Global burden of maternal death and disability

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Sound information is the prerequisite for health action: without data on the dimensions, impact and significance of a health problem it is neither possible to create an advocacy case nor to establish strong programmes for addressing it. The absence of good information on the extent of the burden of maternal ill-health resulted in its relative neglect by the international health community for many years. Maternal deaths are too often solitary and hidden events that go uncounted. The difficulty arises not because of lack of clarity regarding the definition of a maternal death, but because of the weakness of health information systems and consequent absence of the systematic identification and recording of maternal deaths. In recent years, innovative approaches to measuring maternal mortality have been developed, resulting in a stronger information base. WHO, UNICEF and UNFPA estimates for the year 2000 indicate that most of the total 529,000 maternal deaths globally occur in just 13 countries. By contrast, information on the global burden of non-fatal health outcomes associated with pregnancy and childbearing remains patchy and incomplete. Nonetheless, initial estimates based on systematic reviews of available information and confined to the five major direct pregnancy-related complications indicate a problem of considerable magnitude.

Introduction

One of the reasons why maternal mortality was a neglected problem for so long was inadequate information. Countries with the highest levels of mortality seldom have good coverage or reporting of vital events such as births and deaths. And even countries with relatively complete vital registration (generally defined as covering some 90% of the population) may have less than adequate attribution of causes of death. This is important because in order to decide whether the death of a women is a maternal death or not it is essential to know both the timing of the death in relation to the pregnancy status of the woman and the cause of death. Herein lies one of the biggest challenges when it comes to measuring the dimensions of the burden of maternal mortality and morbidity.
Measurement challenges

The Tenth Revision of the International Classification of Diseases (ICD-10) defines a maternal death as 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. There are two problems with this definition, one related to time of death, the second to cause of death. With regard to the first, historically, maternal mortality was defined as deaths occurring within 6 weeks of termination of pregnancy. Modern life-sustaining procedures and technologies can, however, prolong dying and delay death. Even before the era of modern medicine it is likely that some maternal deaths took place beyond the 6 week interval, but the proportion was probably very small. Medical procedures may increase that proportion, but it is likely to remain fairly small though by no means negligible. For example, the Centers for Disease Control reports that 29% of maternal deaths in Georgia, USA, over the period 1974–75 occurred after 42 days of pregnancy termination and 6% occurred after 90 days post-partum.

The second problem with the definition of maternal death lies in the classification of cause of death. The drawback is that maternal deaths can escape being so classified because the precise cause of death cannot be given even though the fact of the woman having been pregnant is known. Such under-registration is frequent in both developing and developed countries. Even in countries where all or most deaths are medically certified, maternity-related mortality can still be grossly underestimated. Record linking and other studies have shown misreporting of between 25% and 70% of maternal deaths.

According to ICD-9 and ICD-10, maternal deaths should be divided into two groups: direct obstetric deaths resulting from obstetric complications of the pregnant state (pregnancy, labour and the puerperium); and indirect obstetric deaths resulting from previous existing disease or disease that developed during pregnancy and which was aggravated by the physiologic effects of pregnancy. Indirect maternal deaths are particularly prone to being reported as non-maternal and there are significant differences between countries in the classification of indirect deaths to the maternal category. Of the 60 countries reporting vital registration figures for causes of maternal deaths over the period 1992–1993, over half (33 countries) reported no indirect deaths at all. Yet the 1997–99 Confidential Enquiry in the UK found that indirect deaths now account for more maternal deaths than deaths due to direct causes.

Deaths from ‘accidental or incidental’ causes have historically been excluded from maternal mortality. However, in practice, the distinction
between incidental and indirect causes of death is difficult to make. Some deaths from external causes may be attributable to the pregnancy itself. It is likely that many homicides and suicides of pregnant or recently pregnant women are attributable in some way to the pregnancy. In practice, different countries use different definitions and this renders it difficult to make comparisons between countries about the dimensions and patterns of maternal mortality.

**Global estimates of maternal mortality**

The difficulty of measuring maternal mortality has long been an impediment to progress in alerting health planners and others to the magnitude and causes of the problem and hence to effective interventions on an appropriate scale. In order to strengthen the information base, WHO, UNICEF and UNFPA have developed an approach to estimating maternal mortality that seeks both to generate estimates for countries with no data and to correct available data for underreporting and misclassification. A dual strategy is used which involves adjusting available country data and developing a simple model to generate estimates for countries without reliable information. Inevitably, given the uncertainty of the available data, the estimates are subject to wide margins of uncertainty and cannot be used to monitor short-term trends. In addition, cross-country comparisons should be treated with considerable circumspection because different strategies are used to derive the estimates for different countries, rendering comparisons fraught with difficulty. Nonetheless, the approach, with some variations, was used to develop estimates for maternal mortality in 1990, 1995 and 2000.

The estimated number of maternal deaths in 2000 for the world was 529,000 (Table 1). These deaths were almost equally divided between Africa (251,000) and Asia (253,000), with about 4% (22,000) occurring in Latin America and the Caribbean, and less than 1% (2500) in the more developed regions of the world. In terms of the maternal mortality ratio (MMR), the world figure is estimated to be 400 per 100,000 live births. By region, the MMR was highest in Africa (830), followed by Asia (330), Oceania (240), Latin America and the Caribbean (190), and the developed countries (20).

The country with the highest estimated number of maternal deaths is India (136,000), followed by Nigeria (37,000), Pakistan (26,000), Democratic Republic of Congo and Ethiopia (24,000 each), the United Republic of Tanzania (21,000), Afghanistan (20,000), Bangladesh (16,000), Angola, China and Kenya (11,000 each), Indonesia and Uganda (10,000 each). These 13 countries account for 67% of all maternal deaths.
However, the number of maternal deaths is the product of the total number of births and obstetric risk per birth, described by the MMR. On a risk per birth basis, the list looks rather different. With the sole exception of Afghanistan, the countries with the highest MMRs are in Africa. The highest MMRs of 1000 or greater are, in rank order, Sierra Leone, Afghanistan, Malawi, Angola, Niger, the United Republic of Tanzania, Rwanda, Mali, Somalia, Zimbabwe, Chad, Central African Republic, Guinea Bissau, Kenya, Mozambique, Burkina Faso, Burundi and Mauritania.

### Causes of maternal deaths and disabilities

In calculating the overall burden of ill-health associated with pregnancy and childbirth, it is necessary to estimate the incidence of obstetric complications, their case fatality rates in different settings, and the incidence and severity of non-fatal health outcomes. A comprehensive analysis of the burden of obstetric mortality and morbidity would need to address both direct and indirect causes of deaths and disabilities, and at least some of the incidental causes. Direct conditions would include temporary, mild or severe conditions which occur during pregnancy and within 42 days of delivery (such as haemorrhage, eclampsia or sepsis) or permanent/chronic conditions that persist beyond the puerperium (such as obstetric fistula, urinary or faecal incontinence, scarred uterus, pelvic inflammatory disease, palsy). Indirect conditions would include, for example, anaemia, malaria, hepatitis, tuberculosis and cardiovascular disease. Psychological

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**Table 1 2000 Maternal mortality estimates by United Nations MDG regions**

<table>
<thead>
<tr>
<th>Region</th>
<th>Maternal mortality ratio (maternal deaths per 100,000 live births)</th>
<th>Number of maternal deaths</th>
<th>Lifetime risk of maternal death, 1 in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>World total</td>
<td>400</td>
<td>529,000</td>
<td>74</td>
</tr>
<tr>
<td>Developed regions*</td>
<td>20</td>
<td>2500</td>
<td>2800</td>
</tr>
<tr>
<td>Europe</td>
<td>24</td>
<td>1700</td>
<td>2400</td>
</tr>
<tr>
<td>Developing regions</td>
<td>440</td>
<td>527,000</td>
<td>61</td>
</tr>
<tr>
<td>Africa</td>
<td>830</td>
<td>251,000</td>
<td>20</td>
</tr>
<tr>
<td>Northern Africa</td>
<td>130</td>
<td>4600</td>
<td>210</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>920</td>
<td>247,000</td>
<td>16</td>
</tr>
<tr>
<td>Asia</td>
<td>330</td>
<td>253,000</td>
<td>94</td>
</tr>
<tr>
<td>Eastern Asia</td>
<td>55</td>
<td>11,000</td>
<td>840</td>
</tr>
<tr>
<td>South-Central Asia</td>
<td>520</td>
<td>207,000</td>
<td>46</td>
</tr>
<tr>
<td>South-Eastern Asia</td>
<td>210</td>
<td>25,000</td>
<td>140</td>
</tr>
<tr>
<td>Western Asia</td>
<td>190</td>
<td>9800</td>
<td>120</td>
</tr>
<tr>
<td>Latin America &amp; the Caribbean</td>
<td>190</td>
<td>22,000</td>
<td>160</td>
</tr>
<tr>
<td>Oceania</td>
<td>240</td>
<td>530</td>
<td>83</td>
</tr>
</tbody>
</table>

*Includes Canada, USA, Japan, Australia and New Zealand which are excluded from the regional totals.
obstetric morbidity would include puerperal psychoses, post-partum depression (baby blues), suicide, and strong fear of pregnancy and childbirth resulting from, for example, obstetric complications, interventions or cultural practices.

In practice, given the paucity of the data, WHO has developed estimates of mortality and morbidity related to just five direct obstetric conditions: post-partum haemorrhage, puerperal sepsis, pre-eclampsia and eclampsia, obstructed labour and abortion. Non-fatal health outcomes of other direct obstetric complications, such as ectopic and molar pregnancies, anaesthetic complications, cerebrovascular accidents, embolisms, are not included here. Nor are the non-fatal health outcomes of indirect causes of maternal deaths.

A general problem encountered in attempting to estimate incidence of pregnancy-related complications is that the different sources of data are neither representative nor comparable. Hospital statistics indicate the incidence of the condition among women delivering in hospitals, and are therefore reliable only for developed countries, where most deliveries take place in hospitals. On the other hand, self-reported maternal morbidity tends to overestimate incidence and the results very much depend on the sensitivity and specificity of the data collection instruments. Several attempts have been made to validate the results of self-reported maternal morbidity, and some of them compared the results from interviewing women shortly after hospital delivery with hospital case notes. Comparisons are difficult, as studies may have used different definitions and study design, and their results may not be generalized to the population which does not deliver in hospital. Thus, self-reported maternal morbidity cannot provide exact estimates of prevalence and incidence.

Given these constraints, estimates of the overall burden of maternal ill-health associated with pregnancy and childbearing are necessarily incomplete. Nonetheless, they provide an idea of the orders of magnitude of the problem. These initial estimates have been developed for WHO’s calculations of the global burden of disease and are based upon both literature review and expert consensus. They are currently under review and final results along with details of the methodologies and data sources will be published in the World Health Report.

Maternal haemorrhage

Maternal haemorrhage consists of bleeding from the genital tract during pregnancy (antepartum), during or after the delivery of the infant (intra- and post-partum). Although in developed countries antepartum haemorrhage is no longer a major cause of maternal mortality, it is still an important cause of maternal and perinatal morbidity. In contrast, post-partum haemorrhage continues to be a major cause of maternal death both in
the developing as well as in the developed world and we therefore focus on post-partum haemorrhage in these estimates. Although the formal definition of post-partum haemorrhage is blood loss of 500 ml or more within 24 h after delivery and/or within 42 weeks following delivery, we considered only blood loss of 1000 ml or more, because it has greater clinical significance. We considered only one major sequela of severe post-partum haemorrhage, namely anaemia.

On the basis of data convened from a review of published literature, combined with expert consensus, we estimate an incidence of severe post-partum haemorrhage globally of around 10.5% of live births. Clearly, incidence is lower in developed country settings where most women deliver in a hospital and where active management of the third stage of labour is the norm, compared to developing areas where large proportions of women deliver at home. Based on the global average, we estimate that each year nearly 14 million women suffer severe blood loss during childbirth or the post-partum period. We estimate that around 140,000 women die as a result, a case fatality rate of 1%. A further 12% survive but with severe anaemia, meaning that each year, some 1.6 million women of reproductive age suffer from long-lasting and debilitating consequences of anaemia due to pregnancy-related complications (Table 2).

### Table 2 Estimated incidence of major obstetric complications and main maternal sequelae (2000)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence (% of live births)</th>
<th>Cases</th>
<th>Case fatality rate (%)</th>
<th>Maternal deaths 2000</th>
<th>Main sequelae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe post-partum haemorrhage</td>
<td>10.5</td>
<td>13,795,000</td>
<td>1.0</td>
<td>132,000</td>
<td>Severe anaemia</td>
</tr>
<tr>
<td>Sepsis</td>
<td>4.4</td>
<td>5,768,000</td>
<td>1.3</td>
<td>79,000</td>
<td>Infertility</td>
</tr>
<tr>
<td>Pre-eclampsia/eclampsia</td>
<td>3.2</td>
<td>4,152,000</td>
<td>1.7</td>
<td>63,000</td>
<td>Eclampsia</td>
</tr>
<tr>
<td>Obstructed labour</td>
<td>4.6</td>
<td>6,038,000</td>
<td>0.7</td>
<td>42,000</td>
<td>Urinary incontinence, fistula</td>
</tr>
<tr>
<td>Abortion</td>
<td>14.8</td>
<td>19,340,000</td>
<td>0.3</td>
<td>69,000</td>
<td>Infertility</td>
</tr>
</tbody>
</table>

### Sepsis

Historically, puerperal sepsis was a common pregnancy-related condition, which could eventually lead to obstetric shock or even death. During the 19th century, it took on epidemic proportions, particularly in lying-in hospitals, where ignorance of asepsis prevailed. The efforts of Wendell Holmes and Semmelweis to improve asepsis during childbirth resulted in a striking decrease in mortality due to puerperal sepsis between 1846 and 1847\(^1\). With the introduction of antibiotics, puerperal fever declined...
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Further in developed countries. Puerperal sepsis is nonetheless still prevalent in developing countries and continues to present a significant risk of obstetric morbidity and mortality. Moreover, nosocomial infections, particularly related to operative deliveries, and antibiotic resistance, are increasingly common in both developed and developing regions. Puerperal infection is a general term used to describe any infection of the genital tract after delivery. Because most pyrexia in the puerperium is caused by pelvic infections, the incidence of fever after childbirth may be a reliable index of their incidence though fever may also be associated with other infections related to childbirth such as mastitis. In the absence of antibiotic treatment or in more severe cases, puerperal infection may be complicated by pelvic chronic pain, pelvic inflammatory disease, bilateral tubal occlusion and infertility.

Estimating the incidence of sepsis around the world is fraught with difficulty because the aetiology and epidemiology of sepsis vary enormously as a result of local conditions, in particular with regard to hygiene during delivery but also as a function of rates of reproductive tract infections, including sexually transmitted infections. Rates of puerperal sepsis are generally higher in settings with high HIV prevalence. Based on a literature review of hospital and community studies, we estimated the incidence of sepsis globally to be 4.4% of live births, giving a total number of puerperal sepsis cases of nearly 6 million and almost 77,000 maternal deaths. The most significant long-term complication is infertility resulting from tubal occlusion, estimated to affect some 450,000 women each year.

Pre-eclampsia and eclampsia

Hypertensive disorders of pregnancy (HDP) represent a group of conditions associated with high blood pressure during pregnancy, proteinuria and in some cases convulsions. The most serious consequences for the mother and the baby result from pre-eclampsia and eclampsia. These are associated with vasospasm, pathologic vascular lesions in multiple organ systems, increased platelet activation and subsequent activation of the coagulation system in the micro-vasculature. Eclampsia is usually a consequence of pre-eclampsia consisting of central nervous system seizures, which often leave the patient unconscious; if untreated it may lead to death. The long-term sequelae of both pre-eclampsia or eclampsia are not well evaluated, and the burden of HDP stems mainly from deaths.

Formulating estimates of the global incidence of pre-eclampsia and eclampsia is difficult because of heterogeneity in definitions, problems related to the measurement of blood pressure in pregnant women, and the validity of urinary protein measurements in the diagnosis of pre-eclampsia.
However, recent estimates developed by WHO are built on somewhat stronger foundations than those for other direct obstetric complications described here. This is because WHO’s Department of Reproductive Health and Research is currently undertaking a systematic review of pre-eclampsia and eclampsia. This has focused on recent, population-based studies from both developed and developing countries whose investigators made efforts to control and/or assure the diagnosis of pre-eclampsia and eclampsia (blood pressure and proteinuria measurements, documentation of seizure, etc.).

Based on initial results, the incidence of pre-eclampsia is estimated at 3.2% of live births, giving a total number of over 4 million cases each year, of which over 72,000 were fatal.

**Obstructed labour**

Labour is considered obstructed when the presenting part of the fetus cannot progress into the birth canal, despite strong uterine contractions. The most frequent cause of obstructed labour is cephalo-pelvic disproportion—a mismatch between the fetal head and the mother’s pelvic brim. The fetus may be large in relation to the maternal pelvic brim, such as the fetus of a diabetic woman, or the pelvis may be contracted, which is more common when malnutrition is prevalent. Other causes of obstructed labour may be malpresentation or malposition of the fetus (shoulder, brow or occipito-posterior positions). In rare cases, locked twins or pelvic tumours can cause obstruction.

Neglected obstructed labour is a major cause of both maternal and newborn morbidity and mortality. The obstruction can only be alleviated by means of an operative delivery, either caesarean section or other instrumental delivery (forceps, vacuum extraction or simp physiotomy). Maternal complications include intrauterine infections following prolonged rupture of membranes, trauma to the bladder and/or rectum due to pressure from the fetal head or damage during delivery and ruptured uterus with consequent haemorrhage, shock or even death. Trauma to the bladder during vaginal or instrumental delivery may lead to stress incontinence.

By far the most severe and distressing long-term condition following obstructed labour is obstetric fistula—a hole which forms in the vaginal wall communicating into the bladder (vesico-vaginal fistula) or the rectum (recto-vaginal fistula) or both. In developing countries, fistulae are commonly the result of prolonged obstructed labour and follow pressure necrosis caused by impaction of the presenting part during difficult labour. In the infant, neglected obstructed labour may cause asphyxia leading to stillbirth, brain damage or neonatal death.
the global dimensions of mortality and morbidity due to obstructed labour is difficult because of the absence of a clear definition and confusion of terms used by different practitioners. The term ‘dystocia’ is most frequently used as an equivalent for obstructed labour, but it covers a broad range of conditions, from labour lasting more than 12 hours to uterine rupture, feto-pelvic disproportion or abnormal fetal presentation. Moreover, estimating the duration of labour may be difficult, especially in settings without appropriate monitoring technology. It is, however, accepted that if obstruction cannot be overcome by manipulation or instrumental delivery, caesarean section is needed and thus it is possible to use the rate of caesarean section carried out for dystocia and malpresentation as a proxy for the incidence of obstructed labour for regions where intervention is universally accessible. In settings where access to caesarean section is limited, obstructed labour is managed by means of instrumental deliveries. We assumed that in 90% of cases of obstructed labour, a caesarean section is carried out, and in the remaining 10% an instrumental delivery.

Based on extensive literature review and expert consensus, we estimate that obstructed labour occurs in around 4.6% of live births, giving a total number of cases of obstructed labour of over 6 million. Over 40,000 women die following neglected obstructed labour and some 73,000 suffer the most serious and debilitating non-fatal health outcome, obstetric fistula.

**Abortion**

The term ‘abortion’ covers a variety of conditions arising during early pregnancy, from ectopic pregnancy and hydatiform mole, through to spontaneous and induced abortion. There are important differences in the dimensions and nature of deaths and disabilities resulting from different kinds of abortion. The overwhelming majority of deaths and disabilities caused by pregnancies with abortive outcome arise from the complications of unsafe abortion, defined as an abortion taking place outwith a health facility (or other place recognized by law) and/or provided by an unskilled person.

Unsafe abortion may lead to haemorrhage, infection and death, particularly in settings where there is poor access to hospital and medical care. When infection spreads upwards through the genital tract, causing damage to the fallopian tubes and ovaries, then pelvic inflammatory disease will develop. This condition causes pain and discomfort, and if left untreated, it can result in chronic pelvic pain, bilateral tubal occlusion (due to adhesions and scars formed around the uterus), and secondary infertility. Secondary infertility is defined as failure to conceive again after an established pregnancy.
In countries where induced abortion is restricted and inaccessible, or even where abortion is legal but difficult to obtain, little information is available on abortion practice. Because of the difficulty of quantifying and classifying abortion in such circumstances, its occurrence tends to be unreported or under-reported. Surveys show that under-reporting occurs where abortion is legal, and when taking place in clandestine conditions it may not be reported at all or as a spontaneous abortion (miscarriage). Estimates have to rely on adjustments to correct for misreporting and under-reporting, the degree of adjustment depending largely on which methods are commonly used to carry out the abortion, and assumptions of its relative incidence in rural and urban areas.

Data on incidence of unsafe abortion are tabulated in a database maintained by the Department of Reproductive Health and Research (RHR) in WHO. Reports included in the database are identified through a search of library databases and by tracing references. A recent in-depth review estimated a global incidence of unsafe abortion of over 14 unsafe abortions for every 100 live births, amounting to 68,000 abortion-related maternal deaths each year.

The views expressed in this article are those of the author and should not be taken to represent those of the World Health Organization.

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