a high prevalence of HIV.[31–33] In countries most severely affected by HIV, such as Malawi, Zimbabwe, and South Africa, the AIDS epidemic is thought to have reversed previous gains in maternal mortality.[33,34]

Ideally, countries should be able to report separate maternal mortality ratios in women with and those without HIV, but only two studies have provided such data.[31,32] In the Rakai district of Uganda, the maternal mortality ratio was five times higher in HIV-infected than in HIV-uninfected women, and in Pointe Noire, Republic of Congo, the relative risk was 4. The excess mortality attributable to HIV was equivalent to a maternal mortality ratio of more than 1300 maternal deaths per 100 000 livebirths in both settings.

HIV affects pregnant women in several ways: HIV infection in pregnancy increases the risk of obstetric complications;[35,36] HIV-related illness such as anaemia or tuberculosis might be aggravated by pregnancy; pregnancy might increase HIV-incidence; or HIV progression itself might be worsened by pregnancy. The quality of care received by women who are known to be HIV-positive might also be worse than that received by other women. Epidemiological evidence does not support the hypothesis that the relative immunosuppression of pregnancy exacerbates HIV-disease,[37–42] but a study in Uganda convincingly showed that the risk of HIV acquisition is much higher in pregnancy than in non-pregnant or lactating women.[43] In this study, pregnancy doubled the incidence of HIV from 1·1 per 100 person-years in women who were not pregnant nor lactating, to 2·3 per 100 person-years in pregnant women. The effects were largely unchanged after controlling for sexual behaviour, suggesting that biological changes in pregnancy have an important role. This finding will have major implications for public health practice.[44] Existing programmes to prevent mother-to-child transmission, which have mainly focused on prevention of HIV infection in newborn babies, might now have to broaden their remit by including women who test negative and counselling them about the risks of pregnancy.

Separation of indirect obstetric deaths from direct causes is important because of the implications for intervention strategies and is especially relevant where

these background diseases kill many women of reproductive age, including pregnant women. For example, if deaths due to malaria[45,46] or HIV/AIDS are not distinguished from direct causes in settings with a high prevalence of malaria or HIV/AIDS, resources might be misdirected away from primary and secondary prevention strategies, which could have a large effect on maternal mortality. Moreover, some indirect causes are highly preventable or treatable—eg, tuberculosis and anaemia[47]—and necessitate collaboration between disease-control and maternal-health programmes.

Finally, deaths from accidents, murders, or suicides while a woman is pregnant or within 42 days of delivery have long been classified as being incidental to the pregnant state (panel 2), and thus excluded from maternal mortality statistics. However, mounting evidence suggests that such deaths might, at least in part, be caused by the pregnancy.[48,49] In India, deaths due to domestic violence were the second largest cause of death in pregnancy (16%).[50] In Matlab, Bangladesh, 20% of deaths in pregnant unmarried women were due to suicide compared with 5% for married women, and pregnant girls were nearly three times more likely to die from violent causes than non-pregnant girls.[48,51] Earlier studies in developed countries suggest that suicide might be precipitated by pregnancy and that some accidents might be pregnancy-related, although a later study in the UK does not support these findings.[52]

Where do maternal deaths take place?

The table[27,53–63] shows a summary of published evidence for where women die. In many settings, a large proportion of all maternal deaths takes place in hospitals. This proportion includes three main types of cases: women who arrive in a moribund state too late to benefit from emergency care, women who arrive with complications who could have been saved if they had received timely and effective interventions, and women admitted for normal delivery who subsequently develop serious complications—either naturally or through iatrogenic factors—and die
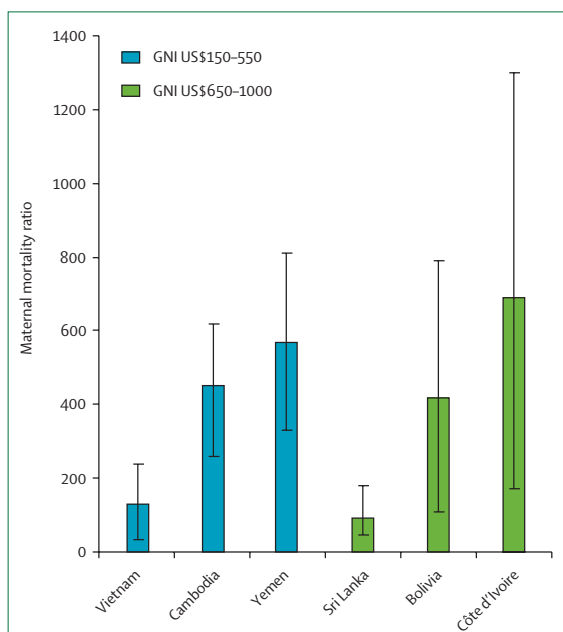

Figure 6: **Maternal mortality by gross national income per head in six developing countries in 2000**
GNI=gross national income. Black lines show range of uncertainty. Data from references 2 and 67.

	Years	Number of maternal deaths	In hospital	In other health facilities	At home	In other places
Egypt (national)[53]	1992–93	718	424 (59%)	36 (5%)	258 (36%)	..
Pakistan (Faisalabad)[54]	1989–93	215	145 (67%)	..	70 (33)	..
Zimbabwe (Masvingo province)[55]	1989–90	26†	14 (54%)	1 (3·8%)	8 (31%)	3 (12%)
Guinea-Bissau[56]	1996–97	111	50 (45%) (any health facility)	..	45 (41%)	8 (7%) 'travelling'; 8 (7%) 'others'
South Africa (national)[57]	1998	676	621 (92%)	13 (1·9%)	16 (2%)	10 (2%) private hospitals, 15 (2%) unknown
Surinam (national)[58]	1991–93	64	53 (83%)	2 (3·1%)	9 (14%)	..
Egypt (national)[59]	2000	580	360 (62%)	..	168 (29%)	52 (9%) during transport
Zimbabwe (Matebeleland province)[60]	1998–2001	92	68 (74%) (any health facility)	..	..	24 (26%) unspecified
Tanzania (Arusha region)[61]	1995–96	45	40 (89%)	..	..	5 (11%) unspecified
Mozambique (Sofala province)[62]	1996–97	40	22 (55%) (any health facility)	..	14 (35%)	4 (10%)
Tanzania[27]				..		..
Dar es Salaam	1993–99	107	76 (71%)		31 (29%)	
Hai District	1992–99	110	86 (78%)		24 (22%)	
Morogoro District	1992–99	224	98 (44%)		126 (56%)	
Vietnam‡[63]	2000–2001	80	32 (40%)	..	35 (44%)	1 (1%) private clinic, 6 (8%) during transport, 1 (1%) other

Data are number (%) unless otherwise indicated. *Studies reporting data for ≥25 maternal deaths. †Deaths due to obstetric haemorrhage only. ‡Maternal deaths by province; Cao Bang (15), Ha Tay (7), Quang Tri (13), Quang Ngai (7), Dak Lak (22), Binh Duong (5), Kien Giang (11).

Table: **Location of maternal death: findings from selected studies***
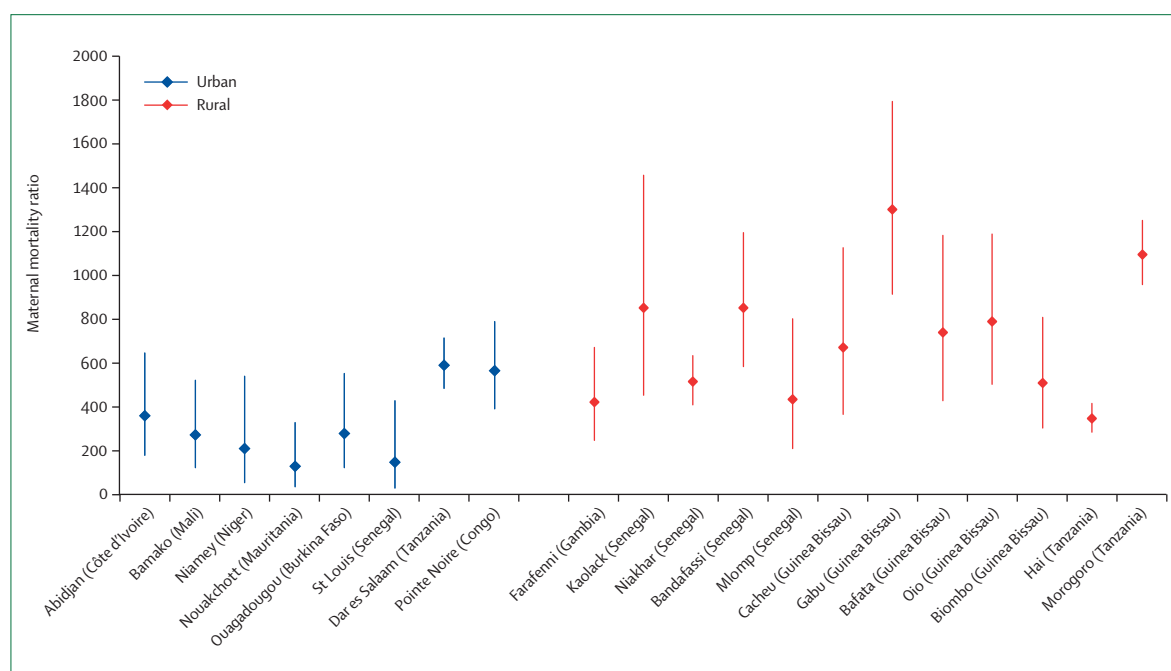
Figure 7: **Maternal mortality ratios in urban and rural sites in sub-Saharan Africa**
Data from references 27, 32, 69. Vertical lines show 95% CI.
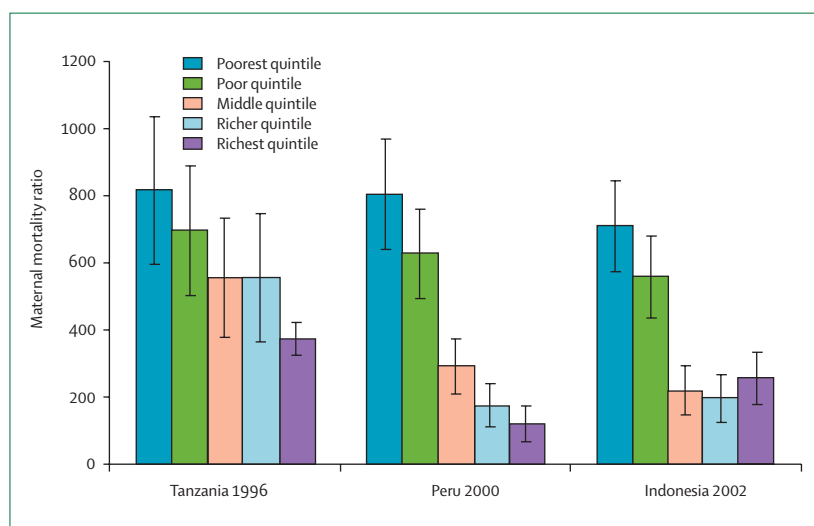
Figure 8: **Maternal mortality ratios by poverty quintile**
Data from reference 71. Black lines show 95% CI.

with or without having received emergency care. The latter two types of cases raise concerns about the quality of care in health facilities, and numerous studies have shown that delays in recognition and treatment of life-threatening complications, as well as substandard practices, contribute directly to maternal deaths.[53,64] Confidential enquiries into maternal deaths in a diverse range of countries, together with findings from clinical audits, suggest the proportion for which substandard care played a substantial role is often more than a third.[65]

The cases in which women arrive in a moribund state give different insights; sometimes into problems with the referral chain between facilities, and sometimes into barriers in the community—which might be physical, cultural, or financial—to accessing care. Delay due to such difficulties is known as the second delay which contributes to deaths;[66] the first delay being in the recognition by women and families of the need to seek care, and the third being the delay in receiving effective interventions, as discussed further in the second paper in this series.

What are the inequalities in the risk of maternal death?

The main differences in maternal mortality between world regions described earlier cannot simply be explained by variations in economic growth.[6] For example, Vietnam and Sri Lanka have achieved much lower levels of maternal mortality than Yemen and Côte d'Ivoire, despite being matched on gross national income per head (figure 6[2,67]). National figures mask substantial internal variations—geographical, economic, and social—which are not confined to developing countries. There is ample evidence of inequities within developed countries:[68] in other words, irrespective of the stage of development or the condition of the health system, inequalities in the risk of maternal death are found everywhere.

Differences in maternal mortality between urban and rural areas within poor countries are also substantial. In Egypt, the maternal mortality ratio was more than twice

as high in the nomadic Frontier region than in the Metropolitan region (120 *vs* 48 deaths per 100 000).[59] In Afghanistan the differences were even more striking, with mortality being 418 per 100 000 in the capital city of Kabul compared with 6507 per 100 000 in the remote district of Ragh.[25] Data from selected population-based studies in sub-Saharan Africa accord with these urban-rural patterns (figure 7).[27,32,69] Although the margins of error are large, a clear pattern exists: the pooled estimate for urban areas is 447 deaths per 100 000 livebirths (95% CI 384–517) compared with 640 per 100 000 in rural areas (590–693). Differences in physical access to obstetric care is likely to explain at least part of this variation.[69] Conversely, the existence of high mortality levels in some urban areas suggests that other mechanisms might be involved, such as high prevalence of HIV[32] or of unsafe abortion,[24] or as mentioned earlier, the poor quality of emergency obstetric care in hospitals.[59]

A link between poverty and maternal health has been clear for more than a century, and is lent support by extensive evidence from rich countries.[6,66] The familial technique, a new method in which survey data is used to examine socioeconomic differences in maternal mortality, has now made it possible to quantify the magnitude of differences between rich and poor people living in poor countries.[70] Figure 8[71] shows new data for the poverty gradient in maternal mortality ratios for three countries. In Peru, for example, the estimate for the poorest group is in excess of 800 maternal deaths per 100 000 livebirths compared with less than 130 per 100 000 for the richest quintile—a greater than six-fold difference. The reasons for these differences are not well understood. Large discrepancies exist between the rich and the poor in the uptake of antenatal and delivery services,[72,73] but this is unlikely to be the sole explanation. Indeed, historical and contemporary research shows that there are many dimensions to disadvantage in addition to economic factors, which operate through subtle and indirect pathways to influence outcomes. Some of these societal factors are group characteristics such as ethnicity, caste, or race, whereas others, such as marital status, social standing, self-esteem, or psycho-social stress, are specific to individuals.[68] In the USA, for example, economic factors cannot explain the higher risks of maternal death in black versus Hispanic women, since they have a similar poverty status.[74] Indeed, Ibison and colleagues[75] showed that immigrant women in England and Wales who died of maternal causes were more likely to come from high-income groups than non-immigrant women who died from these causes.

What else do we need to know about maternal mortality?

Information for maternal mortality serves many different purposes globally and locally, ranging from, for example, improving awareness in local communities, to global monitoring of progress towards MDG-5. The requirements on the scope and quality of information also vary according to purpose and level. The need to be sure that deaths are not missed and that causes are known reliably is considerably greater in the case of monitoring the introduction of a drug such as misoprostol than in advocating for increased resources for maternity care, for example. In other words, information needs to be fit for purpose. This concept of fitness for purpose is crucial because it explains the apparent contradiction between claims that we have enough information to act, and concurrent calls for more information.[76]

Capturing of maternal deaths is not straight forward, even in countries with advanced statistical systems,[77] and much has been written about these measurement constraints.[15,16,49,68] Some of these difficulties relate to the very nature of maternal death—an outcome prone to under-reporting owing to misclassification of causes, to sensitivity in the case of certain complications such as induced abortion, and to absence of a diagnosis or declaration of pregnancy. Other measurement difficulties are inherent to weak routine reporting systems, and others still to the large sample sizes needed to produce current estimates. Not surprisingly, the shortage of reliable information for maternal mortality is most acute in the poorest countries; with some having to rely entirely on model-based estimates.[2] Such countries are also where levels of maternal mortality are expected to be highest.

Although enough is clearly known in these settings, and indeed at a global level, to justify maternal mortality as a priority—whether for country health plans or the Millennium Declaration—how to measure progress towards reduction of this burden overall, and between socioeconomic groups, is far from obvious.[77,78] Generation of data fit for this purpose requires adequate precision and reliability to capture change, and we therefore strongly urge greater use and better understanding of CIs for point estimates. Moreover, from a programmatic perspective, cause-specific changes are also important, as for example with AIDS, which is now the single largest cause of maternal death in some parts of sub-Saharan Africa.

Just as there is no magic bullet to reduce maternal mortality, neither is there a magic method to measure this burden. Rather, a mixed methods approach should be encouraged, seizing all opportunities to gather fit-for-purpose data, such as decennial censuses,[79] indirect approaches,[80] and adjusted routine facility-based data.[81] New additions to the armoury of methods continue to be needed, with the mixture varying between contexts in relation mainly to the expected magnitude and availability of routine sources such as vital registration. Promising developments are on the horizon, such as improved approaches to determining cause of death,[82] meta-analytic techniques, and innovation in

sampling.[76] Unless action is taken to empower countries to gather fit-for-purpose data for maternal mortality, not only will the status in 2015 of MDG-5 remain unknown for much of the world, but also investment might be diverted away from the real goal of preventing maternal death.

Progress will ultimately be dependent on strong health systems ensuring high coverage of midwifery services supported by timely and competent hospital care, especially in the poorest countries in sub-Saharan Africa and south Asia. The persistent emphasis on global differences and strategies for maternal health has often entailed a neglect of biological, geographic, economic, and social differences in maternal mortality within populations. Targeting of interventions towards the most vulnerable groups (mostly rural populations and the poor) also means targeting improvements in measuring their burden of mortality, so enabling the monitoring of governments' accountability for reducing this most basic of inequities—maternal death.

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