The costs of maternal–newborn illness and mortality

M. Kamrul Islam
Ulf-G. Gerdtham
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Moving towards universal coverage

Issues in maternal–newborn health and poverty

The costs of maternal–newborn illness and mortality

M. Kamrul Islam, Ulf-G. Gerdtham
Department of Community Medicine, Lund University, Malmö, Sweden
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Acronyms

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<th>Definition</th>
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<td>AIDS</td>
<td>Acquired immunodeficiency syndrome</td>
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<td>CPI</td>
<td>Consumer price index</td>
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<td>CPP</td>
<td>Chronic pelvic pain</td>
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<td>HIV</td>
<td>Human immunodeficiency virus</td>
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<td>COI</td>
<td>Cost of illness</td>
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<tr>
<td>DALY</td>
<td>Disability-adjusted life year</td>
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<td>EmOC</td>
<td>Emergency obstetric care</td>
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<tr>
<td>GNP</td>
<td>Gross national product</td>
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<tr>
<td>LBW</td>
<td>Low birth weight</td>
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<td>MNIH</td>
<td>Maternal–newborn ill-health</td>
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<td>PAHO</td>
<td>Pan American Health Organization</td>
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<td>PID</td>
<td>Pelvic inflammatory disease</td>
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<tr>
<td>QALY</td>
<td>Quality-adjusted life year</td>
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<td>TB</td>
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Abstract

The aim of this paper is to provide a systematic review of the estimation of the cost of illness (COI) related to maternal–newborn ill-health (MNIH). The methodology used for the review includes a systematic search on electronic databases for published literature and manual searches for the identification of grey (unpublished) literature. Searches are based on the major electronic databases and also on the home pages of some major international organizations. While the problems of MNIH are well known and the importance of conducting COI studies is understood, knowledge is still lacking about the magnitude of the costs of MNIH at the societal level. After a search of the existing electronic databases, only one published paper was found to be relevant for the review; four grey studies (using REDUCE Safe Motherhood model) were also directly relevant. The published study estimates most of the cost components associated with a particular complication of MNIH – emergency obstetric care (EmOC) – and reports a total average cost per user of EmOC in the range of US$ 177–369 in Bangladesh. The unpublished studies based on the REDUCE model illustrate the MNIH issue more directly and elaborately; however, they estimate merely the productivity cost for four African countries. The model estimates a huge amount of productivity losses associated with MNIH: an annual total of about US$ 95 million for Ethiopia and about US$ 85 million for Uganda. To formulate an idea of issues related to data, measurement and methodology the present study also reviews COI studies on other related diseases that are similar to those on MNIH. The review reveals some difficulties in measurement and proposes to incorporate some relevant cost components that MNIH cause society and also suggests probable data sources for COI studies of MNIH. Although it is evident that MNIH results in suffering for women and children and hinders economic development through its huge burden for society, in order to stimulate further policy debate regarding its significance future research efforts should be directed towards theoretically sound and comprehensive COI studies with use of longitudinal and experimental data.

Key Words: maternal–newborn ill-health (MNIH); cost-of-illness (COI); societal cost; systematic review; REDUCE model, related disease.
1. Introduction

1.1 Background
Maternal–newborn ill-health (MNIH) refers generally to health problems related to pregnancy and delivery (1, 2). MNIH comprises both maternal morbidity and mortality. Maternal morbidity is generally defined as any illness or injury caused by, aggravated by, or associated with pregnancy or childbirth. The five major causes of maternal deaths are haemorrhage, eclampsia, unsafe abortion, sepsis, and obstructed labour (3).

It is estimated that more than half a million women die each year as a result of pregnancy and childbirth; millions more become ill or disabled around the world. About 99% of these deaths occur in developing countries of Africa and Asia. The World Health Organization (WHO) estimates that 42% of the approximately 129 million women who give birth annually (according to the United Nations) experience at least mild complications during pregnancy (4, 5). Furthermore, estimates suggest that 15 million women annually develop long-term disabilities attributable to pregnancy-related complications (5). Recent studies in four developing countries show that 58%–80% of pregnant women developed acute health problems as a result of pregnancy; of which 8%–29% went on to develop chronic health problems (6). The World Development Report 1993 estimates that 18% of the burden of disease for these women is related to maternal causes; an additional 16% of the burden of disease is attributable to AIDS and other sexually transmitted infections, which often lead to or exacerbate problems in pregnancy and childbirth (7).

For newborns (from birth through the first 28 days of life), infection is the major killer in the womb (syphilis) and after birth (syphilis or other bacterial infection). During the first minutes of life, asphyxia caused by birthing complications can kill the baby if it is not given adequate basic treatment. It is estimated that more than 8 million infants die each year, one half of them within the first month of life and a large proportion within a few days of birth (8). During the first days of life, cold injury (hypothermia) is a major risk, often interacting with low birth weight or infection and low birth weight attributable to intrauterine growth retardation and/or preterm birth: in developing countries, over 22 million low-birth-weight babies are born each year, corresponding to 20% of all births (9). Failure to initiate early and full breastfeeding contributes significantly to newborn mortality.

Along with the high risk of death associated with pregnancy and childbirth, women in the developing world are at an even greater risk because of the high-fertility norm. Poverty, social and cultural prejudices, gender-based violence, lack of education and less access to essential health-care facilities also contribute to poor maternal health. Cost, distance and quality of services, cultural barriers (for example, many women prefer to deliver in the privacy of their own homes, perhaps assisted by a relative or traditional midwife) and barriers related to knowledge and education (some may lack knowledge about the potential complications of delivery and about the availability of health care to deal with them) are the obstacles to using essential obstetric care services (3). Patients who make a timely decision to seek care may still experience delay because of their inaccessibility to health services (10). This outline provides a general idea of the scope of the problem, even if no reliable population-based statistics are available on the causes of maternal mortality and morbidity in most parts of the world.

The international community has made a commitment to reduce MNIH in the developing countries. One of the key Millennium Development Goals is to reduce the maternal mortality ratio by three quarters between 1990 and 2015. However, there is still a call for definite evidence to persuade policy-makers and donors that interventions to reduce MNIH are valuable and may also reduce poverty. In low-income countries, evidence generally suggests that illness may have a direct effect on the probability of a person ending up in poverty or not (11, 12).

Cost-of-illness (COI) studies identify the different components of cost and the size of the contribution of each sector in society; they are therefore valuable instruments for promoting awareness of particular illnesses and conditions. Such information can help to determine research and funding priorities by highlighting areas where inefficiencies
may exist and savings may be made (13, 14). COI studies make points of reference for economic analyses but are not economic evaluations in themselves: they do not deal with specific health-care interventions but estimate the economic burden that a disease places upon society. There exist several arguments against undertaking COI studies and using the results. Among the criticisms raised are a weak theoretical basis and a lack of evaluation of the outcomes of different interventions (15). However, COI studies that clearly document all assumptions and limitations can minimize many potential problems and provide valuable information about the economic burden associated with a disease (16). When COI studies are detailed and specify who pays for what, the distribution of resource utilization across health-care sectors and populations (e.g. sex and age) can be identified and analysed (16).

1.2 Aim of the study
To stimulate the policy debate about the importance of MNIH, this paper provides a systematic review of the evidence of the costs of illness associated with MNIH. To identify the cost components and to know how MNIH results in costs for mothers, children and society, a general framework of the standard methodology of COI analysis is provided. For a discussion of the methods used, the results and conclusions of the reviewed COI studies are summarized. To obtain total societal cost of MNIH a hybrid estimation is presented, based on the reviewed studies. A review of COI studies on MNIH-related diseases is also provided, because the studies may illustrate issues related to data and methods which are similar to those of COI studies of MNIH. Difficulties in measurement and sources of data are also discussed. Finally, we summarize our observations and discuss problems with the COI approach in general and give some suggestions for future COI studies on MNIH.

1.3 Outline of the study
The paper is organized as follows. Section 2 describes the general methodological issues associated with estimating the costs of illness. Section 3 offers an overview of the probable negative effects of MNIH on mothers, children and society and explores the difficulties in measurement of the cost components. Section 4 reviews methods for COI related to MNIH. The findings of the review are given in Section 5, which also proposes a hybrid estimation of the total societal cost of MNIH and discusses the selected COI studies for related diseases such as malaria, HIV/AIDS and tuberculosis. Section 6 contains a discussion and some key conclusions.
2. Issues in the estimation of cost of illness

Cost is the value of a resource, conceptually defined as the value that could be gained by using the resource in an alternative way. Economists use the concept “opportunity cost” or “economic cost” in conducting COI studies. It is assumed that scarce resources can always have cost even if no money is spent because the resources could be efficiently used elsewhere. The key idea behind cost estimation is that when resources are used to provide health care for one person, they are simply not available for other people or alternative societal uses. Cost studies can be either prevalence based or incidence based. The prevalence-based approach is the most common, by which the researcher estimates total costs for a patient population in a given geographical area for a given period of time (17). In incidence-based studies, the lifetime costs for a patient with a disease, from diagnosis to cure – or death in chronic diseases – are estimated (13). COI analyses can take different perspectives, e.g. societal perspective, patient perspective or ministry of health perspective, but the most frequently used is the societal one. In the societal perspective, all costs except transfers are included, no matter who incurs them. Although there is question about distribution of societal resources, there is, however, no true economic cost or opportunity cost associated with transfer payments (since at the end societal resources do not change). Transfers may be taxes for health-care consumption or reimbursements for income loss attributable to illness. Nonetheless, there is dead-weight loss of taxes, so this would be the cost involved from a societal viewpoint.

2.1 Costing methodology

The estimation of costs can be divided into four steps: (a) identify the relevant resources that are used, regardless of their measurability; (b) quantify these resources in physical units (e.g. hospital bed days, number of working days lost); (c) value the resources used at their opportunity costs, which is the value of foregone benefits as the used resource is not available for its best alternative use; and (d) discount cost due to the fact that the resource use occurs at different points of time (17)

2.1.1. Types of resource costs

Health economics research recognizes four broad categories of costs: direct medical costs, direct non-medical costs, indirect costs and intangible costs. Types of cost centres may be indicated as presented in Figure 1.

![Figure 1. Identification of important cost components](image-url)

Source: adapted from Islam et al., 2003 (29).
Looking at Figure 1, we may define total cost (C) of illness as:

\[ C = \sum \alpha_i C_i \quad (i = 1, 2, 3, 4, 5, 6 \& 7) \quad (1) \]

\(\alpha_i\) is called the unit cost multiplier applied to the quantity of each type of goods and services consumed, and the results are weighted and summed to obtain total cost C, where,

- \(C_1\) = direct health-care costs
- \(C_2\) = direct non-health-care cost of treatment
- \(C_3\) = patient time costs for treatment
- \(C_4\) = informal caregiver’s or volunteer’s time costs
- \(C_5\) = productivity costs, i.e. less production output due to morbidity and mortality
- \(C_6\) = intangible costs
- \(C_7\) = other indirect costs which arise through negative externalities (private and social).

### 2.1.2 Direct health-care costs (C1)
Direct costs include all types of resource use – private and non-private (not only the monetary exchanges of these) – such as drugs, tests, supplies, health-care personnel, and hospital facilities. In addition, they include the costs of further testing to follow up both false positive and true positive results and the future costs (or savings) associated with the disease in question, such as hospitalization and treatment costs.

### 2.1.3 Direct non-health-care costs (C2)
Direct non-health-care costs contain the increase in total costs required by a dietary prescription, for example, and the cost of transport to and from the clinic or the physician’s place of work.

### 2.1.4 Patient time costs (C3)
Patient time costs include costs of time spent in travel and waiting as well as in actually receiving the treatment. Usually the cost of administering a drug is measured by the time and motion method (18, 19). Failure to include these costs would bias cost estimates because time is clearly a resource in limited supply and its use must be adequately imputed in cost calculations.

### 2.1.5 Informal caregiver’s time cost (C4)
Informal care is taken to be care that is provided to disabled or ill persons by family members and friends who are not paid for the help they provide. The time a family member or volunteer spends to provide care, such as chronic nursing for a disabled or ill person or care for a sick child, is considered within this cost component.

The entire time cost borne by a patient or an informal carer may be divided into two broad categories: market activities and non-market activities. Market activities define the burden as loss of time from paid work, giving up work entirely, changes in work status, choosing to retire early, etc. Non-market activities given up include productive activities such as housework and gardening, leisure and pleasure activities (home or public entertainment), and physiological needs (sleep, personal care, etc.). Sometimes all non-market activities are classified as lost leisure time.

### 2.1.6 Productivity costs (C5)
Productivity cost is reduced production output caused by morbidity and mortality. Productivity costs (often labelled “indirect costs”) are: (i) costs associated with lost or impaired ability to work or to engage in leisure activities attributable to illness; and (ii) lost economic productivity due to death. There are several alternative methods to estimate lost productivity. The human capital method is the most common way to estimate productivity losses: losses associated with the illness are measured by estimating the income foregone due to both morbidity and mortality. In the case of mortality attributable to a specific disease, foregone income is estimated by calculating the capitalized value of future lifetime earnings that would have been earned by those who died prematurely. The production loss of morbidity is the value of lost workdays for each person who suffers from related disease. To evaluate the present value of the lost income, future earnings are discounted. The willingness-to-pay approach, also known as “contingent valuation”, attempts to elicit
this value through the use of household surveys. If it were achievable to elicit a dollar value that the household would pay to prevent the disease, it would presumably capture the opportunity costs to the household of treatment and lost productivity, as well as the value of the leisure time given up, the cost of the pain and suffering associated with the disease, and other intangible costs which are difficult to price.

2.1.7 Intangible costs (C6)
Intangible costs reflect the patient's level of pain and suffering and the limitations it imposes on the quality of life. Costs related to reduced quality of life are difficult to estimate but there are instruments that can be used, such as the standardized EQ-5D questionnaire. The EQ-5D questionnaires give a utility value between 0.0 (dead) and 1.0 (perfect health) based on five attributes: mobility, self-care, usual activity, pain/discomfort and anxiety/depression (19). The number of quality-adjusted life years (QALYs) lost to a specific disease can be calculated by comparing the difference in utility between a sample with the disease and the general population for different age groups. A monetary value can be imputed for each QALY lost in order to estimate the intangible costs (15).

2.1.8 Other indirect costs generated through negative externalities (C7):
The negative impacts of illness have external depriving effects on the affected households and the whole of society in various ways. For example, the extra health-care costs for disease may require changes in household consumption, saving and investment patterns. The reduced productivity of an ill adult often results in a reallocation of labour because of the increased economic burden, which may lower the quality of health of children and thus hinder the future productivity of a nation. Illnesses may also lead to depression and other psychological problems in a household and also affect society in a variety of ways, which may result in depreciation of community social capital.

2.2 Valuation of resources
Once the resources used have been identified and measured, the next step in the process for estimating costs is to convert them into summary cost measures. This involves considering how to "cost-out" the inputs and the resources consumed as a result of the disease or illness. COI studies are either "top-down" or "bottom-up". The data for COI studies can be retrieved from, for example, national health-care statistics, patient registers, insurance databases and patient charts or directly from the patients themselves. Top-down studies use statistical databases and registers to estimate costs for a given prevalence sample. Their weakness is that all costs are usually not included in such databases and the total costs may be underestimated. Bottom-up studies collect data directly from a patient sample and their challenge is to ensure that the sample is unbiased and representative for the entire patient population if extrapolated to national level (17). It is also possible to choose a combination of both approaches.

2.2.1 Valuation of resources in microcosting
Microcosting incorporates the bottom-up approach, where all relevant cost components are identified, measured and estimated for each individual patient and then the total cost of treating each patient is estimated at the current market price to come up with the grand total of COI measure. Market price is the best instrument in valuing scarce resources (the opportunity cost of all resources that are used for avoiding or getting rid of illness) under the condition of perfect competition. In order to measure cost with a common yardstick economists express it in terms of (domestic) money prices adjusted for inflation and other forms of market imperfections. For most purposes market prices do provide a reasonable estimate of the opportunity costs, but there are situations where market prices require adjustments.

A common concern in using market prices is that they may not reflect the opportunity cost to society because they include a profit that is sometimes in excess of a fair return on investment and risk allowance. For example, private practitioners or clinics earn revenue much greater than the cost of all inputs. Moreover, market distortions and imper-
fections abound when prices are greater than marginal costs, due to market power and the divergence of administration prices or the underpricing of resources because they are produced under conditions of commons (18).

When the data on prices emanate from different time periods, market prices can vary because of general inflation. The usual approach for handling price changes is to convert prices into a base year term. If the good or input has a different rate of price change than the economy as a whole, then a specific measure such as the medical component of the consumer price index (CPI), if available, could be used for medical costs, because these costs may have been rising faster than general inflation (18–20).
3. Consequences and costs of maternal–newborn ill-health

There are significant economic, social and psychological consequences of MNIH (21). To identify the cost components described in the previous section, evidence is provided below of the pathways through which MNIH involves costs for mothers, children and society. The difficulties in measurement of the estimated COI are also described in this section.

3.1 Consequences and costs for mothers

The nature of maternal morbidity suggests that impacts on the individual woman may be both direct and indirect. Catastrophic direct financial costs of seeking health care have to be borne; these costs comprise all direct expenditure, such as transport, drugs, admission fees, and food and living at the treatment site for the woman and her caregiver. The cost components classified in Section 2 as $C_1$ to $C_4$ are applicable to MNIH. For an indication of the private user cost of maternal services not necessitated by maternal complications, a study from a rural area of the United Republic of Tanzania (22) reports that the average total costs range between US$ 11.60 for antenatal consultation and US$ 135.40 for caesarean section for a complicated delivery at the hospital in Mtwara. The researchers note that travel accounts for about half of these financial costs. The reproductive health costing workbook from WHO’s mother–baby package costing spreadsheet (23) can be used to estimate other non-private costs, i.e. the total social cost related to these cost components. It can be predicted that the user cost would be much higher for services in the event of maternal disabilities or complications.

Death is obviously the most serious consequence of maternal ill-health for the woman and her family; in addition, it carries a consequent loss of productivity. Other pregnancy-related complications might impair the woman’s health, such as iron-deficiency anaemia, existing disease, and haemorrhage, which may reduce her productivity (cost component $C_5$). When women become ill, they cannot work in the home or in the paid labour force. In India, a study found that the female labour force would be about 20% higher if women’s health problems were addressed (24). At least 60% of pregnant women in the developing world are anaemic, which reduces their energy and capacity for work and can thus depress their incomes. Studies in Sri Lanka and China among women tea plantation and mill workers have recognized reduced productivity attributable to anaemia (25). Moreover, because of these illnesses women suffer pain and discomfort and a significant reduction in their quality of life (cost component $C_6$).

Although many women do not die, they suffer from various types of short-term and long-term illnesses and disabilities, such as obstetric fistulae, which may render them outcasts from their own families and society (8). Women with obstetric complications face cultural, social and other barriers to obtaining care and, therefore, become silent sufferers. Indirectly, these complications can affect the behaviour of a woman and her family, for example with respect to decisions over fertility, time allocations, and child caring. It may be difficult to quantify the cost of such consequences. All such costs are contained in cost component $C_7$.

3.2 Consequences and costs for children

Potential economic costs for children are also associated with maternal mortality and morbidity (21). Because of death or illness of a mother (and consequent loss of income and care), there is less money available for children’s health care, education and additional food, which may be reflected in increased health-care costs for children, increased mortality risk and decreased nutrition and schooling.

3.2.1 Low birth weight

Children of malnourished mothers, if they are born with low birth weight (LBW, defined as less than 2500 g), are disadvantaged from birth, fail to grow normally and face a higher risk of disease and premature death. Evidence shows that poor maternal health and nutrition contributes to LBW infants. In a low income context, under plausible assumptions, it is estimated that about US$ 580 per infant is needed to move from the LBW to the non-LBW category (26). Babies born under weight die at significantly higher rates than those of

1 The annual average cash income of a farmer in rural Mtwara is US$ 115. Unofficial payments are not included in the calculation. In developing countries, unofficial payments may be a significant part of total cost.
normal weight, and are at greater risk for infection, malnutrition and long-term disabilities, including visual and hearing impairments, learning disabilities and mental retardation.

3.2.2 Increased mortality risk
It is revealed that, when a mother dies, surviving children are 3–10 times more likely to die within two years than children who live with both parents, and motherless children are likely to receive less health care and education as they grow up (27). In addition, a high level of neonatal mortality may provoke couples to have more children than would have been the case had more babies survived. A study conducted in Matlab, Bangladesh, between 1983 and 1987 found that a mother’s death sharply increases the chances of surviving children up to 10 years of age dying within two years; this is especially true for daughters (27). Moreover, it is also evident that most deaths are among children under one year old.

3.2.3 Decreased schooling and nutrition
Evidence of the effects of maternal deaths on children’s overall welfare is scant; some research has been conducted, however, on the effects of parental death on the nutritional status and schooling of children. MNIH may have a direct effect on the educational attainment of a child. When mothers die in childbirth, surviving children are less likely to complete their education or to attend school regularly. A recent longitudinal study conducted in the Kagera region of the United Republic of Tanzania reported that, in households where an adult woman had died during the previous 12 months, children spent half as much time in school as children from households where an adult woman had not died (28). The impact on children’s survival and education is not significant when an adult male has died. Children who have lost their mothers or fathers, or both, have somewhat lower school enrolment rates overall; children who have lost a parent in the poorest households have the lowest enrolment rates; those in relatively better-off households have enrolment rates similar to those of children with both parents living. The most remarkable result of the study is that the death of a prime-aged male does not have any effect on enrolment. This finding suggests that teenage children are important substitutes for women’s time in home production activities. Based on random-effects and fixed-effects panel data models, the authors show that children who lose their mothers are much more likely to be stunted than children who lose their fathers or children with both parents living. The study also shows that the children who are most affected are those who lose their mothers or whose mothers have no education.

3.3 Consequences and costs for families and society
Very little is known about the social and economic consequences of MNIH for society as a whole (21). It is predictable that when disease and disability reduce women’s ability to work, families unavoidably face negative consequences because women’s wages and their work within the home – both of which depend on their staying healthy – are increasingly important. The extra costs associated with MNIH problems can lead women and families into debt. Studies also reveal that women are more likely than men to spend their own income on improving family welfare, through additional food, health care, school supplies and clothing for young children (6). As women’s health is an important component of building healthy future generations, it can be envisaged that the direct and indirect negative impacts of their ill-health have depriving effects on the affected households and society as a whole. For example, the extra health-care costs for a mother’s treatment may require changes in household consumption, saving and investment patterns. A study conducted by Mead Over & Julia Dayton (1998) showed that morbidity reduces household consumption when any type of disease or injury is concerned, not only reproductive or maternal ill-health (cited in 21).

The reduced productivity of an ill adult often results in a reallocation of labour to account for the increased economic burden of one parent and changes in responsibility for the care of children and elderly and disabled family members. It is recognized that in developing countries women are the main group who provide informal care. One recent COI
study in Dhaka, Bangladesh, attempted to estimate the societal cost of treating chronic hepatitis B patients (29). The study revealed that about 80% of the carers are married women and 85% of the carers are spouses or parents of the patients. The study estimated that about US$ 150 per person per year (more than 6% of total costs) is borne by informal caregivers as income loss from caregiving.

Maternal illness may also increase children’s participation in the labour force, which results in illness, injury and poor hygiene for the children. In the event of maternal deaths, society is left with a higher number of one-parent households and an increased number of orphans, which may lead to deterioration or loss of social cohesion (or social capital) and may foster depression and other psychological problems within households. Ultimately, these consequences have a repercussion on society in a number of ways, such as higher crime rates.

Through different pathways, therefore, MNIH results not only in the suffering of women and babies but also in losses to society and hinders economic development.

3.4 Difficulties in measurement

While the potential social and economic consequences of maternal mortality seem obvious, they have not been verified, partly because of measurement problems. For instance, Henry Mosley noted that the consequences of maternal mortality are extremely difficult to measure, because it is a relatively rare demographic event. In particular, he reveals that if the maternal mortality ratio is about 400 deaths per 100 000 live births, one would have to follow an average population of 500 000 annually for five years to observe 400 maternal deaths (cited in 21). This rarity makes it difficult to disaggregate maternal mortality from the total of female deaths, so maternal mortality studies generally have a special surveillance system set up in a large population (30, 31).

In most developing countries — and even in many developed ones — the quality of the epidemiological data does not permit consistent and complete attribution of cause of death. As a result, ill-defined causes of death can account for a large share of deaths (32). It is also important to note that households that experience an adult death may have been economically and socially disadvantaged before the death occurred. Selection bias, therefore, has the potential to affect the results of this research.

The “microcosting approach”, which is often recommended, suggests that unit costs should be applied to each type of resource use in order to give a good precision of the cost estimate (17). Because of a lack of data on different type of morbidities related to MNIH, however, precise cost estimation is not possible, specifically the estimation of productivity losses. In addition, the complex nature and interdependence of related diseases make it difficult to separate out the consequences and costs of MNIH. Many conditions involve discomfort, pain, suffering, stigma, or social or economic consequences that are not possible to add in the COI calculations, for example the social and economic consequences of obstetric fistula or infertility. Moreover, the paucity of information about the dimensions, causes and consequences of much MNIH are not adequately accounted for and inevitably lead to its neglect even in the calculations of disability-adjusted life years (DALYs) (33). Thus, it is often both difficult and expensive to acquire specific MNIH information with sufficient level of detail to conduct a microcosting approach. Similarly, it is also difficult to identify all of the indirect consequences created by MNIH and put a monetary value on these cost components.
4. Methods of the review

The methodology used consisted of a systematic search on electronic databases for published literature and manual searches for the identification of grey (unpublished) literature.

4.1 Search terms

This paper mainly follows review methods applied by Farooq for WHO (34). Farooq observed that the evidence base for the extent to which socioeconomic development is affected by MNIH is weak and that there is an overlap between search terms that could be used for other aspects of the relationship between MNIH and poverty. This review therefore included supplementary terms expected to be relevant and with an extended time frame (January 1990 to June 2004).

Searches were conducted on ECONbase, EconLit, Eldis, PAHO, Popline, PubMed and Lilac electronic databases. Various combinations of the following search terms were used:

Search #1: Maternal/infant/neonatal/newborn health AND poverty
#1 AND morbidity/mortality/childbirth/obstetric/pregnancy
#1 AND cost-of-illness/disease burden/society/national-level

Various approaches including “quick searches” “advanced searches” and “Boolean searches” were performed. In addition to the electronic databases, the home pages of some major international organizations were searched using similar methods. Institutional sites included the World Bank, WHO, Pan-American Health Organization and Save the Children (UK/US), and personal communication was also established with relevant personnel. Once the searches were completed, the title, key words and abstracts were reviewed for final selection. All searches were saved electronically where that option existed.

4.2 Inclusion criteria

The studies in the review conform to the following inclusion criteria.

- Area of study: maternal and/or newborn health (morbidity, mortality), cost-of-illness and poverty.
- Type of study: case study, evaluation, review, survey, empirical evidence.
- Publication: peer-reviewed journal, unpublished (grey literature).
- Language: English.
- Country: all (both developed and developing).
5. Results of the literature search

5.1 Summary of searches
As described above, while the problems of MNIH are well known and the importance of finding cost-effective interventions is understood, knowledge is lacking about the magnitude of the costs of MNIH at the societal level. Farooq (34) concluded that the evidence base for the role of MNIH in socioeconomic development is weak. After completing a search of the existing electronic databases, we concur with this conclusion; in fact, we did not find a single study from her data sources that could be relevant to our review. To widen the search base we elaborated our search terms as describe in the methods section. The summary of the search results is presented in Table 1. After examination of the abstracts only one published COI study (moderately related) was found to correspond to our inclusion criteria. Thus it is clear that there is a wide gap in the evidence base on this specific issue.

5.2 Cost-of-illness studies on maternal–newborn ill-health
After finding only one published COI study (moderately related) that could be matched with our inclusion criteria (35), through personal communication with WHO we were given access to four grey studies using the REDUCE Safe Motherhood model that are directly relevant. To make the review useful, we examined the REDUCE Safe Motherhood model, including assumptions, that has been applied in four developing countries – Ethiopia, Mauritania, Senegal and Uganda (36–39). The studies are reviewed below, by aims, design, cost components and estimation methods, main findings and comments.

5.2.1 Published study

Aim
To illustrate a method of determining the geographical distribution of health facilities for estimating the optimal distribution and number of emergency obstetric care (EmOC) facilities. In order to achieve this objective, the authors estimated the average total societal cost associated with EmOC services for the 20 districts of Bangladesh and reported estimations for one selected district, Mymensingh.

Table 1. Electronic literature search: total hits, by database

<table>
<thead>
<tr>
<th>Database</th>
<th>Number of hits</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal health poverty</td>
<td>80</td>
<td>No relevant study</td>
</tr>
<tr>
<td>Infant health poverty</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Child health poverty</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>ECONbase</td>
<td>68</td>
<td>No relevant study</td>
</tr>
<tr>
<td>EconLit</td>
<td>40</td>
<td>No relevant study</td>
</tr>
<tr>
<td>Eldis</td>
<td>8</td>
<td>No relevant study</td>
</tr>
<tr>
<td>PAHO</td>
<td>26</td>
<td>No relevant study</td>
</tr>
<tr>
<td>Popline</td>
<td>334</td>
<td>No relevant study</td>
</tr>
<tr>
<td>PubMed</td>
<td>66</td>
<td>1 moderately related study</td>
</tr>
<tr>
<td>LILACS</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Save the Children</td>
<td>63</td>
<td>No relevant study</td>
</tr>
<tr>
<td>The World Bank</td>
<td>4</td>
<td>No relevant study</td>
</tr>
<tr>
<td>WHO</td>
<td>217</td>
<td>No relevant study</td>
</tr>
</tbody>
</table>
Study design
An incidence-based COI exercise applied to a specific maternal health component, EmOC.

The study used qualitative surveys to gather information on transport costs and travel time. Secondary data from different sources and assumed values were utilized for different parameters used for the estimation of other cost components.

Cost components and estimation methods
To estimate the societal cost, the study divided total costs into health centre-related costs and costs borne by households or users. The authors categorized cost in two main components: provider costs and user costs. Provider costs include fixed costs (calculated by totalling annualized cost of construction, annualized cost of equipment, maintenance cost and personnel cost) and variable costs (the cost of managing a case at the health centre). Construction and equipment costs were distributed over 50 years and 10 years, respectively. WHO’s mother–baby package reproductive health costing spreadsheet (23) was used to estimate personnel costs; according to the directions for the spreadsheet’s use, the study assumed that all the relevant personnel allocate 20% of their working time to obstetric care, and the obstetrics consultant and staff with limited midwifery skills were assumed to be assigned full time to EmOC service delivery. To estimate the maintenance cost of buildings, the study used the Ministry of Works cost parameters per m² of floor space.

User costs include cost of travelling per admission (assuming that length of stay at the health centre is three days and that three round trips are necessary) and opportunity cost of time of one family member, calculated at US$ 1.7 per day using the average wage rate of an unskilled worker in rural Bangladesh. The authors assume zero out-of-pocket cost to the households for using EmOC services. However, they do not estimate opportunity cost of time for the patient (cost component C₃).

To quantify productivity losses attributable to maternal mortality, the authors use the human capital approach and the gross national product (GNP) per capita (US$ 220 per year) to estimate economic loss resulting from death. They also assume all lives in the country are of equal value. To estimate the present value of productivity losses attributable to mortality, a 5% discount rate has been used for future income for an additional 35 years of life, assuming that average age at death from pregnancy-related complications in Bangladesh is 30 years. However, because of a lack of data on different types of morbidity related to pregnancy, the study does not estimate cost associated with pregnancy-related morbidity.

Main findings
In a selected district (Mymensingh), the total average cost per user is estimated to be between US$ 177 and US$ 369 for catchment areas defined by circles of 6 km radius from the health centre and 2 km, respectively, and the cost-per-user trend increases beyond the 6 km radius. The authors concluded that, for most districts in Bangladesh, the minimum average cost per user/case occurs when the catchment area radius of a health centre providing EmOC is about 10 km. Thus, the societal cost will be at its minimum if the EmOC facilities are located about 19 km apart, and a total of 450 facilities should be established in Bangladesh to provide comprehensive EmOC services to minimize societal costs associated with pregnancy and pregnancy-related death.

Comments
It seems that Khan and colleagues take into consideration most of the cost components (C₁, C₂, C₃, and part of C₅) in estimating societal cost associated with EmOC. In estimation of the non-private costs (for example costs related to the health centre, which appear as a significant portion of total costs), the method seems to be robust and easily applicable for other countries. In the sense of relevance and measurement of cost components, however, we consider the study to be moderate, since it only considers one aspect of MNIH, i.e. EmOC, and does not estimate other direct and indirect costs such as patient time cost, productivity cost attributable to morbidity, and cost arising from other negative consequences, such as effects on children.
5.2.2 Unpublished studies (grey literature)

The REDUCE model, developed by Barton Burkhalter (38, 39) to support policy development and advocacy for safe motherhood in developing regions, was initially formed by the SARA Project for USAID’s Africa Bureau through the Academy for Educational Development, Washington, DC.

**Aim**

To identify several important consequences of MNIH and to estimate productivity losses attributable to maternal morbidity and mortality as well as child disability. In addition, the REDUCE model aims to estimate net gains after implementing programmes to improve maternal care and health.

**Study design**

Incidence-based COI studies applied to several consequences of MNIH in four African countries for different time periods. Based on different assumptions, the model estimates cost of productivity losses attributable to different consequences of MNIH. The assumptions are supported by published and unpublished sources and national and international statistics for different parameters.

**Cost components and estimation methods**

The REDUCE model estimates several important consequences of MNIH, such as maternal deaths, maternal disabilities, child deaths, child disabilities, and economic losses. To identify the cost components, the model defines three main categories: direct causes, indirect causes, and other conditions with negative consequences. Direct causes include major maternal complications such as postpartum haemorrhage, sepsis, hypertensive disorders, obstructed labour and unsafe abortion. Indirect causes include morbidities for which pregnancy is a risk factor, i.e. malaria, anaemia and other micronutrient deficiencies. Other conditions benefiting from safe motherhood programmes include, for example, reduction in neonatal tetanus as a result of a maternal tetanus immunization programme and reduction in mentally impaired newborns as a result of efforts to reduce iodine deficiency in pregnant women.

To estimate productivity losses from MNIH, REDUCE applies the human capital approach. Average annual wage is used to estimate the annual productivity of an average healthy person of working age (15–65 years), and annual productivity is adjusted downwards to obtain “net annual productivity”, which is annual productivity less the amount consumed by the worker. In lieu of available data on average annual wage the REDUCE application uses GNP per capita, adjusted downwards to account primarily for the contribution of non-labour factors to GNP. For all relevant countries, REDUCE assumes that women are productive whether or not they earn a monetary wage during the ages of 15–65 years and applies a 20% reduction for contribution of non-labour factors to GNP. Table 2 illustrates the assumptions and values used to estimate productivity losses in different countries.

Productivity losses attributable to direct maternal disabilities associated with maternal ill-health are assumed to reduce the productivity of the woman for the duration of the disability. To estimate the degree of losses from different di-

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**Table 2. GNP and annual productivity in four countries studied using the REDUCE model**

<table>
<thead>
<tr>
<th>Country</th>
<th>Annual GNP per capita (US$)</th>
<th>Net annual productivity (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia</td>
<td>100 (in 2001) (40)</td>
<td>100 x 80% = 80</td>
</tr>
<tr>
<td>Mauritania</td>
<td>364 (93 000 ouguiya in 2001)</td>
<td>364 x 80% = 291</td>
</tr>
<tr>
<td>Senegal</td>
<td>700 (in 2000) (40)</td>
<td>700 x 80% = 560</td>
</tr>
<tr>
<td>Uganda</td>
<td>330 (in 2000) (40)</td>
<td>330 x 80% = 264</td>
</tr>
</tbody>
</table>

* Converted to US$ at the 2001 exchange rate of 255.629 ouguiya to US$ 1.
Sources: Assumptions and estimates for the application of REDUCE Safe Motherhood model in Ethiopia, Mauritania, Senegal, and Uganda.
ability or illness, REDUCE uses published evidence in some cases, for example for severe anaemia (41), micronutrient deficiency (42) and stress incontinence (43). For other associated disabilities, the duration of each disability is obtained from the global burden of disease study. In estimating the degree of losses, the model uses similar assumptions for all relevant countries. The average percentage productivity loss and average duration of each disability used in the REDUCE model are given in Annex 1.

REDUCE uses an estimation method originally employed to determine benefits of family planning in developing countries: Enke (44) assumes that 60% of the population is productive, that total consumption is 90% of total output with per capita consumption of each non-productive member equaling 70% of per capita output, and that labour accounts for 75% of the total output (land and capital contribute 25%). Based on these assumptions, it is estimated that 16.8% of output per worker is a net contribution to the economy. REDUCE estimates the discounted productivity loss attributable to premature death from maternal causes as net annual productivity x 16.8% x the lifetime discount factor, where the lifetime discount factor is the number of lost productive years (65 minus the age of death). In other words, REDUCE accounts for both production-consumption surfaces in its calculation of loss due to death.

Productivity losses in future years are discounted to obtain the present value at the time the disability first occurred. An annual discount rate of 3% is used for all cases. REDUCE computes the lifetime discount factors for different maternal disabilities, as shown in Annex 1. The discounted lost productivity per person over the duration of the disability equals annual productivity x percentage loss x lifetime discount factor (for details see REDUCE model).

Main findings
Annex 2 illustrates the total cost for productivity losses borne by different complications associated with MNIH in the status quo (before intervention and if no intervention is made). Since REDUCE estimates total MNIH consequences for different time periods for selected countries, to compare the estimates among the countries we calculated number of consequences and productivity losses on an annual basis. Table 3 presents the estimates of the number of complications per year and cost of productivity losses per complication related to MNIH. We also report total maternal early deaths and disability along with child deaths on an annual basis for the relevant countries. Using REDUCE estimation, productivity losses are also re-estimated per consequence or per case by countries. It is observed that productivity loss for mother’s early death ranges between US$ 850 and US$ 1838, the lowest being for Uganda and the highest for Senegal. For maternal disability, the cost varies from US$ 83 to US$ 628, the lowest in Ethiopia and, again, the highest in Senegal. Notice that, in the REDUCE model, the cost estimation for child disability is available with total child deaths for two countries (Senegal and Uganda), but the model does not report the total number of disabilities related to children. We therefore calculated the cost of productivity losses attributable to child disability per child death and find the cost is more or less US$ 1200.

The REDUCE model projects the total number of live births for different time periods for different countries, which may not be comparable between the countries. Thus we calculated the total number of live births per year and estimated total productivity losses per live birth per year. In addition, the model does not provide information on population. We imputed total population of the selected countries from another source and estimated productivity loss per person per year. Using the REDUCE estimates, Table 4 illustrates the status quo costs of lost productivity attributable to MNIH per person per year and productivity loss per live birth per year. It was found that a large amount of productivity losses are associated with MNIH; for instance, every year in Ethiopia a total productivity loss of about US$ 95 million and per capita productivity losses of about US$ 1.5 are incurred from MNIH. The corresponding figures for Senegal are about US$ 51 million total and about US$ 5 per capita. From REDUCE estimates we also assessed productivity losses per live birth per year: it was found that, every year, productivity losses are about US$ 30 for every live birth in Ethiopia and about US$ 122 in Senegal (Table 3).
## Results of the literature search

### Table 3. Number of maternal–newborn ill-health complications and productivity losses in four countries

<table>
<thead>
<tr>
<th>MNIH complications</th>
<th>Ethiopia</th>
<th>Mauritania</th>
<th>Senegal</th>
<th>Uganda</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. per year</td>
<td>Annual productivity loss (US$ million)</td>
<td>Productivity loss per case (US$)</td>
<td>No. per year</td>
</tr>
<tr>
<td>Maternal early deaths</td>
<td>27,930</td>
<td>44.34</td>
<td>1,588</td>
<td>964</td>
</tr>
<tr>
<td>Maternal disabilities</td>
<td>602,435</td>
<td>50.08</td>
<td>83</td>
<td>30,494</td>
</tr>
<tr>
<td>Child deaths</td>
<td>147,342</td>
<td>n. a.</td>
<td>n. a.</td>
<td>3,298</td>
</tr>
</tbody>
</table>

* Converted to US$ at the 2001 exchange rate of 255.629 ouguiya to US$ 1.
A = Column; B = Column; n. a. = not available.
Sources: Calculated from the estimates of REDUCE Safe Motherhood model in Ethiopia, Mauritania, Senegal, and Uganda.
The costs of maternal–newborn illness and mortality

Comments

The REDUCE model captures the MNHI issue directly and elaborately. It considers most of the consequences and also sketches the connection with other related diseases and evaluates the consequences and estimates the productivity cost. Nevertheless, this model is still incomplete for estimating total COI for MNHI. For its relevance we consider the model to be a good study; concerning cost components we consider it to be a moderate study. Other than productivity losses, the model does not consider other important cost components identified in Section 2, such as cost components C₁ to C₄. In addition, the model does not recognize other important direct and indirect consequences that might be related to maternal morbidity and mortality (discussed in Section 3), particularly consequences for children and affected households, or costs that might eventually be borne by society, such as those relating to child mortality or decreased schooling.

Table 4. Total productivity losses per year and per capita in four countries

<table>
<thead>
<tr>
<th>Country (MMR)</th>
<th>Total population</th>
<th>Total projected live birth per year</th>
<th>Estimated total productivity loss per year</th>
<th>Productivity loss per person per year</th>
<th>Productivity loss per live birth per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(millions)</td>
<td>(millions)</td>
<td>(US$ million)</td>
<td>(US$)</td>
<td>(US$)</td>
</tr>
<tr>
<td>Ethiopia (871)</td>
<td>64.31</td>
<td>3.200</td>
<td>94.43</td>
<td>1.49</td>
<td>29.51</td>
</tr>
<tr>
<td>Mauritania (747)</td>
<td>2.61</td>
<td>0.129</td>
<td>8.19ₕ</td>
<td>3.14ₕ</td>
<td>63.49ₕ</td>
</tr>
<tr>
<td>Senegal (510)</td>
<td>10.28</td>
<td>0.418</td>
<td>51.07</td>
<td>4.97</td>
<td>122.18</td>
</tr>
<tr>
<td>Uganda (506)</td>
<td>23.98</td>
<td>1.208</td>
<td>84.86</td>
<td>3.54</td>
<td>70.25</td>
</tr>
</tbody>
</table>

ₕ Figures are for 2001, from: http://www.library.uu.nl/wesp/populstat/populhome.html

ₖ Converted to US$ at the 2001 exchange rate of 255.629 ouguiya to US$ 1.

A = Column; B = Column; C = Column.

MMR = Maternal mortality ratio (the number of maternal deaths per 100 000 live births).
Sources: Calculated from the estimates of REDUCE Safe Motherhood model in Ethiopia, Mauritania, Senegal, and Uganda.

Finally, to estimate the net productivity losses attributable to premature death, REDUCE uses assumptions made by Enke (44). His study is about 40 years old and consequently, to some extent, all assumptions are also time dependent as technology has changed tremendously during last four decades. Thus, the relative contribution from some factors – land, labour and capital – might not be the same as before but are crucial to future predictions.

5.3 Total societal cost of maternal–newborn ill health: a hybrid estimation exercise

None of the studies above considered all relevant cost components. We develop below a hybrid COI estimation exercise, based on the existing evidence presented in the review combined with plausible assumptions. Using our previous discussion and empirical evidence, we provide an estimate of the total societal cost related to MNHI.
Khan et al. (39) considered most of the cost components in their estimation of societal cost related to services for EmOC, which is a major complication of MNIH. However, their study did not consider productivity losses attributable to morbidity associated with EmOC complications. The REDUCE model captures the MNIH issue more directly and elaborately. It considers most of the consequences and sketches the connection with other related diseases, evaluates the consequences and estimates the productivity cost, but is still incomplete in estimating total COI for MNIH. Other than productivity losses, the model does not consider cost components such as direct cost and other indirect cost, for example direct medical care costs, or time costs for patients and caregivers.

To obtain our hybrid total societal cost estimate with regard to EmOC complications, we extrapolate REDUCE estimates and amalgamate the cost components with those that Khan and colleagues did not consider in their calculation. A problem arises in the determination of an EmOC centre’s catchment area, because total cost and the proportion of cost components are rather sensitive to the operational radius, i.e. the catchment area or half the distance from one EmOC centre to another. We assume that radius of an EmOC facility’s operations is 10 km, as Khan et al. concluded that societal cost will be at its minimum if the EmOC facilities are located about 19 km apart. According to their estimation, the average cost per user is about US$ 188 (Tk 9133) if the radius is 10 km, of which about US$ 135 (72%) is estimated to be attributable to death associated with per user (39, Table 3). If productivity losses due to per EmOC-related morbidity are included with this cost estimate, then we get at least a rough measure of the total societal cost per EmOC user in Bangladesh (since Khan and colleagues did not consider this cost component).

5.3.1 Estimating total societal cost of MNIH in Bangladesh (a hybrid of the estimate by Kahn et al. and the REDUCE estimate for Uganda)

Using the REDUCE estimate, we apply figures from Uganda, such as US$ 145 per consequence of morbidity attributable to obstructed labour. We use Ugandan estimates because GNP per capita for Uganda (US$ 330) is nearest to Bangladesh’s GNP per capita (US$ 220) among the countries considered in the REDUCE model. In addition, we consider 2/3 of this figure (US $145) because the GNP per capita in Bangladesh is about 2/3 of Uganda’s GNP per capita and productivity cost estimation is significantly related to a country’s GNP per capita. Thus the estimated societal cost per EmOC user in Bangladesh is about US$ 285 ($ 188 + $ 145*2/3), of which US$ 232 ($ 135 + $ 97) is for productivity losses attributable to both mortality and morbidity, i.e. about 81% ($ 232/$ 285*100) of total cost associated with EmOC users is for productivity losses that incur for both mortality and morbidity.

5.3.2 Estimating total societal cost of MNIH in Uganda (a hybrid of the REDUCE estimate and the Bangladesh estimate by Kahn et al.)

By extrapolating the estimate by Khan et al. (39), we estimate the total societal cost for obstructed labour complications for Uganda as well. Apart from productivity losses the REDUCE model does not consider other costs, so adding these costs with the productivity cost (both mortality and morbidity) would be an option for obtaining the total societal cost for obstructed complication in Uganda. Considering our estimation exercise above (with these estimates), we assume that productivity losses due to mortality and morbidity consist of about 80% of total cost and the remaining 20% is from other cost components (C_1 to C_4). In Uganda, the REDUCE estimate of the annual cost for

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2 Calculated as cost due to death associated with a centre (Tk 603 553) divided by number of users per centre (92) and converted to US$ (at 1998/99 exchange rate of Tk 48.5 to US$ 1) such as (Tk 603 553/223)/48.5 = US$ 234.6.

3 The REDUCE estimates for Uganda suggest that every year there are about 480 maternal deaths, 50 526 maternal disabilities occur from obstructed labour and about 318 children die from this specific maternal death. Moreover, the annual total cost estimated for this maternal complication is US$ 0.46 million for maternal death and US$ 7.34 million for maternal disabilities (see REDUCE estimates for Uganda (39), Table 6).
lost productivity is about US $7.80 million ($ 0.46 million + $ 7.34 million) attributable to both maternal mortality and morbidity related to obstructed labour complications. Adding other direct costs (20%) the total COI associated with obstructed labour complications (one complication of MNIH) would be about US $9.36 million ($ 7.80 million + $ 7.80 million*0.20). Notice that this cost does not include other negative consequences such as adverse effects on children and pain and discomfort caused by illness. To obtain a complete measurable COI due to MNIH in Uganda, we add 20% extra cost with the REDUCE estimate, as given in Table 3. The total COI of MNIH for Uganda would then be US $101.83 million ($ 84.86 million + $ 84.86 million*0.20) per year or US $ 4.25 per capita per year.

5.4 Cost-of-illness studies on related diseases

This section illustrates some COI studies in areas related to MNIH which are interesting because they may provide some idea on issues of data and methods that are similar to those of COI studies on MNIH. Abstracts revealed by the electronic search were reviewed; studies that seemed to meet the purpose were retrieved in full and reviewed again and a final selection was made.

5.4.1 Cost-of-illness studies on malaria

To understand the nature of the COI studies related to malaria, we review some of the evidence from studies that used traditional microeconomic methods and a study that estimated willingness to pay to avoid malaria at household level. By use of national statistics (a top-down approach), Etting et al. (45) estimated the costs of malaria for the whole of Rwanda. For this, the authors first estimated the total non-private costs for personnel, drugs and supplies. They found the non-private medical costs for malaria to range from US $2.32 to US $4.64 (in 1987 dollars) per case. Moreover, they also estimated that direct costs borne by households range between US $0.39 and US $1.64. Based on these estimates they found the direct costs per case of malaria to average US $2.58 and the per capita cost to be US $0.63. Using the human capital approach, indirect costs are calculated to include productivity lost to morbidity and mortality attributable to malaria. For calculating lost productivity the average rural wage is used and assumed to be US $1.01 per adult per day. Lost time from malaria is calculated using actual number of hospital days per adult plus an estimate of three days lost to the illness at home. Moreover, the authors assume that one adult day is spent on caring for every child episode. However, the significant portions of the indirect costs arise from foregone income as a result of premature mortality associated with malaria; this cost is estimated using the Rwandan life expectancy of 49 years, and future income is discounted at a rate of 5%. In most countries the morbidity associated with malaria is concentrated among children, and their future earnings are highly discounted. Because the rate of adult morbidity is particularly high in Rwanda, however, the indirect cost of malaria is correspondingly large. The total indirect cost in 1989 was estimated to be US $ 9.24 per case and US $ 2.25 per capita.

Using a cross-sectional household sample survey, Cropper et al. (46) estimated the COI associated with malaria per household through a study conducted in Tigray, Ethiopia. To estimate direct COI they calculated households’ out-of-pocket expenditure for visits to a health professional, medicine and transport to the place of care. For the entire sample, the direct COI ranged between US $1.6 (for adults) and US $0.8 (for children). To estimate indirect COI, the authors included the productive time lost by patients, substitute labour and caregivers who did not perform their usual household activities. The average number of work-days lost per malaria episode is calculated as 21 days for adults and 12 for children. Daily productivity is estimated using two assumptions: a “high productivity” assumption equates adult productivity with the daily wage and a “low productivity” assumption assumes productivity is half the daily wage. For both productivity assumptions, on average, the COI per episode for the whole sample ranged between US $7 and 24 for adults, and between US $4 and 12 for children. Average annual household COI estimates ranged from US $31 with high productivity assumption to US $9 using low productivity assumption.
Employing willingness-to-pay methodology through the use of a carefully constructed survey instrument, the same study estimated willingness to pay to avoid malaria. Crop-Pen et al. (46) used a questionnaire (asking participants how much they would be willing to pay for a hypothetical vaccine that would prevent malaria with certainty for one year) and placed the issue in a market context, successfully avoiding the issue of existence values. Respondents indicated that vaccines would be directed primarily to adults, a signal that the principal benefit is seen to be prevention of lost productivity. The authors compared the results of the willingness-to-pay approach with a human capital assessment of the COI on households, excluding the non-private medical costs that are generally included in traditional COI studies. They found that among this sample of primarily agricultural households with a mean income of US$ 220, the value of preventing malaria with vaccines is approximately US$ 36, or about 15% of imputed annual household income. The results are on average two to three times the expected COI estimated by the authors in the same sample. This conclusion indicates that standard COI studies that use the human capital approach grossly underestimate the economic burden of the disease on households.

5.4.2 Cost-of-illness studies on HIV/AIDS

A recent systematic review on COI studies related to HIV/AIDS was carried out by Mänd (47). We use her review and highlight the methodological aspects from selected studies. Following the selection criteria, 20 studies from eight countries are included in the review. The studies are reviewed with regard to perspective, type of analysis, main data sources, sample size, number of service providers where patients received care, top-down or bottom-up approach, retrospective or prospective data collection, the use of disease classification, the application of unit costs, use of standardized costs per time unit and breakdown of final costs. The studies are also examined with regard to the approach chosen to estimate indirect costs (i.e. the human capital method) and the use of any quality-of-life indicator.

The results of the review show that seven of the studies clearly state what perspective is chosen for the study. Eight studies can be categorized as observational; six are patient surveys, and four link activity to cost data. The data sources that are most frequently used are cost databases, insurance and hospital claims, interviews, patient diaries, patient charts and cost estimates from other studies. Eleven studies use a prospective approach; six use a retrospective approach and one study uses both. Fifteen studies are bottom-up studies, one is top-down, and two employ a combined bottom-up/top-down approach when estimating costs.

It is found that most studies concentrate on direct costs (17 of the 20 studies). Two studies focus only on indirect costs (48, 49) and one study focuses on all aspects with direct, indirect and intangible costs from a private cost perspective (50). All studies that deal with indirect costs employ human capital methodology to estimate production loss. Two of the studies also used some sort of quality-of-life indicator, though intangible costs are not given monetary values in any of the studies.

Because estimating the direct cost of HIV/AIDS is less problematic, it can be useful to review the studies that focus on indirect cost or intangible cost and their estimation procedure. For instance, Oliva et al. (48) used a patient survey where patients were asked about their income and wage at the time of diagnosis and at the time of the survey, and the loss of income, wage and family income were calculated from the difference. The difference in family income is also meant to reflect the loss of income of other family members.

From Mänd’s review (47) we note that four studies on direct costs estimated the lifetime costs per patient and the results ranged from US$ 52 200 to US$ 161 600 (at the 2003 CPI value). The yearly costs ranged from US$ 2800 in the lowest disease category to US$ 74 000 in the highest disease category (at the 2003 CPI value) per patient. None of the studies on indirect costs estimated lifetime costs. Their yearly estimates ranged from US$ 5700 to US$ 40 000 per patient, depending on disease category.
Despite the efforts to make the cost estimations analogous, it is difficult to compare results. Along with different healthcare systems, some of these studies are performed before the widespread use of highly active antiretroviral therapy (51), which makes the whole cost structures different between older and newer studies (47). Some studies also collected limited data on resource use and obtained it from a single provider, and very few studies in this sample looked at indirect costs. A previous literature review on COI studies about HIV/AIDS (52) also acknowledged that methodological differences led to wide variation in estimated costs and large information gaps.

5.4.3 Cost-of-illness studies on tuberculosis

We lack knowledge about the COI studies on tuberculosis (TB) at the societal level. To provide some insights into COI studies on tuberculosis we discuss one published study conducted by Rahman et al. (53). In fact, the study is not a literal COI study: rather, it evaluates user cost of health services related to treating TB and does not consider other cost components. To estimate the cost of treating a TB case and to analyse TB-related medical service utilization, a study was performed of all patients with a primary diagnosis of TB admitted to a public hospital in Osaka prefecture, Japan. The study was retrospective in design: in-patient and out-patient medical records were examined concerning 57 paediatric patients diagnosed with TB during 1993–1998. Costs were estimated based on third party payer perspectives according to the service utilization pattern. Cost of preventing a case of TB was abstracted from the published literature. The estimated average cost of treatment was found to be US$ 8384, while the average length of hospitalization was 63 days. Based on 20–80% vaccine efficacy, the cost of preventing a case of TB is US$ 35 950–175 862. The authors concluded that the cost of treating a case of paediatric TB is much lower than that of preventing one and that Japan’s universal BCG vaccination policy should be re-examined in the light of economic, social and political issues.
6. Discussion and conclusions

6.1 Discussion
In developing countries, MNIH is the leading cause of morbidity and mortality for women and children. This paper conducts a systematic review that focuses on the total societal costs associated with the burden of MNIH. The review reveals that the published and unpublished evidence on COI related to MNIH is scant: the one published study estimated most of the cost components associated with EmOC and the unpublished studies based on the REDUCE model estimated merely the productivity cost for four African countries. To obtain an idea of issues related to methodology, the paper also reviews COI studies on other diseases related to MNIH.

It is obvious from both published and unpublished studies that a significant cost is associated with MNIH and that about 80% of the cost is associated with productivity losses attributable to both mortality and morbidity.

Economists use the term “opportunity cost” or “economic cost” in conducting COI studies. Theoretically, the use of the opportunity cost approach can generally be seen as preferable to other approaches because it gives a true sense of the economic costs of the disease. Measurement of the opportunity cost of an illness is by no means an easy task, however. One of the difficult issues is to estimate the lost productivity attributable to illness. Employing human capital methodology, GNP per capita or wage rates are often used to estimate productivity loss resulting from morbidity and mortality. In the case of wage rates, however, it is often pointed out that imperfections occur in the labour market (market failures are known to distort the price of labour) so that a person’s earnings differ from the actual value of his or her output or productivity (54). Thus, in a developing country context where the labour market is not well developed, wages may not be a good measure to be used in estimating productivity losses.

Moreover, serious methodological problems may exist in estimating foregone income due to mortality. The human capital methodology attempts to evaluate the capitalized value of lost wages associated with an inward shift of the labour supply curve. This would be the difference in the wage receipt associated with the old equilibrium, with a greater number of workers, and a new equilibrium that takes into account mortality associated with the disease. However, the formula for the calculation uses the original wage ignoring that an inward shift of the supply curve of labour generally causes an increase in wages (55). The only extreme case in which this approach would be correct as it stands would be if the demand for labour were perfectly elastic, which is invalid empirically. It is also argued that the human capital approach underestimates rather than overestimates true productivity cost, because it values life using market price and thereby yields low values for people outside the labour force, e.g. children or retired persons (56).

Furthermore, the costs of pain and suffering cannot be judged by this method.

One argument against COI studies is that, because of differences in data and methods, COI estimates are not comparable across studies. Another argument is that there may be a substantial double counting of costs for related diseases. COI studies may substantially overestimate or underestimate the true cost a disease places upon society, according to different arguments (16). A review of published COI studies in the United States of America finds that variations among the estimates are so wide and out of proportion in relation to factual health-care expenditures that the results are unreliable and the value of COI studies in decision-making must therefore be limited (57).

Theoretically, the willingness-to-pay approach has the advantage that it elicits the full range of personal costs associated with the illness. However, it has come under much criticism in the context of “existence” values, which do not derive from private consumption of a good (58, 59). It has also been acknowledged that the results are sometimes subject to personal interpretations of questions and can be biased by respondents’ desire to engage in strategic behaviour. Based on the difficulty of conducting effective willingness-to-pay investigations, there are few studies using this approach that can be used to estimate COI (55).

From our review it is evident that no study is complete: none considers all measurable cost components and none
is beyond limitations in respect of methods used for calculating cost. The results of the COI studies show considerable variation, in part resulting from variations in methods but also, no doubt, because the burden caused by, for instance, malaria morbidity and mortality are highly dependent on the endemicity of the disease and the species of parasite involved. Moreover, cost estimations largely depend on the countries, their health-care systems, and – of course – the cost components that are taken into consideration.

It can be the case that there are potentially large economic costs that microeconomic cost studies are not able to capture, or negative externalities associated with the disease that make its national impact even greater than its impact on individuals and households (55). For example, using cross-country regression analysis, economists estimate the economic burden of malaria and find the disease to be a significant factor in long-term economic growth, accounting for 0.25–1.3 percentage points of economic growth (60, 61). Many area-specific studies, varying from South and South-East Asia to Latin America and Africa, estimate the costs imposed by the disease on both households and the country. The general observation is that the cost of malaria to households estimated from microeconomic studies shows a much smaller burden than that revealed by cross-country estimates (55). The considerable difference between the estimates of the economic cost derived from microeconomic studies and the macroeconomic cross-country regressions may provide a valuable insight into the mechanisms through which disease inhibits further negative externalities for hindering development.

6.2 Conclusions

Although the problems of MNIH are fairly well known, knowledge is lacking about the precise magnitude of the costs of MNIH at the societal level. From the information available, it is estimated that not only is the COI of MNIH high, but the components of the costs that affect economic growth (through reduced productivity) are also expected to be high. In addition, MNIH results in suffering for women and children who are the most vulnerable groups in low income societies. In addition, maternal health services can be considered as a merit good, since they produce positive externalities through the improved health of the child (63). Consequently, one could expect that interventions to reduce MNIH would lead not only to health gains for disadvantaged people but also to future productivity gains (from healthy children) that may reduce poverty. Thus devoting greater resources to the reduction of MNIH consequences through public interventions may be justified under the public good rationale (externalities related to MNIH) as well as their poverty impact.

Based on the findings of our review, the following recommendations can be made. In order to conduct COI studies associated with MNIH, future researchers may use data from several sources. In estimating direct costs (cost components C1 to C4 described in Section 2), researchers may use secondary information such as assumptions made by Khan et al. (39) for different complications. One can also pursue the approach of Ettling et al. (45) for MNIH, used in estimating COI for malaria in Rwanda (a top-down approach). Since MNIH complications and cost may depend on the specific country context, household surveys may be a more appropriate way to obtain more accurate information, though this approach may take more time and resources. One can also gather relevant information by qualitative surveys (interviewing key informants and service providers), such as Kowalewski et al. (22) did in order to estimate different private out-of-pocket costs for maternal health-care services. In developing countries, non-private cost is also an important portion of total societal costs; WHO’s mother–baby package of reproductive health costing workbook (23) may be used to estimate non-private cost, such as personnel costs. The REDUCE model may be used to estimate productivity losses attributable to morbidity and mortality.

Nonetheless, much more research is needed before the relationships between maternal morbidity and mortality and the consequences for women, children and society are

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4 Merit goods can be defined as goods that the government feels that people will underconsume and which therefore ought to be subsidized or provided free (62).
clearly understood and estimated. For instance, to explore the interrelationship between MNIH and other related diseases and to identify the important cost components for conducting a COI study on MNIH, more epidemiological and clinical research are required. For methodological concern, standard COI guidelines should be followed without omission of key cost components and quantified with theoretical justification. To understand dynamic properties and consequences of MNIH and to estimate its costs on society, in particular, efforts should be directed towards producing better data, preferably longitudinal data.
The costs of maternal-newborn illness and mortality
References


### Annex 1. Productivity loss assumptions used in the REDUCE model

<table>
<thead>
<tr>
<th>Maternal illness</th>
<th>Disability</th>
<th>Average productivity loss (%)</th>
<th>Average duration (years)</th>
<th>Lifetime discount factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postpartum Haemorrhage</td>
<td>Sheehan’s syndrome</td>
<td>40</td>
<td>37.2</td>
<td>18.70</td>
</tr>
<tr>
<td></td>
<td>Severe anaemia</td>
<td>40</td>
<td>2.5</td>
<td>2.38</td>
</tr>
<tr>
<td></td>
<td>Infertility</td>
<td>1</td>
<td>11.5</td>
<td>9.31</td>
</tr>
<tr>
<td>Sepsis</td>
<td>Infertility</td>
<td>1</td>
<td>15.0</td>
<td>11.52</td>
</tr>
<tr>
<td></td>
<td>PID/CPP</td>
<td>10</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Hypertensive disorders</td>
<td>Neurological sequelae</td>
<td>25</td>
<td>37.2</td>
<td>18.70</td>
</tr>
<tr>
<td>Obstructed labour</td>
<td>Stress incontinence</td>
<td>2</td>
<td>38.2</td>
<td>18.99</td>
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<tr>
<td></td>
<td>Fistula</td>
<td>70</td>
<td>17.4</td>
<td>12.86</td>
</tr>
<tr>
<td>Unsafe abortion</td>
<td>Reproductive tract infection</td>
<td>0</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Severe anaemia</td>
<td>40</td>
<td>2.5</td>
<td>2.11</td>
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<tr>
<td></td>
<td>Infertility</td>
<td>1</td>
<td>15.0</td>
<td>11.52</td>
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<tr>
<td></td>
<td>PID/CPP</td>
<td>10</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

CPP = chronic pelvic pain; PID = pelvic inflammatory disease.

Source: Assumptions made for REDUCE Safe Motherhood model in all relevant countries.
Annex 2. Estimates of total lost productivity cost for maternal–newborn ill-health in four countries

<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>Ethiopia (15 years: 2001–2015)</td>
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<td></td>
<td>Mauritania(^a) (10 years: 2001–2010)</td>
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<td>Senegal (7 years: 2001–2007)</td>
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<td></td>
<td>Uganda (10 years: 2001–2010)</td>
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<tr>
<td>All direct</td>
<td>589.54</td>
<td>390.49</td>
<td>n. a.</td>
<td>8.117</td>
<td>35.37</td>
<td>n. a.</td>
<td>20.70</td>
<td>n. a.</td>
<td>n. a.</td>
<td>42.0</td>
<td>89.5</td>
<td>n. a.</td>
<td></td>
</tr>
<tr>
<td>All indirect</td>
<td>75.609</td>
<td>360.75</td>
<td>n. a.</td>
<td>1.029</td>
<td>37.40</td>
<td>n. a.</td>
<td>6.70</td>
<td>153.5</td>
<td>n. a.</td>
<td>10.0</td>
<td>299.1</td>
<td>n. a.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>665.15</td>
<td>751.24</td>
<td>n. a.</td>
<td>9.146</td>
<td>72.77</td>
<td>n. a.</td>
<td>27.40</td>
<td>209.1</td>
<td>102.9</td>
<td>52.0</td>
<td>388.6</td>
<td>408.0</td>
<td></td>
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</tbody>
</table>

\(^a\) Converted US$ at 2001 exchange rate of 255.629 ouguiya to US$ 1.

n. a. = not available.

Source: Assumptions and estimates for the application of REDUCE Safe Motherhood model in Ethiopia, Mauritania, Senegal, and Uganda.
Moving towards universal coverage—about the series

This series is a joint product of three Geneva-based WHO Departments: Making Pregnancy Safer; Reproductive Health and Research; and Health Policy, Development and Services. It aims to provide, through peer-reviewed papers, the latest evidence and thinking on key issues that are important for making progress towards the goal of universal coverage for essential health-care interventions. Issues related to the health and coverage of the poor are a special focus of the series, as are the implication of universal coverage for health-care programmes and systems.

Issues in maternal–newborn health and poverty—about the subseries

The global status of maternal and newborn health provides one of the most striking examples of disparity between rich and poor countries. Of the approximately half a million and four million newborn deaths that occur each year, 98%–99% occur in the poorest countries of the world. Little is known about the actual impact and costs of maternal and newborn ill-health and death at the individual, familial and societal level and their effect on poverty. Papers in this subseries address these important issues, providing a synthesis of available evidence and original perspectives for further research and debate, all of which are expected to contribute to the international efforts towards the attainment of the Millennium Development Goals.