Neonatal and Perinatal Mortality

Country, Regional and Global Estimates

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Executive summary

All over the world, major changes are taking place in the area of maternal and child health to achieve the goals set out in international declarations and country commitments. The need for evaluation and information has, therefore, become increasingly apparent. Governments and professional organizations have to monitor the overall impact of the changes that are set in motion and compare them internationally. As under-five mortality is decreasing in almost all countries, except in those affected by the HIV/AIDS epidemic *(1)*, neonatal mortality emerges as an increasingly prominent component of overall under-five mortality and is thus receiving additional attention. Consequently, information on perinatal and neonatal mortality at international level is in great demand.

The report provides neonatal and perinatal mortality estimates by country, regional groupings and globally. For countries that do not have data, models were developed to estimate mortality. Since data on deaths come from a number of different sources, the methods used to obtain the estimates are also described. Country-specific estimates of stillbirth and early neonatal deaths are published here for the first time. Estimates of stillbirth deaths that occur during delivery (intrapartum) by regional groupings, as well as estimates of sex ratio in neonatal, early neonatal and stillbirth mortality for the developing world are other recent contributions to the understanding of early mortality that are presented in this document.

The results show that every year over 4 million babies die in the first four weeks of life; 3 million of these deaths occur in the early neonatal period. Moreover, it is estimated that more than 3.3 million babies are stillborn every year; one in three of these deaths occurs during delivery and could largely be prevented. Ninety-eight per cent of the deaths take place in the developing world.

In developing countries, the risk of death in the neonatal period is six times greater than in developed countries; in the least developed countries it is over eight times higher. With 41 neonatal deaths per 1000 live births, the risk of neonatal death is highest in Africa; the sub-Saharan regions of Eastern, Western and Central Africa have between 42 and 49 neonatal deaths per 1000 live births. South-central Asia, with 43 neonatal deaths per 1000 live births, shows rates close to those registered in sub-Saharan Africa, while the neonatal mortality rate for Latin America and the Caribbean is 15 per 1000 live births. Most neonatal deaths occur in Asia, which is where most children are born. Given the high mortality rate in the South-central Asia subregion, over 40% of global neonatal deaths take place here, which presents a formidable challenge.

Early neonatal deaths occur during the perinatal period, and have obstetric origins, similar to those leading to stillbirths. Worldwide, there are over 6.3 million perinatal deaths a year, almost all of which occur in developing countries, and 27% of them in the least developed countries alone. Stillbirths account for over half of all perinatal deaths. One third of stillbirths take place during delivery, and are largely avoidable. Intrapartum deaths (i.e. those occurring during delivery) are closely linked to place of, and care at, delivery. In developing countries, just over 40% of deliveries occur in health facilities and little more than one in two takes place with the assistance of a doctor, midwife or qualified nurse *(2)*.

Compared with earlier estimates, global and regional neonatal and perinatal mortality rates have slowly declined. Improvements appear to have been more noticeable in South America than in other regions of the world.

Thanks to public health interventions, under-five and infant mortality rates are decreasing at a faster pace than neonatal mortality; consequently, neonatal deaths will represent an increasing proportion of child deaths. This document will allow countries to review their achievements in the area of maternal and neonatal health and compare their results with those obtained by other countries. Problems related to early mortality data will, it is hoped, stimulate further research and collection

of population-based data, which will help to improve mortality monitoring and provide health managers with comparative information about the nature and extent of the problem in their country.

This is the second comprehensive report on this topic by the World Health Organization (WHO) and presents country, regional and global estimates of perinatal, neonatal, early neonatal and stillbirth mortality for the year 2000. The first report was published in 1996 *(3)* and presented perinatal and neonatal mortality rates around the year 1995. However, since different methodologies were used, the estimates are not directly comparable, but must be seen as discrete evaluations[a] *(4,5)*.

Government, parliament and society at large in every country need reliable information, analysis and advice to improve decision-making, stimulate research and inform debate. This document constitutes a small contribution to such a debate.

a Information on other pregnancy outcomes is available from other WHO sources: Low birthweight: Country, regional and global estimates *(4)* and the Skilled attendant at birth estimates *(5)* provide information for the same period and regions.

1. Introduction

Over 130 million babies are born every year, and more than 10 million infants die before their fifth birthday *(6)*, almost 8 million before their first.

Many countries have set under-five and maternal mortality reduction as their key development goal, as suggested by international conferences such as the World Summit for Children in 1990, the United Nations Millennium Declaration *(7)* and the United Nations Special Session on Children in 2002 *(8)*. In preparing child-mortality-reduction strategies it is important for countries to know the magnitude of perinatal and neonatal mortality in order to assess needs and develop programmes that will reduce avoidable child deaths more quickly. However, national indicators of the health of mothers and newborn infants are often not readily available, especially in countries that lack vital registration systems.

This document focuses on **neonatal mortality**, i.e. deaths occurring during the first four weeks after birth. It also addresses **perinatal mortality**, which includes both deaths in the first week of life and fetal deaths (stillbirths). Countries will have to ensure a noticeable reduction in the number of deaths during the relatively brief neonatal period, when more than one in three deaths in children under five occur. Reducing neonatal deaths is, therefore, an essential step towards reducing under-five mortality.

Country neonatal and perinatal mortality rates cover a wide range with obvious differences and similarities. However, analysing and comparing mortality rates between countries is also fraught with pitfalls, as minor differences or similarities may be the result of real distinctions in mortality levels, or may be due to diverging definitions and reporting systems, sources of data, or levels of accuracy and completeness.

This report has several aims:

- to bring together epidemiological data on neonatal and perinatal mortality, describing how data/statistics were collected and analysed, and how the estimates were produced, in order to help readers interpret them alongside other reports related to pregnancy, childbirth and newborn infants
- to present neonatal and perinatal estimates and their components by country, region and globally for the year 2000, in order to guide efforts to reduce the number of deaths
- to stimulate interest in this type of data and assist health professionals and decision-makers in producing better statistics relevant to their work.

This document begins with a description of neonatal and perinatal mortality and ways of measuring it, especially those used to assess progress in preventing deaths. It provides definitions, followed by the most common sources of data, and describes the methods used to obtain the estimated rates and numbers. It shows the estimates by country and region for the year 2000, followed by an analysis and interpretation of the results. The report also provides tables, showing the rate and numbers of stillbirths and early neonatal, neonatal and perinatal deaths by United Nations and WHO region, and by country. In addition, it presents regional estimates of intrapartum deaths and sex ratios in developing regions for stillbirths, early neonatal and neonatal deaths.

As in the previous report *(3)*, the main sources of data used are demographic and health surveys and vital registration data. While the focus is on the magnitude of neonatal and perinatal mortality, the accuracy and completeness of the data sources are discussed, and strengths and weaknesses of country and global estimates are emphasized.

The current estimates cannot be directly compared with earlier ones, since the methodology used to obtain them has been modified and improved. One of the major changes is the calculation of

current estimates within the under-five mortality envelope estimated by WHO for each country and for the year 2000. Within this envelope, data were adjusted proportionately to arrive at the current estimates.

We hope that this second edition of neonatal and perinatal estimates will stimulate interest in routine data collection and stress the need for better data to inform and monitor change.

This document is also available on the WHO web site (www.who.int/making_pregnancy_safer/en/)[b].

2 Neonatal and perinatal mortality

Although being newborn is not a disease, large numbers of children die soon after birth: many of them in the first four weeks of life (**neonatal deaths**), and most of those during the first week (**early neonatal deaths**). For every baby who dies in the first week after birth, another is born dead (**fetal deaths or stillbirths**). Causes and determinants of neonatal deaths and stillbirths differ from those causing and contributing to postneonatal and child deaths.

Neonatal deaths and stillbirths stem from poor maternal health, inadequate care during pregnancy, inappropriate management of complications during pregnancy and delivery, poor hygiene during delivery and the first critical hours after birth, and lack of newborn care. Several factors such as women's status in society, their nutritional status at the time of conception, early childbearing, too many closely spaced pregnancies and harmful practices, such as inadequate cord care, letting the baby stay wet and cold, discarding colostrum and feeding other food, are deeply rooted in the cultural fabric of societies and interact in ways that are not always clearly understood.

In many societies, neonatal deaths and stillbirths are not perceived as a problem, largely because they are very common. Many communities have adapted to this situation by not recognizing the birth as complete, and by not naming the child, until the newborn infant has survived the initial period. Health workers at primary and secondary level of care often lack the skills to meet the needs of newborn infants, since the recognition of opportunity is only just emerging in countries, and their experience in this area is therefore limited.

2.1 Neonatal deaths

Babies die after birth because they are severely malformed, are born very prematurely, suffer from obstetric complications before or during birth, have difficulty adapting to extrauterine life, or because of harmful practices after birth that lead to infections.

Around 1% of infants have a major congenital anomaly. These anomalies are more common in developing than in developed countries, especially those caused by diseases such as syphilis, or by nutrient deficiency, which leads to neural tube defects and cretinism.

Low birth weight has long been debated as one of the causes of neonatal deaths. It is associated with the death of many newborn infants, but is not considered a direct cause. Around 15% of newborn infants weigh less than 2500 g, the proportion ranging from 6% in developed countries to more than 30% in some parts of the world. The main "culprit" is preterm birth and the complications stemming from it, rather than low birth weight per se. There is, however, no doubt that maternal health and nutrition at conception are important determinants of weight at birth, neonatal health and frequency and severity of complications, and that maternal infections such as malaria and syphilis contribute to adverse pregnancy outcomes and thus to mortality.

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b To obtain a printed copy, contact: Department of Making Pregnancy Safer, World Health Organization, 20 Avenue Appia, CH-1211 Geneva 27, Switzerland, MPSinfo@who.int.

Complications during birth, such as obstructed labour and fetal malpresentation, are common causes of perinatal death in the absence of obstetric care. Birth asphyxia and trauma often occur together and it is, therefore, difficult to obtain separate estimates. In the most severe cases, the baby dies during birth or soon after, due to damage to the brain and other organs. Less severe asphyxia and trauma will cause disability. Modern obstetric practices have almost eliminated birth trauma. Conversely, where modern obstetric care is not available, intrapartum or early postnatal deaths are very frequent. It is estimated that in developing countries asphyxia causes around seven deaths per 1000 births, whereas in developed countries this proportion is less than one death per 1000 births. The majority of deaths occur soon after birth, some just before birth.

Prolonged labour or prolonged rupture of membranes causes infections in mothers and babies. However, babies are more susceptible than mothers and infections in infants are more difficult to detect. It is estimated that 26% of newborn infants who die do so as a result of infections that occur around birth.

Although during pregnancy the uterus protects the baby from environmental infections, some infections break through the safety barrier and affect the fetus. The most common are syphilis and HIV. In countries where maternal syphilis is prevalent, many babies are stillborn, die soon after birth or are infected themselves.

Neonatal tetanus has been, and remains, a common cause of neonatal death in settings where lack of hygiene at birth and inadequate cord care are prevalent, as many women are not immunized against tetanus and cannot protect the baby at birth. The majority of deaths from neonatal tetanus occur between the seventh and tenth day of life. Through massive tetanus toxoid immunization efforts, neonatal tetanus has been almost eliminated from many countries. There are, however, over 50 countries where, in some districts, the proportion of cases of neonatal tetanus is 1 per 1000 births.

After the first week of life, infections are the main cause of neonatal death in many countries. These are mostly acquired either in hospital as a complication of treatment for other perinatal conditions, or at home. Preterm infants are at greatest risk of becoming ill and dying. Harmful cord care practices cause neonatal tetanus if the mother is not protected by immunization; poor feeding practices cause diarrhoea and poor growth; an unhygienic environment causes sepsis.

The relative contribution of each of these factors varies according to the health of the pregnant woman and the prevalence of endemic diseases such as syphilis or malaria, but mostly according to the availability of adequate care during pregnancy, childbirth and the neonatal period. Early neonatal deaths are mostly due to complications during pregnancy or childbirth, preterm birth and malformations; late neonatal deaths are due to neonatal tetanus and infections acquired either at home or in hospital, when complications in special neonatal care occur.

2.2 Stillbirths

Stillbirth is a professional and lay term that refers to a deadborn fetus *(9)*. Intrauterine death occurs either before onset of labour (antepartum death) or during labour (intrapartum death). Fetuses may die intra utero, before onset of labour, because of pregnancy complications or maternal diseases; however, no special reason can be found for many antepartum intrauterine deaths. Complications arising during birth are the main cause of death among almost all infants who were alive when labour started, but were born dead. It is therefore important to know at what point before birth the baby died, so that appropriate interventions can be planned accordingly. It is relatively easy to determine, in the context of childbirth care, approximately when the death occurred. The proportion of babies that die intrapartum is, therefore, a very important indicator enabling health personnel to take the most appropriate measures to prevent such deaths. Where women receive good care during childbirth, intrapartum deaths represent less than 10% of stillbirths due to unexpected severe complications.

While national and international attention, statistics and interventions focus on liveborn infants, stillborn infants have largely been overlooked. However, these deaths matter too – they matter to the mother and the family, to the society and to the health care system.

2.3 Perinatal mortality

Neonatal deaths and stillbirths have many common causes and determinants. For the last 50 years, the term "perinatal mortality" has been used to include deaths that might somehow be attributed to obstetric events, such as stillbirths and neonatal deaths in the first week of life. This approach does not raise the question whether babies above a certain weight or gestational age (and thus showing some potential for survival) showed any signs of life at birth or not.

The perinatal mortality indicator plays an important role in providing the information needed to improve the health status of pregnant women, new mothers and newborns. That information allows decision-makers to identify problems, track temporal and geographical trends and disparities and assess changes in public health policy and practice.

Perinatal mortality is an important indicator of maternal care and of maternal health and nutrition; it also reflects the quality of obstetric and paediatric care available. Although social factors exert the main influence on the outcome of a birth, as societies advance good medical care tends to play a greater role.

2.4 Determinants or causes of death

New technologies are not necessarily beneficial, as sex-selection procedures and inappropriate assisted reproduction show. The way they contribute to adverse pregnancy outcomes is not captured in current methods of collecting, analysing or presenting perinatal data.

It has long been known that multiple pregnancy is associated with greater risk for both the mother and the fetus, when compared with singleton pregnancy. Up to one half of twins and almost all triplets are born preterm and die at higher rates than term infants *(10)*. Data from Demographic and Health Surveys (DHS) for 1990-2000 *(11)* show that, in less developed countries, the risk of neonatal death in multiple births, when compared with single births, was about six times higher in the neonatal period (range 3-15), and gradually decreased to 2.2 in the postneonatal period, and to 1.4, in the age group 1-4 years. The incidence of multiple births varies according to the region, the country and the availability of technology. In Europe and North America, twin-pregnancy rates had stabilized around 1-1.2% of pregnancies (1.9% to 2% of births)[c], but they have risen to 2.7-2.8% of births over the past two decades, owing to assisted reproduction *(12)*.

Assisted reproduction techniques are becoming increasingly available in less developed countries, and there is reason to believe that the proportion of multiple pregnancies is rising. The cost of health care and other services associated with preterm birth and its sequelae is very high.

More boys than girls are born in the world. The sex ratio[d] at birth — 105-106 boys to 100 girls — is a natural phenomenon and has been stable or decreasing slightly, as has been observed in some European countries *(13)*.

It is well known that mortality rates for boys in the early neonatal period are higher than those for girls. However, it is less well known that differences in attitude towards boys and girls affect their future lives. Gender preference and its consequences vary throughout the world. Most societies prefer sons, and the strong preference for boys observed in some settings is also reflected in neonatal mortality: neonatal mortality among girls may be up to one third higher than that registered

c Multiple-birth rate is defined as the number of live births and stillbirths following a multiple pregnancy, expressed as a proportion of all live births and stillbirths. The DHS measure is for live births only.

d The sex ratio is defined as the number of males divided by the number of females, and is multiplied by a factor of either 100 or 1000.

among boys, thus counteracting the biological differences observed in societies without strong gender preference *(14)*.

Sex ratios at birth higher than 106 can be the result of differential underreporting or sex-selective induced abortion after prenatal sex determination by ultrasound. This method, which represents an advance in medical technology, and economic development, has made it possible to determine the sex of the baby in mid-pregnancy and to abort females. Increasingly information on sex is therefore withheld in routine ultrasound examinations.

Since no sex-specific global estimates of neonatal, early neonatal or stillbirth mortality were available, we used the existing information to explore the relationship between these mortality measures for boys compared with girls (see Annex 8 and Section 7.4) *(15)*.

The current way of drawing up perinatal mortality statistics does not take this phenomenon into account. That is why it is important to monitor the proportion of multiple births and the ratio of boys to girls at birth for both liveborn and stillborn babies.

2.5 Historical trends

Neonatal deaths and stillbirths in developed countries are falling. This is the result of changing patterns in reproductive health, socioeconomic progress and the quality of obstetric and neonatal facilities *(16)*. The pace of this decrease is the same for most developed countries, although where rates were high from the start, they have remained fairly high.

No good historical data on neonatal mortality and stillbirth rates are available for developing countries. Perinatal deaths are seen as a natural occurrence in many societies, which consider the birth of a child accomplished only when the baby has survived the initial period. Vital registration systems usually do not record and report stillbirths.

2.6 Interventions

Public health interventions such as immunization, improved nutrition, water and sanitation have certainly contributed to child survival, as has treatment for diarrhoea, respiratory infections, malaria and malnutrition. Maternal, perinatal and neonatal survival requires additional interventions and approaches.

Appropriate technologies for most critical medical problems and complications are best delivered within a programme that ensures a continuum of care for the woman and her baby throughout pregnancy, childbirth and the postpartum period, at the primary care level for all pregnant women and at higher levels of care for women and babies with complications. Depending on disease patterns, other key interventions for optimal pregnancy outcomes can be integrated into maternity services.

At the beginning of the 21st century, half of the world's women still give birth at home without skilled care. This global average conceals large differences among and within countries, between rural and urban settings, between rich and poor. Furthermore, not all institutions offering maternity services meet minimum standards for safe childbirth and newborn care: absence of health-care providers, outdated knowledge and inadequate skills, lack of essential medicines, supplies and equipment, overcrowding and inadequate hygiene are far too common.

Countries are facing a major challenge to build health systems that can meet the needs of the increasing number of women and their infants.

3 Definitions and rates: statistics for international comparison

WHO has long recognized the importance of international comparison of perinatal and neonatal mortality and its components. One of the many tasks of WHO is to coordinate the compilation of health statistics and to encourage member countries to rely on the same definitions in order to allow for the comparison of those statistics. Events related to birth, death and the perinatal period, as well as the reporting requirements for the data from which internationally comparable statistics are drawn, are defined in the *International classification of diseases* (ICD) *(17)*.

The detailed definitions and instructions are contained in the 10th edition (ICD-10) *(9)*, Chapter 5 "Standards and reporting requirements related to fetal, perinatal, neonatal and infant mortality", which is reproduced in Annex 3. Not all sources concur with these definitions at all times. Some key issues of neonatal and perinatal mortality are mentioned below for ease of reference; however, for precise definitions the reader should refer to Annex 3.

Live birth is the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered liveborn.

Stillbirth or **fetal death** is death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles.

The **perinatal period** commences at 22 completed weeks (154 days) of gestation and ends seven completed days after birth.

The **neonatal period** begins with birth and ends 28 complete days after birth. Neonatal deaths may be subdivided into **early neonatal deaths**, occurring during the first seven days of life (0-6 days), and **late neonatal deaths**, occurring after the seventh day but before the 28th day of life (7-27 days).

The legal requirements for registration of fetal deaths and live births vary between and even within countries. WHO recommends that, if possible, all fetuses and infants weighing at least 500 g at birth, whether alive or dead, should be included in the statistics. The inclusion in national statistics of fetuses and infants weighing between 500 g and 1000 g is recommended both because of its inherent value and because it improves the coverage of reporting at 1000 g and over. For international comparison, 1000 g and/or 28 weeks gestation is recommended.

Evaluation of reporting of early deaths has shown that we may be underestimating perinatal deaths in many countries. It is likely that the decision whether to classify a delivery long before term as a spontaneous abortion or as a birth, which must be registered, may be affected by the circumstances in which the birth occurred and by the cultural and religious backgrounds of the people making the decision, as described for the past *(15)*. For example, a stillbirth at 22 weeks of gestation must be registered as such: at 21 weeks and six days, registration is not required.

Underestimates associated with maternal death in high-mortality settings may be as high as 5% for stillbirths and 3% for neonatal deaths. These estimates are based on Egyptian survey data for 1993 and 2000 *(18,19)*.

Developed-country historical data suggest that, as smaller and sicker babies survive, an increasing number of small babies are registered. The extent to which this affects mortality rates is difficult to assess *(15)*.

Given these differences in recording the fact of death, it is not surprising that there are even greater differences in the way in which causes of stillbirths and neonatal deaths are recorded. One of the objectives of this report is to stimulate interest in improving the quality of reporting and clinical diagnosis of causes of perinatal death.

4 Sources of perinatal and neonatal mortality data

Live births and mortality data for liveborn infants can be obtained from vital registration, sample registration or community studies, while stillbirth data are derived from mortality statistics or community studies. These sources are all, to some extent, prone to underreporting. Some characteristics and inherent limitations of common data sources, as well as the effect of underreporting, are discussed below.

4.1 Vital and mortality statistics

Reporting of vital events refers to the outcomes of live births, such as the birth and death of an infant or death later in life. Although generally accepted, in many countries WHO definitions are not the basis for birth registration. Countries may have legal definitions of events such as live birth, stillbirth or infant death which differ from those recommended by WHO. The criteria for registering births also vary, and the time within which an event must be registered varies between events and between countries.

The reporting of stillbirths, which is an alternative outcome to live birth, is frequently not clearly defined or included in national statistics; perinatal data are often collected as a by-product of administrative or legal processes. The accepted timespan for registration is usually longer for live births and stillbirths than for deaths of liveborn infants and adults. As a consequence, early deaths are not reported, since births are not recorded.

Reliable vital registration is available for only about one third of the world's population. For vital registration data to be considered reliable, WHO requires at least 85% reporting of both completeness and coverage of mortality *(20)*, which is slightly different from the United Nations definition of 90% or more completeness of adult and infant mortality *(21)*. Assessments of reliability of national statistics are not available for all countries; the present work relies on countries classified by WHO, and in the absence of WHO reliability classification, the United Nations classification was used.

4.2 Survey data

The reliability of mortality estimates calculated from prospective and retrospective birth or pregnancy histories collected in community studies depends on the completeness with which births and deaths are reported. Underreporting of infant deaths is usually greater for deaths that occur very early in infancy *(22,23)*. In some cultures and societies, a pregnancy loss may never be reported *(24)*. Completeness and accuracy of recall, including age at death, may deteriorate with time, as in all surveys, and is also related to the skill and cultural sensitivity of the person carrying out the interview.

In surveys, which are the main source of data for developing countries, women are asked about the outcomes of their pregnancies in the 60 months preceding the survey. It is difficult to adhere to the recommended WHO definitions, as babies are often not weighed at birth, the gestational age is not known, menstrual periods are irregular and women may not have records to rely on.

4.3 Hospital data

Hospital studies are not an appropriate source of data for calculating mortality incidence unless all babies are born in a health facility.

4.4 Underreporting

Underreporting remains a problem, especially with regard to early deaths and stillbirths in particular. Data on stillbirths are less frequently available than data on deaths after birth, and are most prone to underreporting. Stillbirth data are available for fewer countries and are less consistent than early neonatal and neonatal mortality data. We found that, in many instances, stillbirths reported in surveys in developing countries accounted for half, or even one third, of the early neonatal deaths, which is counterintuitive, as the same factors causing early neonatal death also come into play before birth. Stillbirths should equal, or more likely exceed, early neonatal deaths, as shown by data from developed countries, historical datasets *(25,26,27)* and hospital data.

Reliability of data depends on reliable reporting and recording of births and deaths. Underreporting and misclassification are common, originating both with the mother and with the recording mechanism. The reason for underreporting may be to avoid a tedious process of registration, particularly in the case of an early death, or it may be due to ignorance of requirements. It can also be related to disincentives, such as having to pay a registration fee, or simply not seeing any obvious benefit. Misclassification of live births and deaths can also occur; there may be misunderstanding of the definition of live birth and fetal death, or misunderstanding of the purpose of reporting. Live births are more likely to be reported than fetal or early neonatal deaths, and nonviable births may systematically be reported as stillbirths *(28)*. A review of studies on underreporting indicates that, while both live births and neonatal deaths may be underreported, fetal deaths are much more likely to go unreported *(29,30)*. Moreover, the earlier the gestational age and the lower the birth weight, the less likely it is that birth and death will be reported *(29,30)*. A number of studies in developed countries show that incomplete reporting of vital events varied between 10% and 30% *(33,34,35,36,37)*. In countries with incomplete reporting or misreporting of vital statistics, underestimation may vary between 20% and 40% *(38,39)*. Comparison between vital statistics and surveys carried out by the Centers for Disease Control (CDC) in some eastern European *(40)* and western Asian *(41)* countries show important underreporting of infant and earlier deaths. In developing countries, there are even greater discrepancies between reporting of vital events and the findings of community studies. For example, only 6% of infant deaths and 62% of births were reported in Cameroon *(42)*, and only 76% of births and 69% of early neonatal deaths of babies weighing over 1500 g were reported in Chile *(43)*. A recent study in Kenya showed that, while civil registration underestimated deaths, particularly in the neonatal period, the age distribution of death in children between 1 and 59 months of age was the same as with active surveillance *(44)*. Therefore, while underreporting may occur at all times, the earlier the death, the greater the underreporting. This means that data on stillbirths are less frequently available than data on deaths after birth and are also most prone to underreporting.

5 Methodology to estimate rates of neonatal and perinatal mortality

WHO encourages countries to collect statistics for key health indicators and to build monitoring capacity. Although fairly widely available nowadays, perinatal and neonatal mortality data are not available for all countries; in particular, stillbirth data are lacking. Neonatal mortality and the stillbirth and early neonatal components of perinatal mortality in countries were estimated when no data were reported; all rates were finally adjusted within the under-five mortality for the country for the year 2000. The method used to arrive at rates by country and to calculate regional and global estimates comprised the following steps, which are further described below:

- establishing the estimation dataset of available data (Section 5.1)
- estimating missing neonatal, early neonatal and stillbirth mortality rates (Section 5.2)
- adjusting mortality rates to WHO under-five (5q0) mortality estimates for the year 2000 (Section 5.3)
- calculating rates and numbers by country, region and globally (Section 6).

5.1 Establishing the estimation dataset of available data

The first step in the estimation methodology was to identify the most recent and reliable national data series for under-five, infant, neonatal, early neonatal and stillbirth mortality from population-based data sources available by August 2003. Population-based sources for under-five and earlier mortality consisted of vital registration and mortality data and community surveys. The estimation relied solely on accurate registration data and reputed surveys, and included the most pre-eminent data.

WHO regional offices, government reports and United Nations and national yearbooks provided registration data and vital statistics. National surveys or registration data were available for 164 countries; however, registration data for five countries did not meet the reliability standards for vital registration. Registration data were, therefore, ultimately used for estimation purposes only for countries with reliable reporting by WHO standards *(20)*: in the absence of any evaluation of data reliability by WHO, the United Nations definition of completeness of adult and infant mortality was used *(21)*.

Reliable data were extracted from national demographic and health surveys originating with Macro International[e], the Pan Arab Project for Child Development (PAPChild)[f], the Gulf Child Health Surveys (GCHS)[g], Centers for Disease Control (CDC)[h] and other national surveys (often relying on an adaptation of the Macro Demographic and Health Survey questionnaire). These organizations carry out and/or support demographic and health surveys in developing countries in collaboration with country partners, providing comparable mortality data; for some other health indicators definitions may differ, e.g. presence of a skilled attendant at delivery. However, surveys did not always provide all the age-at-death rates, and frequently did not report stillbirth data.

There are over 200 countries or areas in the world; 192 countries with a population of 300 000 or more *(45)* were used to obtain global and regional estimates by geographical (United Nations) regions. The countries of the United Nations regions and subregions are listed in Annex 9. Table 5.1 summarizes the availability of reliable age-at-death data for the 192 countries or areas mentioned above.

Table 5.1 Mortality data in the estimation dataset for 192 countries/areas with a population of 300 000 or more

	Stillbirth rate	Early neonatal mortality rate	Neonatal mortality rate	Infant mortality rate	Child mortality rate
Countries with available data in the estimation dataset	102	141	159	159	152
% of countries with data	53%	73%	83%	83%	79%
% of births	40%	76%	95%	95%	91%

e Macro International Inc., an Opinion Research Corporation company, (ORC Macro) is headquartered in the Washington, DC area. The MEASURE DHS project is funded by USAID and implemented by ORC Macro in partnership with Johns Hopkins University Bloomberg School of Public Health/Center for Communication Programs (Hopkins CCP), PATH, Casals & Associates and Jorge Scientific Corporation (JSC). As a key participant in the MEASURE program, the Demographic and Health Surveys (DHS) project is specifically charged with the task of collecting and analysing reliable demographic and health data for regional and national family planning and health programmes.

f The Pan-Arab Project for Child Development (PAPCHILD) endeavours to "diagnose and improve the health and social status of the mother and child through the building of a solid information base" that would "help in determining the problems and thus in identifying priority areas and in planning developmental policies and programmes". The Arab Mother and Child Health Survey (AMCHS) provides "detailed information on the factors that affect maternal and child's health and survival: biological, demographic, social, economic and environmental factors".

g The GCHS is a research programme implemented by the Council of Health Ministers of the Gulf Cooperation Council, under the auspices of the Arab Gulf Programme for United Nations Development Organizations (AGFUND) and with the collaboration of the United Nations Children's Fund, WHO and the United Nations Population Fund.

h The Centers for Disease Control and Prevention (CDC) is part of the Department of Health, which is the main health agency of the United States Government. It supports demographic surveys in countries.

The table shows that reliable population-based data for the derivation of year-specific neonatal mortality estimates were available for a majority of countries (83%); early neonatal mortality rates were available for three out of four countries, while stillbirth data were available for over half. This corresponds to 95%, 76% and 40% of births, respectively.

5.1.1 Survey and registration data for neonatal mortality

The most frequently available early mortality data concern neonatal deaths. The neonatal mortality rates also provide reliable national survey or registration rates that can be used to derive estimates of earlier mortality, if required. Table 5.1 shows there were only 5% of births for which it was impossible to identify neonatal mortality data at national level, as these data were available for 83% of countries and 95% of births.

Table 5.2 shows that most neonatal mortality data came from surveys carried out in 87 countries, corresponding to 81% of births, thus highlighting the enormous value of demographic and health surveys. It is evident that the age-at-death data for almost 50% of countries and over 80% of births came from surveys.

Data originating from civil registration were available for 72 countries (developed and developing) or 37% of all countries, which represents only 14% of births. Where WHO had not classified the reliability of national civil registration data *(20)*, the United Nations classification *(21)* was used. These sources are presented separately in Table 5.2.

Table 5.2 Neonatal mortality data obtained from registration and surveys

	No. of countries	% of countries	Births (000)	% of births
Registration data (WHO definition)	54	28	17558	13
Registration data (United Nations definition)	18	9	818	0.6
Survey data	87	45	108167	81
Total countries with available data	159	83	126543	95
Countries/areas with no reliable data	33	17	6312	5
Grand total	192	100	132882	100

5.1.2 Correcting reported data

Reported mortality rates were verified and corrected when the necessary numbers were available, using the definitions detailed in Annex 3. This applies, for example, to surveys that tended to use "one month" (usually defined as 30 days) and "0-7" days (corresponding to 8 days), rather than "28 days" and "7 days", after birth in the numerator of neonatal and early neonatal rates, respectively. Early neonatal mortality rates were calculated from the day-by-day deaths reported in surveys and corrected for obvious heaping by attributing half of deaths on day 8 to early neonatal deaths and half to late neonatal deaths.

Stillbirth rates, although apparently underreported in some surveys in developing countries, were not corrected (see Section 4.4). It was decided to take the data for those countries at face value, knowingly accepting an underestimation in the absence of any reliable method of correcting this shortcoming.

5.2 Estimating missing neonatal, early neonatal and stillbirth mortality rates

When one or more rates were not available, the missing rate was estimated using regressions and ratios detailed below.

5.2.1 Estimating the neonatal mortality rate of countries with no data

For 33 countries or areas, corresponding to less than 5% of births, no neonatal data were available (Table 5.2). For 28 of these, neonatal mortality was estimated using WHO under-five mortality rates and applying a regression formula corrected for AIDS with an R^2 of 0.92[i], provided by the Department of Measurement and Health Information Systems (MHI), Evidence and Information for Policy (EIP), WHO (Annex 4, Figure A4.1). However, for five small countries/areas, between them representing 0.1% of births, no estimates could be made, since even WHO under-five mortality rates were not available.

5.2.2 Estimating the early neonatal mortality rate of countries with no data

For countries with registration data, neonatal and early neonatal mortality data were available and did not need to be estimated. For countries with survey data, all neonatal mortality rates were available, while early neonatal mortality rates were not provided for 18 countries. Therefore, when there was no primary source of data for the early neonatal mortality rate, this was calculated from the regression analysis with neonatal mortality survey data (R^2 0.92), as shown in Figure A4.2 (Annex 4).

With regard to those 28 countries for which neonatal mortality was estimated from WHO under-five mortality, the regression for neonatal with early neonatal mortality rates (Annex 4, Figure A4.3) was calculated using the combined survey and registration data of the estimation dataset for input, yielding an R^2 of 0.97.

5.2.3 Estimating the stillbirth rate of countries with no data

National stillbirth rates are less frequently available than early neonatal mortality rates (Table 5.1) and insufficient data were available to calculate the relationship by regression. For those countries which lacked data on stillbirths, rates were estimated from the early neonatal mortality rate, on the assumption that the ratio of the perinatal mortality components—stillbirth and early neonatal mortality—was similar for countries of each of the five WHO mortality strata; these are described in Section 6.4.2 and listed in Annex 9, Section A9.2. The methodology used to estimate stillbirth rates is described in detail in Annex 6.

The stillbirth/early neonatal mortality ratios show that low early neonatal mortality and high-technology settings are generally found in stratum A (1.9) and stratum C (1.7); early neonatal deaths are consequently minimized and the stillbirth/early neonatal mortality ratio is high. When early neonatal mortality is higher, as in the moderate and high-mortality strata B, D and E, the stillbirth/early neonatal mortality ratio is lower, here estimated at 1.2. Missing stillbirth rates were therefore estimated from the early neonatal mortality rates by applying the estimated stillbirth/early neonatal mortality ratios for the five WHO mortality strata.

Data were available for strata A and C, and the stillbirth rate was not estimated for countries that were used to calculate regional and global averages; however, national estimates were calculated for countries with smaller populations. While it is recognized that empirical stillbirth data were sometimes inconsistent with epidemiology in strata D and E, reported (low) rates were nevertheless retained; this means that country, regional and global stillbirth estimates are probably further underestimated.

It is important to know how many stillbirths occur intrapartum, since they can be prevented by the presence of a skilled birth attendant and appropriate interventions during delivery. An analysis of the proportion of all stillbirths that occur intrapartum is detailed in Annex 7, and the results are discussed in Section 7.3.

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i The R^2 is a number between 0 and 1 that reveals how closely the estimated values for the trendline correspond to the actual data. The closer the R^2 is to 1, the more reliable is the predicted value of the trendline.

5.3 Adjusting mortality rates to WHO under-five (5q0) mortality estimates for the year 2000

The reported neonatal, early neonatal and stillbirth mortality rates mostly refer to the second half of the 1990s or early 2000s. In order to project year-specific mortality estimates, and to contain early mortality within WHO's under-five mortality for the year 2000, neonatal and earlier mortality rates were adjusted to the under-five mortality rate as estimated by WHO for the year 2000 *(46)*. The ratio between WHO's estimated under-five mortality rate for the year 2000 and the under-five mortality rate of each country's estimation dataset was calculated. This was then used to adjust the stillbirth, neonatal and early neonatal mortality rates of surveys or civil registration. This proportional change maintained the observed age-at-death distribution within the overall WHO estimated under-five mortality envelope. Using this approach, the rates for the year 2000 were projected country by country on the basis of the latest information available on neonatal mortality and the components of perinatal mortality: early neonatal mortality and stillbirths.

6 Calculating rates and numbers by country and region, and globally

The estimation methodology described above provided neonatal, early neonatal and stillbirth rates for 187 of the 192 countries and areas with a population of more than 300 000 used to create the global estimates (Annex 9). The corresponding number of deaths by country are calculated and early neonatal deaths and stillbirths are added together to calculate numbers and rates of perinatal deaths. Rates for five small areas representing 0.1% of births could not be estimated. Estimated rates and numbers by country are presented in Section 6.3 and Annex 1.

Country data are aggregated in order to arrive at regional and global rates and numbers in Section 6.5, summarized in Table 6.1. Margins of error of global estimates are calculated for neonatal and early neonatal mortality and presented in Annex 5.

6.1 Number of neonatal and early neonatal deaths by country

The number of neonatal and early neonatal deaths by country is calculated by applying the estimated neonatal and early neonatal mortality rates to the number of births for the year 2000 as estimated by the United Nations Population Division in its 2002 revision of population estimates *(47)*. The formula is:

$$\text{Number of deaths} = \text{rate} * \text{live births}/1000$$

6.2 Number of stillbirths and perinatal deaths by country

The number of stillbirths and perinatal deaths is calculated in the same way, but for the total number of births, i.e. live births plus stillbirths. As the stillbirth rate is estimated, but the total number of births is not available, the number of stillbirths by country is calculated using the following equation:

$$SBN = SBR * LB/(1000 - SBR)^{j}$$

where

SBN is the number of stillbirths
SBR is the stillbirth rate
LB is the number of live births.

j Derived from the formula for the number of stillbirths SBN=SBR*(LB+SBN)/1000.

In order to calculate the number of perinatal deaths and the perinatal mortality rate, the figures for early neonatal deaths and stillbirths are added together to give the number of perinatal deaths, while the sum of stillbirths and live births makes up the total number of births required to calculate the perinatal mortality rate using the formula:

$$\text{Perinatal mortality rate} = \frac{(\text{Early neonatal deaths} + \text{stillbirths})}{\text{Total births}} \times 1000$$

where

total births = live births + stillbirths.

6.3 Country estimates

The neonatal, perinatal, early neonatal and stillbirth country estimates in Annex 1 are based on the analysis of data available before August 2003. The methodology used to arrive at these estimates is described in Section 5 above. Estimates were calculated for countries and areas with a population of more than 300 000 (Annex 9, Section A9.1) *(45)* and also for WHO Member States with smaller populations (identified in Annex 1 by the symbol placed after the country name). Data sources are numbered in the last column. Estimates that are derived through regression and other estimation methods are marked with an asterisk (*). When stillbirth or early neonatal mortality, or both, have been estimated, the perinatal mortality figures have been estimated too (not marked).

National stillbirth rates lower than early neonatal mortality rates are inconsistent with perinatal epidemiology. However, the reported rates were nevertheless retained, which means that such country stillbirth rates are probably underestimated. On the other hand, stillbirth rates in some developed countries may have included very early stillbirths, overemphasizing the rate slightly.

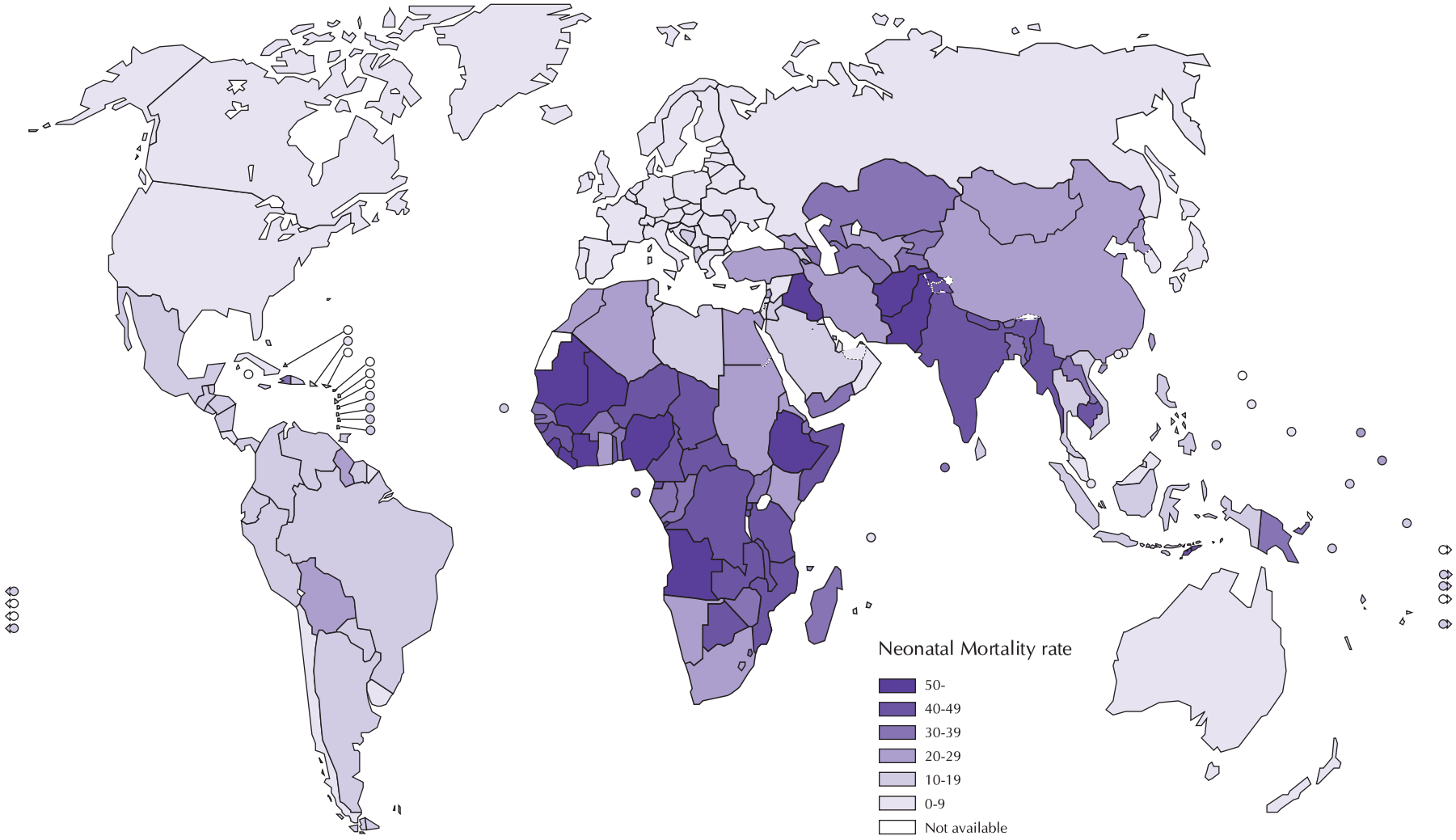
The estimates shown in Annex 1 represent a substantial improvement over earlier efforts at compiling internationally comparable information. Direct comparison of these estimates with earlier rates is not advisable, however: the number of countries with usable mortality data has increased and the estimation methodology has changed, and the rounds of estimation should therefore be seen as discrete events.

By adjusting reported rates to the WHO under-five mortality estimates for the year 2000, a degree of comparability between countries for that year has been achieved. Caution should nevertheless be exercised when comparing rates across countries, keeping in mind that the data used to calculate estimates have different sources and levels of accuracy. Some rates have been estimated from regressions or by applying ratios, while others have merely been adjusted within the WHO under-five mortality framework for the year 2000.

Country estimates should thus be understood as indicating orders of magnitude rather than precise figures. The estimates may differ from countries' own estimates; national authorities are invited to notify significant differences to WHO, specifying the sources and values used for calculating their figures.

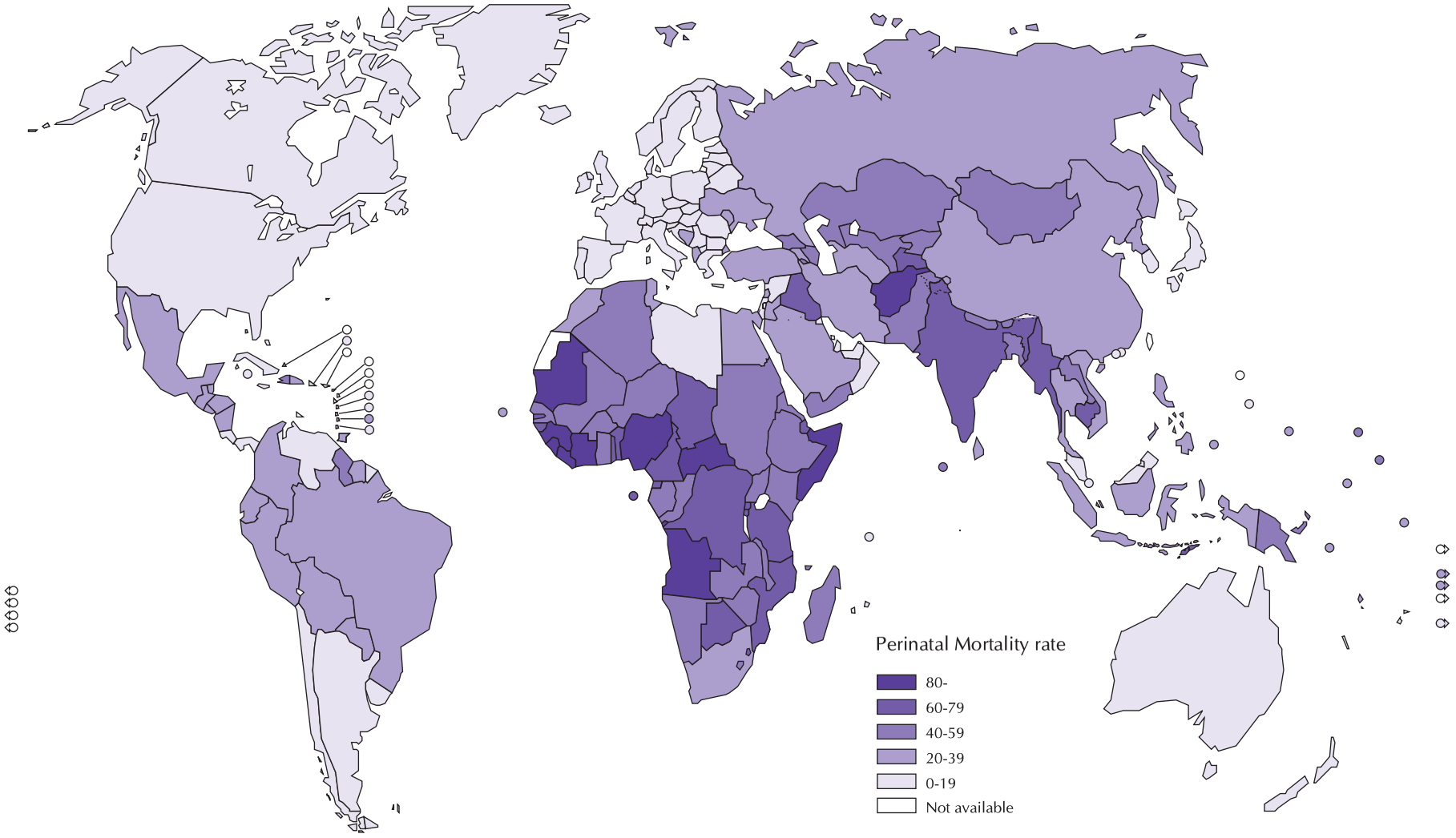
Country estimates are presented alphabetically in Annex 1. Global maps summarizing neonatal and perinatal mortality rates by country are illustrated in Figures 6.1 and 6.2.

Figure 6.1 Neonatal mortality rate, by country, 2000



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dashed lines represent approximate border lines for which there may not yet be full agreement.

Figure 6.2 Perinatal mortality rate, by country, 2000



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dashed lines represent approximate border lines for which there may not yet be full agreement.

6.4 Regions of the United Nations and the World Health Organization

The United Nations and its specialized agencies rely on a number of different country groupings. Relevant for this document are the United Nations and WHO regional groupings, which are briefly described below and listed in Annex 9, Section A9.1-2.

The discussions in this paper refer mainly to the United Nations regions, which follow geographical borders familiar to most readers. Tables are presented in the main text by geographical (United Nations) regions, and in Annex 2 by WHO regions.

6.4.1 United Nations regions and subregions

The United Nations Population Division provides live-birth and other estimates by country, subregion, region and globally, and also according to the level of development. Those estimates are revised every two years. The estimates in this document refer to the year 2000 and are drawn from the 2002 revision *(45)*. This provides a list of 192 countries with a population of over 300 000, on which global estimates are based. When calculating and discussing rates and numbers for Asia, Eastern Asia and Oceania in this document, it should be borne in mind that Australia, Japan and New Zealand are excluded from their respective subregions, but included among developed countries; this is indicated in a footnote below the relevant tables. The regions and subregions of the United Nations are:

- Africa: Eastern Africa, Middle Africa, Northern Africa, Southern Africa, Western Africa
- Asia: Eastern Asia, South-central Asia, South-eastern Asia, Western Asia
- Europe: Eastern Europe, Northern Europe, Southern Europe, Western Europe
- Latin America and the Caribbean: Caribbean, Central America, South America
- Northern America
- Oceania: Australia/New Zealand, Melanesia, Micronesia, Polynesia.

The United Nations also groups countries according to their level of development:

- more developed regions: Europe, North America, Australia, New Zealand and Japan
- less developed regions: the remaining regions, excluding Japan, Australia and New Zealand
- least developed countries: this refers to 50 countries in the less developed regions; of those 50 countries, 35 are in Africa, nine in Asia, one in the Caribbean and five in Oceania.

Countries are listed by geographical region and level of development in Annex 9. “More developed regions” are also referred to as “developed regions” or “developed countries”; “less developed regions” are also referred to as “developing regions” or “developing countries”.

6.4.2 World Health Organization regions and mortality strata

WHO Member States are grouped into six regions, as listed in Annex 9:

- WHO African Region (AFRO)
- WHO Region of the Americas (AMRO)
- WHO South-East Asia Region (SEARO)
- WHO European Region (EURO)
- WHO Eastern Mediterranean Region (EMRO)
- WHO Western Pacific Region (WPRO).

WHO has also defined five mortality strata (A-E) to indicate different levels of child and adult mortality. Those mortality strata are as follows:

- A: very low child, very low adult mortality
- B: low child, low adult mortality
- C: low child, high adult mortality
- D: high child, high adult mortality
- E: high child, very high adult mortality

Combining the mortality strata with the WHO regions, WHO has categorized countries into 14 mortality subregions (Annex 9, Section A9.2). Not all strata are represented in each region. For example, in the Region of the Americas there are countries in strata A, B and D. Countries in stratum E are all in the African Region.

Estimates are presented by WHO region and mortality stratum in Annex 2. In a step of the estimation methodology detailed in Section 5.2.3 and in Annex 6, reference is made specifically to WHO mortality strata.

6.5 Global, regional and subregional rates and numbers

Estimated country stillbirth, neonatal, early neonatal and perinatal mortality rates, weighted by the number of live births *(45)* or total births when appropriate, were aggregated in order to calculate the subregional, regional and global rates and numbers. These are summarized in Table 6.1 by United Nations regions that follow geographical borders. The corresponding numbers and rates are calculated also for WHO regions and subregions, and reported in Annex 2. Confidence intervals for the estimates have been calculated for neonatal and early neonatal mortality and global and regional estimates are listed in Annex 5 for United Nations and WHO regions.

Table 6.1 Global estimates of stillbirths, early neonatal, perinatal and neonatal mortality rates and numbers by level of development and geographical (United Nations) region and subregion, 2000

	Live births (000)	Perinatal mortality rate	No. of perinatal deaths (000)	Stillbirth rate	No. of stillbirths (000)	Early neonatal mortality rate	No. of early neonatal deaths (000)	Neonatal mortality rate	No. of neonatal deaths (000)
WORLD	**132882**	**47**	**6337**	**24**	**3328**	**23**	**3008**	**30**	**4002**
More developed regions*	13160	10	134	6	84	4	50	5	63
Less developed regions	119721	50	6203	26	3244	25	2959	33	3938
Least developed countries	26639	61	1683	31	850	31	834	42	1132
AFRICA	**30305**	**62**	**1929**	**32**	**1002**	**31**	**927**	**41**	**1240**
Eastern Africa	10649	58	630	27	297	31	333	42	443
Middle Africa	4413	75	343	41	191	35	152	46	204
Northern Africa	4587	34	160	18	85	16	75	22	103
Southern Africa	1243	37	47	21	26	17	21	23	28
Western Africa	9412	76	748	41	403	37	345	49	463
ASIA*	**77490**	**50**	**4016**	**27**	**2124**	**24**	**1892**	**32**	**2517**
Eastern Asia *	20537	34	720	19	396	16	324	21	428
South-central Asia	39937	65	2687	34	1410	32	1278	43	1716
South-eastern Asia	11743	33	401	19	223	15	177	19	227
Western Asia	5273	39	208	18	94	21	113	28	146
EUROPE	**7185**	**13**	**91**	**8**	**61**	**4**	**30**	**5**	**38**
Eastern Europe	2709	21	59	15	41	7	18	8	22
Northern Europe	1070	8	8	5	5	3	3	4	4
Southern Europe	1440	8	11	5	7	3	5	4	6
Western Europe	1965	6	13	4	8	2	4	3	6
LATIN AMERICA AND CARIBBEAN	**11671**	**21**	**247**	**10**	**112**	**12**	**135**	**15**	**175**
Caribbean	754	31	24	18	14	14	11	19	14
Central America	3423	22	76	11	37	11	39	16	53
South America	7494	19	147	8	62	11	85	14	107
NORTHERN AMERICA	**4479**	**7**	**33**	**3**	**16**	**4**	**17**	**5**	**21**
OCEANIA*	**255**	**42**	**11**	**23**	**6**	**19**	**5**	**26**	**7**
Australia/New Zealand	300	6	2	3	1	3	1	3	1
Melanesia	226	45	10	25	6	21	5	28	6
Micronesia	13	13	0.2	7	0.1	6	0.1	8	0.1
Polynesia	15	20	0.3	11	0.2	9	0.1	12	0.2

Figures may not add exactly to the total owing to rounding

Confidence intervals for the estimates have been calculated for neonatal and early neonatal mortality and global and regional estimates are listed in Annex 5.

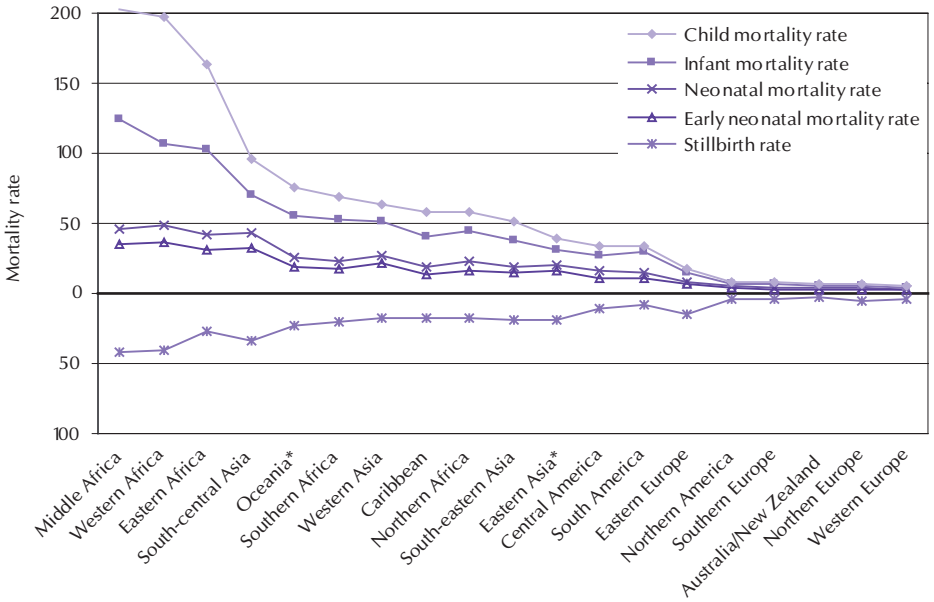
* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries.

7 Estimates of perinatal and neonatal mortality: analysis and interpretation

The global and regional estimates of perinatal, stillbirth, early neonatal and neonatal mortality summarized in Table 6.1 have been calculated using the methodology described in Section 5 and aggregated from the country estimates in Annex 1. An overview of neonatal and perinatal mortality by country is presented in global maps and Figures 6.1 and 6.2. The estimates refer to the year 2000.

Figure 7.1 below illustrates the relationship between the age-at-death rates for stillbirths, early neonatal and neonatal mortality derived from the estimates outlined in this document, and infant and child mortality data from the Evidence and Information for Policy cluster at WHO. The graph shows that age-at-death rates move in parallel. However, as rates decrease, under-five and infant mortality decrease at a faster pace than neonatal, early neonatal and stillbirth mortality. Postneonatal mortality and deaths in children aged 1-5 years can be dramatically reduced through vaccination and other common interventions. As excess mortality which can be prevented by medical interventions decreases in this age group, the focus must be directed towards the neonatal and perinatal periods if overall mortality is to be further reduced. The graph also shows that the sub-Saharan regions of Middle, Western and Eastern Africa, followed by South-central Asia and Oceania, are those with the highest mortality for all of these indicators, and therefore the ones most in need of interventions.

Figure 7.1 Mortality rates by geographical regions, 2000



* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries. The corresponding figure by WHO region appears in Annex 6, Figure A6.2.

7.1 Neonatal mortality

More than half of the approximately 7.5 million infant deaths in the world occur in the first four weeks after birth. Ninety-eight percent of these neonatal deaths occur in developing regions, 28% in least developed countries. Overall, there are 30 neonatal deaths per 1000 live births; 5 per 1000 in developed and 33 per 1000 in developing regions, and 42 per 1000 in least developed countries. This means that, in developing regions, the risk of death in the neonatal period is more than six times that of developed countries; in the least developed countries, it is more than eight times higher.

With 41 neonatal deaths per 1000 live births, the risk of neonatal death is highest in Africa, mainly in the sub-Saharan regions of Western, Middle and Eastern Africa that have between 42 and 49 neonatal deaths per 1000 live births, whereas Southern and Northern Africa have lower rates. Asia has an average neonatal mortality rate of over 32 per 1000 live births. However, subregional averages vary: in South-central Asia, where the average rate is 43 per 1000 live births, the risk of neonatal death is as high as in sub-Saharan Africa, while South-eastern Asia, with 19 deaths per 1000 live births, has the lowest rate. The neonatal mortality rate for Latin America and the Caribbean is 15 per 1000, showing a narrow range of 14 (South America) to 19 (the Caribbean) per 1000 live births. Oceania's neonatal mortality rate, at 26 per 1000, falls between those of Asia and Latin America, mainly because of high mortality in Melanesia.

The highest number of neonatal deaths occurs in Asia, which is where most children are born. As mortality is very high in the South-central Asia subregion, over 40% of global neonatal deaths take place here, representing a formidable challenge.

Most deaths in the neonatal period occur in the first few days after birth. Consequently, early neonatal mortality represents about 75% of neonatal mortality, and this applies to all regions of the world. Early neonatal deaths have obstetric origins similar to those leading to stillbirth.

7.2 Perinatal mortality

The perinatal period covers the period leading up to birth and the first week of life; deaths occurring in this period are largely due to obstetric causes. More than 3.3 million stillbirths and over 3 million early neonatal deaths are estimated to take place every year. In the year 2000, over 6.3 million perinatal deaths occurred worldwide: almost all of them (98%) occurred in developing countries and 27% in the least developed countries. In developing countries stillbirths represent more than half of perinatal deaths, while in developed countries, where interventions have largely eliminated excess early neonatal mortality, over 6 out of 10 perinatal deaths are stillbirths. More than one third of stillbirths take place intrapartum, i.e. during delivery, and are largely avoidable (see Section 7.3).

The perinatal mortality rate is five times higher in developing than in developed regions: 10 deaths per 1000 total births in developed regions; 50 per 1000 in developing regions and over 60 per 1000 in least developed countries. It is highest in Africa, with 62 deaths per 1000 births, and especially in middle and western Africa, which have rates as high as 75 and 76 per 1000. The perinatal mortality rate in Asia is 50 per 1000 total births, with a peak of 65 per 1000 in South-central Asia, the third highest rate among the subregions, lower only than those of Middle and Western Africa. Oceania's rate of 42 per 1000 falls between the rates of Asia (62) and those of the Latin America and Caribbean region *(21)*. Differences within the latter region are nevertheless significant, with a rate of 31 in the Caribbean and around 20 in Central and South America.

7.3 Intrapartum stillbirths

Intrapartum stillbirths are estimated using the methodology outlined in Annex 7. The analysis confirms that intrapartum stillbirths are rare in developed countries, where they represent approximately 10% of the estimated 84 000 stillbirths, with an average intrapartum stillbirth rate of 0.6 per 1000 births. On the other hand, intrapartum deaths in developing regions are estimated to account for between 24% and 37% of all stillbirths (see Table 7.1), which means that overall 34% of 3.2 million stillbirths, or 9 out of every 1000 births, occur during delivery. Consequently the risk of an intrapartum stillbirth is on average 14 times greater in developing than in developed countries. In the least developed countries, the risk increases to at least 17 times more than in developed countries.

Complications of childbirth are the cause of almost all deaths during delivery. Intrapartum deaths are largely avoidable through appropriate care during delivery, and therefore closely related to

Table 7.1 Intrapartum stillbirth mortality for the year 2000, by United Nations region and subregion

	Stillbirth rate	No. of stillbirths (000)	Intrapartum deaths as % of stillbirths	No. of intrapartum deaths (000)	Intrapartum mortality rate
WORLD	**24**	**3328**	**33**	**1097**	**8**
More developed regions*	6	84	10	8	41
Less developed regions	26	3244	34	1089	9
Least developed countries	31	850	35	301	11
AFRICA	**32**	**1002**	**35**	**349**	**11**
Eastern Africa	27	297	33	98	9
Middle Africa	41	191	37	71	15
Northern Africa	18	85	32	27	6
Southern Africa	21	26	28	7	6
Western Africa	41	403	36	147	15
ASIA*	**27**	**2124**	**33**	**709**	**9**
Eastern Asia*	19	396	24	96	5
South-central Asia	34	1410	37	518	13
South-eastern Asia	19	223	30	68	6
Western Asia	18	94	29	27	5
EUROPE	**8**	**61**	**10**	**6**	**1**
Eastern Europe	15	41	10	4	1
Northern Europe	5	5	10	1	1
Southern Europe	5	7	10	1	0.5
Western Europe	4	8	10	1	0.4
LATIN AMERICA AND CARIBBEAN	**10**	**112**	**25**	**28**	**2**
Caribbean	18	14	31	4	6
Central America	11	37	24	9	3
South America	8	62	24	15	2
NORTHERN AMERICA	**3**	**16**	**10**	**2**	**0.3**
OCEANIA*	**23**	**6**	**35**	**2**	**8**
Australia/New Zealand*	3	1	10	0.1	0.3
Melanesia	25	6	36	2	9
Micronesia	7	0.1	24	0.02	2
Polynesia	11	0.2	24	0.04	3

Figures may not add exactly to the total owing to rounding.

Estimates by WHO regions and mortality strata can be found in Annex 2, Table A2.2.

* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries.

the place of birth and the availability of qualified birth attendants. In developed countries, most deliveries take place in institutions and almost without exception in the presence of qualified health personnel. In developing countries, just over 40% of deliveries occur in health facilities and only slightly more than 1 in 2 takes place with the assistance of a doctor, midwife or qualified nurse *(2,5)*.

7.4 Sex differentials in neonatal and early neonatal mortality and stillbirths

The male-to-female ratio in neonatal mortality and in early neonatal mortality in developing countries is estimated at 1.3. Stillbirths show a lower ratio of 1.1, only slightly higher than the natural sex ratio at birth (see Section 2.4). The ratios illustrate the increasing risk of neonatal death in boys and the importance of monitoring changes in the ratio of boys to girls in perinatal statistics.

The method used to estimate the male-to-female ratio in neonatal, early neonatal and stillbirth mortality is detailed in Annex 8.

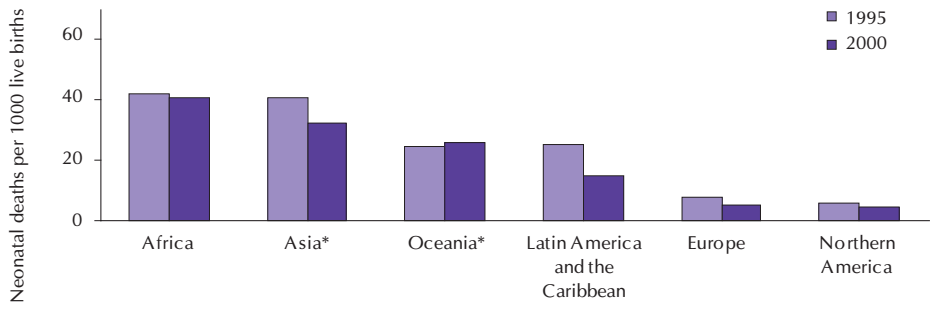
7.5 Comparison with earlier estimates

Perinatal mortality has been estimated for 1983 *(48)*, 1995 *(3)* and recently for 2000; neonatal mortality has previously been estimated only for 1995 *(3)*. Over time, different methods have been used to derive these estimates, regions have changed and data have become more abundant. While estimates should generally be considered discrete events, particularly at the individual country level, it is possible to make some cautious comparisons at regional level, avoiding a fixation with numbers and just looking at the overall trend. A somewhat higher or lower rate in the current round of estimates could, therefore, either indicate stagnation or merely reflect better data and estimates.

At the regional level (see Figure 7.2), neonatal mortality shows a slow decline, although this decline may be greater for Latin America and the Caribbean. Oceania appears to show stagnation. At the subregional level (see Figure 7.3), a slow improvement is noticeable. Not surprisingly, in some regions – Northern and Southern Africa, the three subregions of Latin America, and Eastern and South-eastern Asia – rates seem to be improving faster.

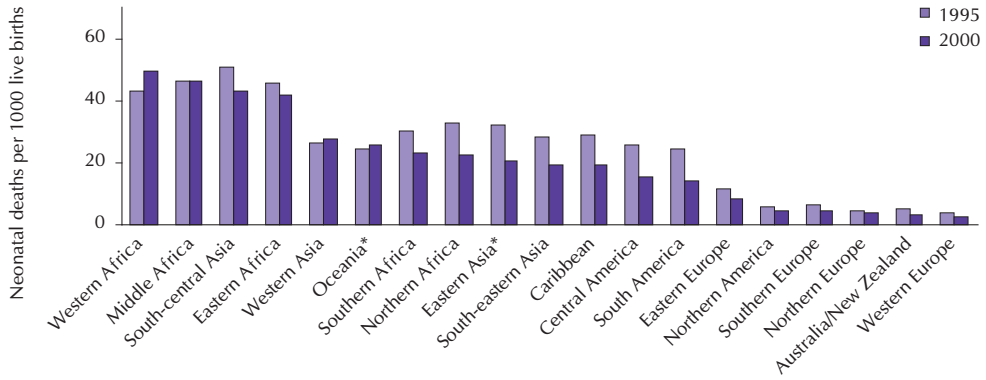
Perinatal mortality estimates are available for three different years. At the regional level (see Figure 7.4), the rates show a steady decline over time, declining more rapidly in Latin America and the Caribbean. However, if we look closely at the subregional graph (see Figure 7.5), it becomes evident that rates for 1983 were underestimated in some instances, especially for Eastern Asia. Nevertheless, perinatal mortality shows slow but steady improvement, with rates decreasing over time. The apparent increase in perinatal mortality in Eastern Europe reflects changes in definition, although some worsening of perinatal mortality cannot be excluded. The most noticeable improvements appear to have taken place in South America.

Figure 7.2 Neonatal mortality by region, 1995 and 2000



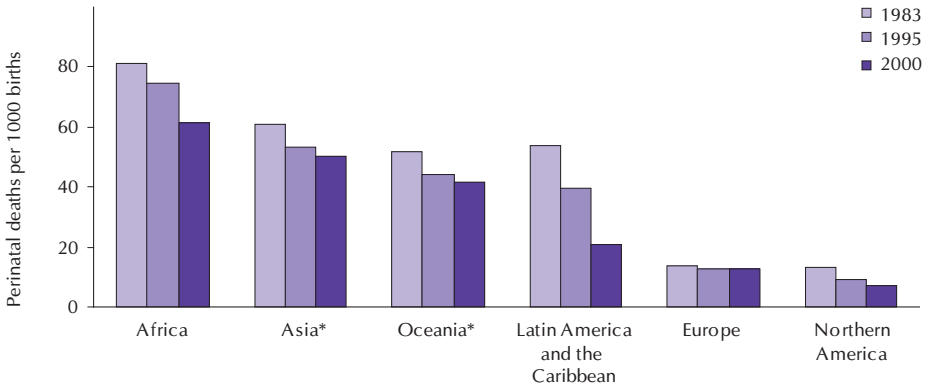
* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries.

Figure 7.3 Neonatal mortality by subregion, 1995 and 2000



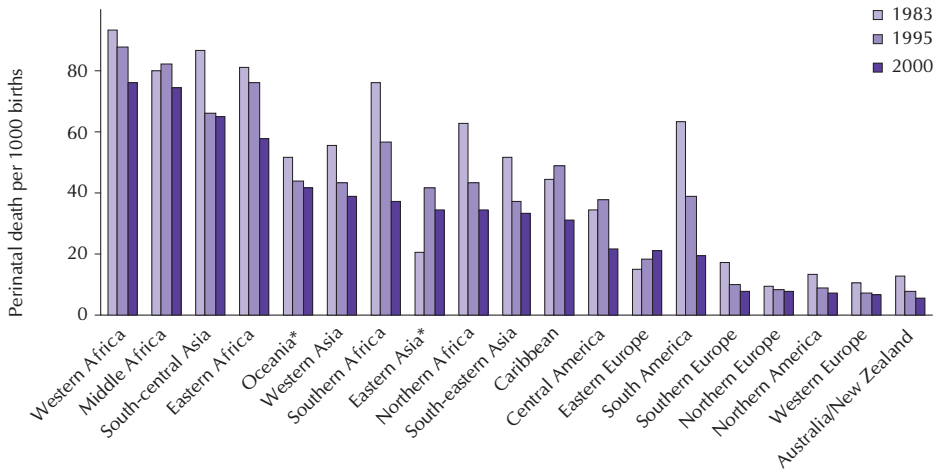
* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries.

Figure 7.4 Perinatal mortality by region, 1983, 1995 and 2000



* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries.

Figure 7.5 Perinatal mortality by subregion, 1983, 1995 and 2000



* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries.

7.6 Limitations of estimates

Every effort has been made to arrive at balanced estimates, but it is not possible to calculate precise mortality rates, because reliable population-based data are not available for all countries and for all years. While good, recent mortality observations were available for most countries, particularly with regard to neonatal mortality, regressions were applied and assumptions made to calculate estimates for all countries (Section 5) that are comparable within the year 2000 under-five mortality framework.

Nevertheless, it should be emphasized that country estimates should be regarded as the best estimates possible on the basis of the information available, using the methods indicated in Section 5. Mortality rates and numbers by country are listed in Annex 1; estimates derived through regression and other estimation methods are indicated by an asterisk (*).

The set of estimates shown in Annex 1 and Table 6.1 represents a substantial improvement over earlier efforts at compiling internationally comparable information. Firstly, the number of countries with usable mortality data has increased. Secondly, by adjusting reported rates to the WHO under-five mortality estimates for the year 2000, a measure of comparability between countries and regions has been achieved with regard to the mortality estimates for that year.

In spite of improvements in the availability of data, there are 33 countries, many of them small, and which among them account for less than 5% of births, for which no recent information on mortality was available. Furthermore, civil registration data are incomplete to varying degrees, and there are inconsistencies in reporting standards. Among developed countries, mortality rates may reflect differences in the definitions used for reporting births, such as cut-offs for registering live births and birth weight. However, it is also important to bear in mind that survey data are also prone to reporting errors. Although the survey-based estimates have their limitations, they are likely to be more accurate than developing-country routine reporting systems of unknown completeness, or hospital data, which are incomplete unless all births take place in health facilities.

8 The way forward

A large proportion of infant and under-five deaths occur soon after birth, in the neonatal period. Globally, the lower the child mortality, the higher the proportion of deaths that occur before the age of four weeks, as under-five mortality is easier to reduce. Early neonatal mortality accounts for three out of four neonatal deaths; this figure is only slightly higher in developed regions. Worldwide neonatal mortality represents more than half of overall infant mortality and over one third of under-five deaths (see Table 8.1). There are, however, considerable differences between developed and developing countries. It is noteworthy that, as overall under-five mortality is still very high in Africa, neonatal deaths represent just over 40% of infant mortality and one quarter of under-five mortality, unlike other regions of the world.

Table 8.1 Relationship between mortality rates by level of development and region

	Neonatal mortality as % of under-five mortality	Neonatal mortality as % of infant mortality	Early neonatal mortality as % of neonatal mortality	Early neonatal mortality as % of perinatal mortality
World	36	53	75	47
More developed regions*	52	63	79	37
Less developed regions	36	53	75	48
Africa	26	42	75	48
Asia*	45	61	75	47
Latin America and Caribbean	42	51	77	55
Oceania*	34	47	73	45

Figures may not add exactly to the total owing to rounding

* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries.

Early neonatal deaths can only be reduced through effective pregnancy, childbirth and postnatal care reaching all mothers and their babies. This will also reduce the large number of—mostly invisible—stillbirths.

Through public health interventions, under-five and infant mortality rates are decreasing at a faster pace than neonatal mortality; consequently, neonatal deaths account for an increasing proportion of child deaths. Early neonatal deaths constitute approximately 75% of neonatal deaths, and for every early neonatal death there is at least one stillbirth; these deaths can be prevented by the same interventions. We have also shown that one third of stillbirths take place during delivery – deaths that are largely avoidable and closely linked to the place of and care provided at delivery. If under-five mortality is to be reduced, neonatal mortality, early neonatal mortality and stillbirths must be accorded increasing prominence.

Mortality and morbidity in the perinatal and neonatal period are mainly caused by preventable and treatable conditions. Interventions that benefit mothers by reducing maternal deaths and complications, as well as special attention to the physiological needs of the newborn baby—resuscitation when necessary, immediate breast-feeding, warmth, hygiene (especially for delivery and cord care) and the prevention, early detection and management of major diseases—will help ensure the survival and health of newborn infants. Safe and clean delivery, early detection and management of sexually transmitted diseases, infections and complications during pregnancy and delivery and taking into account the physiological needs of the newborn baby, are all interventions that should be available, attainable and cost-effective. They all have an immediate beneficial impact on the mother and the unborn and newborn infant. Good maternal nutrition, the prevention and management of anaemia and high-quality antenatal care will reduce the incidence of complications and thereby improve the chances of survival of the mother, the fetus and the newborn infant. The incidence of low birth weight—an important determinant of perinatal survival—may take time to change substantially. Universal access for women to care in pregnancy and childbirth and care of the newborn is required to improve the chances for both mother and baby.

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Annex 1 Country estimates

Table A1.1 Country estimates of stillbirths, perinatal, early neonatal and neonatal mortality rates and numbers for the year 2000

Country name[a b]	Live births (000)	Perinatal mortality rate	No. of perinatal deaths (000)	Stillbirth rate	No. of stillbirths (000)	Early neonatal mortality rate	No. of early neonatal deaths (000)	Neonatal mortality rate	No. of neonatal deaths (000)	Data sources[c]
Afghanistan	1044	96	106	* 54	59	* 45	47	* 60	63	*1*
Albania	59	20	1	* 11	1	* 9	1	* 12	1	*1*
Algeria	701	47	34	32	23	* 16	11	20	14	*2*
Andorra[o]	1	9	<1	* 6	<1	* 3	<1	* 4	<1	*1*
Angola	655	86	59	* 48	33	* 40	26	* 54	35	*1*
Antigua and Barbuda[o]	1	13	<1	* 7	<1	* 6	<1	* 8	<1	*1*
Argentina	721	14	10	6	5	8	6	10	7	*3*
Armenia	31	29	1	16	<1	13	<1	17	1	*4*
Australia	246	6	1	3	1	3	1	3	1	*3, 5*
Austria	75	7	1	4	<1	2	<1	3	<1	*6*
Azerbaijan	150	58	9	32	5	* 27	4	36	5	*7*
Bahamas	6	11	<1	3	<1	8	<1	10	<1	*8*
Bahrain	14	19	<1	* 10	<1	* 9	<1	11	<1	*9, 10*
Bangladesh	4226	50	217	24	105	27	112	36	153	*11*
Barbados	3	17	<1	11	<1	6	<1	8	<1	*8, 12*
Belarus	87	9	1	6	1	3	<1	5	<1	*6*
Belgium	112	6	1	4	<1	2	<1	3	<1	*13*
Belize	7	33	<1	18	<1	16	<1	18	<1	*14*
Benin	265	67	19	* 37	10	31	8	38	10	*15*
Bhutan	73	40	3	* 22	2	18	1	38	3	*16*
Bolivia	257	31	8	11	3	20	5	27	7	*17*
Bosnia and Herzegovina	38	20	1	* 11	<1	9	<1	11	<1	*6*
Botswana	54	79	4	* 44	2	37	2	40	2	*18, 19*
Brazil	3474	20	69	8	27	12	42	15	51	*20*
Brunei Darussalam	8	9	<1	6	<1	3	<1	4	<1	*21*
Bulgaria	62	13	1	8	<1	5	<1	8	<1	*6*
Burkina Faso	580	54	32	* 30	18	25	14	36	21	*22*
Burundi	276	60	17	* 33	9	28	8	41	11	*23*
Cambodia	461	66	32	* 37	18	31	14	40	18	*24*
Cameroon	551	70	40	* 39	22	32	18	40	22	*25*
Canada	332	6	2	3	1	3	1	4	1	*3, 5*
Cape Verde	12	30	<1	22	<1	8	<1	10	<1	*26*
Central African Republic	143	81	12	*45	7	38	5	48	7	*227*
Chad	381	63	25	*35	14	29	11	45	17	*28*

a ° = country with population of less than 300 000.

b * = Estimate derived through regression and other estimation methods.

c See reference list.

Country name[a b]	Live births (000)	Perinatal mortality rate	No. of perinatal deaths (000)	Stillbirth rate	No. of stillbirths (000)	Early neonatal mortality rate	No. of early neonatal deaths (000)	Neonatal mortality rate	No. of neonatal deaths (000)	Data sources[c]
Channel Islands	2	-		-		-		-		-
Chile	288	8	2	4	1	4	1	6	2	*29*
China	19428	35	700	* 19	385	* 16	315	21	416	*30*
China, Hong Kong SAR	61	6	<1	4	<1	1	<1	2	<1	*3*
China, Macao SAR	5	4	<1	2	<1	2	<1	3	<1	*3*
Colombia	980	23	23	11	11	12	12	14	14	*31*
Comoros	27	48	1	* 26	1	22	1	29	1	*32*
Congo	153	52	8	* 29	4	* 24	4	* 32	5	*1*
Cook Islands[o]	<1	20	<1	* 11	<1	* 9	<1	* 12	<1	*1*
Costa Rica	79	13	1	8	1	6	<1	7	1	*3*
Côte d'Ivoire	573	96	58	* 53	32	44	25	65	37	*33, 34*
Croatia	49	9	<1	5	<1	4	<1	5	<1	*6*
Cuba	137	14	2	11	2	3	<1	4	1	*3*
Cyprus	10	7	<1	* 4	<1	* 3	<1	* 4	<1	*1*
Czech Republic	88	4	<1	3	<1	2	<1	2	<1	*6*
Dem. Rep. of the Congo	2463	76	195	* 42	108	* 35	86	* 47	116	*1, 35*
Dem. Rep. of Timor-Leste	19	65	1	* 36	1	* 30	1	* 40	1	*1*
Dem. People's Rep. of Korea	388	37	15	* 20	8	* 17	7	* 22	9	*1*
Denmark	65	8	1	5	<1	3	<1	4	<1	*6*
Djibouti	27	62	2	* 34	1	* 29	1	* 38	1	*1*
Dominica[o]	2	12	<1	* 7	<1	* 5	<1	* 7	<1	*1*
Dominican Republic	199	28	6	14	3	14	3	19	4	*36*
Ecuador	300	20	6	7	2	12	4	16	5	*37*
Egypt	1808	27	49	10	19	16	30	21	39	*38*
El Salvador	164	20	3	12	2	9	1	16	3	*39*
Equatorial Guinea	20	65	1	* 36	1	* 30	1	* 40	1	*1*
Eritrea	153	42	7	* 23	4	19	3	25	4	*40*
Estonia	12	9	<1	5	<1	4	<1	6	<1	*6*
Ethiopia	2865	57	168	20	58	38	110	51	147	*41*
Fiji	20	16	<1	9	<1	7	<1	9	<1	*8*
Finland	57	6	<1	4	<1	2	<1	2	<1	*6*
France	758	7	5	5	4	2	1	3	2	*6*
French Guiana	4	14	<1	* 7	<1	6	<1	8	<1	*3*
French Polynesia	5	-		-		-		-		-
Gabon	41	59	3	* 33	1	27	1	31	1	*42*
Gambia	49	79	4	* 44	2	37	2	46	2	*43, 44*
Georgia	57	42	2	23	1	* 19	1	25	1	*45*
Germany	749	6	4	4	3	2	2	3	2	*6*

a ° = country with population of less than 300 000.

b * = Estimate derived through regression and other estimation methods.

c See reference list.

Country name[a b]	Live births (000)	Perinatal mortality rate	No. of perinatal deaths (000)	Stillbirth rate	No. of stillbirths (000)	Early neonatal mortality rate	No. of early neonatal deaths (000)	Neonatal mortality rate	No. of neonatal deaths (000)	Data sources[c]
Ghana	645	45	29	19	12	26	17	27	18	*46*
Greece	101	8	1	5	1	3	<1	4	<1	*6*
Grenada[o]	2	21	<1	* 12	<1	* 10	<1	* 13	<1	*1*
Guadeloupe	7	9	<1	* 5	<1	4	<1	6	<1	*3*
Guam	3	7	<1	* 4	<1	3	<1	4	<1	*3*
Guatemala	406	23	9	9	4	14	6	19	8	*47*
Guinea	361	81	31	* 45	17	38	14	48	17	*48*
Guinea-Bissau	69	78	6	* 43	3	* 36	2	* 48	3	*1*
Guyana	17	40	1	* 22	<1	* 19	<1	* 25	<1	*1, 49*
Haiti	248	54	14	* 30	8	25	6	34	8	*50*
Honduras	204	28	6	15	3	13	3	18	4	*51*
Hungary	92	10	1	6	1	5	<1	6	1	*6*
Iceland	4	6	<1	5	<1	2	<1	2	<1	*6*
India	25780	70	1889	* 39	1049	33	840	43	1098	*52*
Indonesia	4564	30	141	* 17	77	14	63	18	82	*53*
Iran (Islamic Republic of)	1258	35	44	17	22	* 17	22	22	28	*54, 55*
Iraq	843	76	67	32	28	* 46	39	63	53	*56, 57*
Ireland	54	9	<1	6	<1	3	<1	4	<1	*6*
Israel	125	8	1	5	1	3	<1	4	<1	*6*
Italy	518	5	3	3	2	2	1	3	2	*6*
Jamaica	54	17	1	* 9	1	* 8	<1	* 10	1	*1, 58*
Japan	1196	7	8	5	6	1	2	2	2	*59*
Jordan	148	26	4	13	2	12	2	17	2	*60, 61*
Kazakhstan	257	57	15	29	8	29	7	32	8	*62, 63*
Kenya	1026	53	56	* 29	31	24	25	29	30	*64*
Kiribati[o]	2	44	<1	* 24	<1	* 20	<1	* 27	<1	*1*
Kuwait	48	11	1	6	<1	4	<1	6	<1	*10, 65*
Kyrgyzstan	110	57	6	32	4	26	3	31	3	*66*
Lao People's Dem. Republic	195	57	11	* 32	6	* 26	5	* 35	7	*1, 67*
Latvia	18	12	<1	8	<1	5	<1	7	<1	*6*
Lebanon	68	34	2	* 19	1	* 16	1	20	1	*68*
Lesotho	56	46	3	* 26	1	* 21	1	* 28	2	*1*
Liberia	145	104	16	* 58	9	48	7	66	10	*69, 70*
Libyan Arab Jamahiriya	121	19	2	* 11	1	* 9	1	11	1	*71*
Lithuania	31	10	<1	6	<1	3	<1	5	<1	*6*
Luxembourg	6	10	<1	7	<1	3	<1	4	<1	*6*
Madagascar	687	53	38	* 29	21	24	17	33	23	*72*
Malawi	526	43	23	13	7	30	16	40	21	*73*
Malaysia	549	7	4	3	2	4	2	5	3	*3*
Maldives	11	54	1	25	<1	30	<1	37	<1	*3*
Mali	596	51	31	12	7	40	24	55	33	*74*
Malta	5	8	<1	4	<1	4	<1	5	<1	*6*

Country name[a b]	Live births (000)	Perinatal mortality rate	No. of perinatal deaths (000)	Stillbirth rate	No. of stillbirths (000)	Early neonatal mortality rate	No. of early neonatal deaths (000)	Neonatal mortality rate	No. of neonatal deaths (000)	Data sources[c]
Marshall Islands[o]	1	43	<1	* 24	<1	* 20	<1	* 26	<1	*1*
Martinique	6	5	<1	* 3	<1	2	<1	3	<1	*3*
Mauritania	113	111	13	* 63	8	* 52	6	70	8	*75*
Mauritius	20	17	<1	9	<1	9	<1	12	<1	*3*
Mexico	2324	22	51	11	25	11	26	15	35	*3*
Micronesia (Fed. States of)	3	20	<1	* 11	<1	* 9	<1	* 12	<1	*1*
Monaco[o]	<1	7	<1	* 4	<1	* 2	<1	* 3	<1	*1*
Mongolia	58	46	3	* 25	2	21	1	26	1	*76*
Morocco	691	31	22	* 17	12	14	10	21	14	*77*
Mozambique	753	76	60	* 42	33	* 35	27	48	36	*78*
Myanmar	1194	65	81	* 36	45	* 30	36	40	48	*79, 80*
Namibia	67	46	3	* 26	2	21	1	25	2	*81*
Nauru[o]	<1	24	<1	* 13	<1	* 11	<1	* 14	<1	*1*
Nepal	805	51	42	23	19	29	23	40	32	*82*
Netherlands	195	8	2	5	1	3	1	4	1	*6*
Netherlands Antilles	3	-		-		-		-		-
New Caledonia	4	10	<1	5	<1	4	<1	6	<1	*3, 83*
New Zealand	54	6	<1	3	<1	3	<1	4	<1	*5, 3*
Nicaragua	170	23	4	11	2	13	2	18	3	*84*
Niger	599	56	35	* 31	19	26	16	43	26	*85*
Nigeria	4645	86	422	* 48	235	40	187	53	247	*86*
Niue[o]	<1	22	<1	* 12	<1	* 10	<1	* 13	<1	*1*
Norway	57	6	<1	4	<1	2	<1	3	<1	*6*
Oman	82	11	1	* 6	<1	* 5	<1	6	<1	*10, 87*
Pakistan	5230	59	318	22	118	38	200	57	298	*88, 89*
Palau[o]	1	23	<1	* 13	<1	* 10	<1	* 14	<1	*1*
Panama	69	15	1	8	1	8	1	11	1	*3*
Papua New Guinea	180	51	9	* 28	5	24	4	32	6	*90*
Paraguay	166	20	3	10	2	9	2	16	3	*91*
Peru	639	20	13	8	5	12	7	16	10	*92*
Philippines	2029	23	47	11	22	12	25	15	30	*90*
Poland	380	8	3	4	1	4	2	6	2	*6*
Portugal	113	8	1	6	1	3	<1	3	<1	*6*
Puerto Rico	57	11	1	6	<1	5	<1	7	<1	*3*
Qatar	12	11	<1	* 6	<1	* 5	<1	5	<1	*10*
Republic of Korea	597	5	3	2	1	2	1	3	2	*94*
Republic of Moldova	49	31	2	16	1	16	1	16	1	*6*
Réunion	14	14	<1	11	<1	3	<1	4	<1	*8*

a ° = country with population of less than 300 000.

b * = Estimate derived through regression and other estimation methods.

c See reference list.

Country name[a b]	Live births (000)	Perinatal mortality rate	No. of perinatal deaths (000)	Stillbirth rate	No. of stillbirths (000)	Early neonatal mortality rate	No. of early neonatal deaths (000)	Neonatal mortality rate	No. of neonatal deaths (000)	Data sources[c]
Romania	231	12	3	6	1	6	1	9	2	*6*
Russian Federation	1246	25	32	18	23	7	9	9	12	*6*
Rwanda	323	75	25	* 42	14	35	11	45	14	*95*
Saint Kitts and Nevis[o]	1	20	<1	* 11	<1	* 9	<1	* 12	<1	*1*
Saint Lucia	3	20	<1	12	<1	8	<1	10	<1	*3*
Saint Vincent and Grenadines	2	19	<1	* 10	<1	* 9	<1	* 11	<1	*1*
Samoa	5	21	<1	* 12	<1	* 10	<1	* 13	<1	*1*
San Marino[o]	<1	6	<1	* 4	<1	* 2	<1	* 2	<1	*1*
São Tomé and Principé	5	61	<1	* 34	<1	* 28	<1	* 38	<1	*1*
Saudi Arabia	718	21	15	* 11	8	* 10	7	12	8	*10*
Senegal	355	49	18	* 27	10	22	8	31	11	*96, 97*
Serbia and Montenegro	127	13	2	6	1	7	1	9	1	*6*
Seychelles[o]	1	15	<1	* 8	<1	* 7	<1	* 9	<1	*1*
Sierra Leone	225	90	21	* 50	12	* 42	9	* 56	13	*1*
Singapore	47	4	<1	3	<1	1	<1	1	<1	*3, 98*
Slovakia	55	7	<1	4	<1	4	<1	5	<1	*6*
Slovenia	17	7	<1	4	<1	3	<1	4	<1	*6*
Solomon Islands	15	20	<1	* 11	<1	* 9	<1	* 12	<1	*1*
Somalia	461	80	38	* 44	21	* 37	17	* 49	23	*1*
South Africa	1028	33	35	* 18	19	15	16	21	22	*99*
Spain	384	6	2	4	1	2	1	3	1	*6*
Sri Lanka	310	20	6	* 11	3	9	3	11	3	*100*
Sudan	1092	44	49	* 24	27	20	22	29	32	*101, 102*
Suriname	10	30	<1	* 16	<1	* 14	<1	* 18	<1	*1, 103*
Swaziland	38	61	2	* 34	1	* 28	1	* 38	1	*1, 104*
Sweden	88	5	<1	3	<1	2	<1	2	<1	*6*
Switzerland	68	6	<1	3	<1	3	<1	3	<1	*6*
Syrian Arab Republic	473	16	8	* 9	4	* 7	4	* 9	4	*1, 105*
Tajikistan	160	62	10	* 34	6	* 29	5	* 38	6	*1, 6*
TFYR Macedonia	29	16	<1	9	<1	7	<1	9	<1	*6*
Thailand	1082	20	22	* 11	12	9	10	13	14	*19, 106*
Togo	179	72	13	* 40	7	33	6	40	7	*107*
Tonga	3	18	<1	* 10	<1	* 8	<1	* 10	<1	*1*
Trinidad and Tobago	17	26	<1	16	<1	10	<1	13	<1	*3*
Tunisia	166	20	3	11	2	9	2	14	2	*19, 108*
Turkey	1495	36	55	17	26	19	29	22	33	*109*
Turkmenistan	105	39	4	13	1	26	3	35	4	*110*
Tuvalu[o]	<1	36	<1	* 20	<1	* 16	<1	* 22	<1	*1*
Uganda	1195	40	48	15	19	25	29	32	38	*111*
Ukraine	418	37	16	28	12	9	4	9	4	*6*

Country name[a b]	Live births (000)	Perinatal mortality rate	No. of perinatal deaths (000)	Stillbirth rate	No. of stillbirths (000)	Early neonatal mortality rate	No. of early neonatal deaths (000)	Neonatal mortality rate	No. of neonatal deaths (000)	Data sources[c]
United Arab Emirates	50	9	<1	* 5	<1	* 4	<1	5	<1	*112*
United Kingdom	681	8	6	5	4	3	2	4	3	*6*
United Republic of Tanzania	1423	69	101	* 38	56	32	45	43	62	*113*
United States of America	4146	7	31	4	15	4	16	5	20	*3, 114*
United States Virgin Islands	2	-		-		-		-		-
Uruguay	58	14	1	9	<1	5	<1	7	<1	*3*
Uzbekistan	567	46	27	25	15	21	12	27	15	*115*
Vanuatu	6	31	<1	* 17	<1	* 14	<1	* 19	<1	*1*
Venezuela	578	18	11	9	5	9	5	12	7	*3*
Viet Nam	1593	37	60	24	40	13	21	15	24	*116*
West Bank and Gaza Strip	129	-		-		-		-		-
Western Sahara	8	-		-		-		-		-
Yemen	820	44	37	* 17	14	27	22	37	30	*117*
Zambia	450	56	26	* 31	14	26	12	40	18	*118*
Zimbabwe	419	43	18	17	7	27	11	33	14	*119*

a ° = country with population of less than 300 000.

b * = Estimate derived through regression and other estimation methods.

c See reference list.

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Annex 2 Estimates by WHO region and subregion[a]

Table A2.1 Estimates of stillbirths, early neonatal, perinatal and neonatal mortality rates and numbers by WHO region and subregion, 2000

	Live births (000)	Stillbirth rate	No. of stillbirths (000)	Early neonatal mortality rate	No. of early neonatal deaths (000)	Perinatal mortality rate	No. of perinatal deaths (000)	Neonatal mortality rate	No. of neonatal deaths (000)
WHO Member States	**132624**	**24**	**3325**	**23**	**3005**	**47**	**6330**	**30**	**3997**
AFRO	**25915**	**34**	**918**	**33**	**845**	**66**	**1763**	**44**	**1128**
AFRO D	11930	39	487	34	405	72	892	45	540
AFRO E	13986	30	431	31	439	60	870	42	588
AMRO	**16066**	**8**	**127**	**9**	**151**	**17**	**279**	**12**	**195**
AMRO A	4614	4	17	4	18	8	35	5	22
AMRO B	9432	9	86	11	103	20	190	14	132
AMRO D	2020	12	24	15	30	26	54	20	41
EMRO	**15185**	**22**	**342**	**28**	**426**	**49**	**768**	**40**	**603**
EMRO B	3169	13	43	12	39	25	81	16	50
EMRO D	12016	24	299	32	388	56	687	46	553
EURO	**10238**	**12**	**128**	**9**	**94**	**21**	**222**	**11**	**116**
EURO A	4371	4	19	2	10	7	29	3	14
EURO B	3657	17	64	17	62	34	126	21	76
EURO C	2210	20	45	10	22	30	67	12	26
SEARO	**38452**	**33**	**1321**	**29**	**1096**	**61**	**2417**	**38**	**1443**
SEARO B	5956	15	93	13	76	28	169	17	99
SEARO D	32496	36	1228	31	1020	67	2247	41	1344
WPRO	**26766**	**18**	**489**	**15**	**392**	**32**	**881**	**19**	**512**
WPRO A	1551	5	7	2	3	6	10	2	4
WPRO B	25215	19	482	15	389	34	872	20	509

Figures may not add exactly to the total owing to rounding.

a WHO regions and mortality subregions are described in Section 6.4.2 and listed in Annex 9.

Table A2.2 Intrapartum stillbirth mortality for the year 2000 by WHO region and subregion[a]

	Live births (000)	Stillbirth rate	No. of stillbirths (000)	Intrapartum deaths as % of stillbirths	No. of intrapartum deaths (000)	Intrapartum mortality rate
WHO Member States	**132624**	**24**	**3325**	**34**	**1115**	**8**
AFRO	**25915**	**34**	**918**	**37**	**341**	**13**
AFRO D	11930	39	487	40	196	16
AFRO E	13986	30	431	34	145	10
AMRO	**16066**	**8**	**127**	**23**	**29**	**2**
AMRO A	4614	4	17	11	2	0.4
AMRO B	9432	9	86	24	21	2
AMRO D	2020	12	24	28	7	3
EMRO	**15185**	**22**	**342**	**34**	**115**	**7**
EMRO B	3169	13	43	24	10	3
EMRO D	12016	24	299	35	105	9
EURO	**10238**	**12**	**128**	**21**	**27**	**3**
EURO A	4371	4	19	10	2	0.5
EURO B	3657	17	64	29	18	5
EURO C	2210	20	45	15	7	3
SEARO	**38452**	**33**	**1321**	**36**	**477**	**12**
SEARO B	5956	15	93	24	22	4
SEARO D	32496	36	1228	37	454	13
WPRO	**26766**	**18**	**489**	**26**	**126**	**5**
WPRO A	1551	5	7	10	1	0.5
WPRO B	25215	19	482	26	125	5

Figures may not add exactly to the total owing to rounding.

a WHO regions and mortality subregions are described in Section 6.4.2 and listed in Annex 9.

Annex 3 Extract from the *International statistical classification of diseases and related health problems*, 10th revision (ICD-10) (1)

5.7 Standards and reporting requirements related to fetal, perinatal, neonatal and infant mortality

The following definitions have been adopted by the World Health Assembly in relation both to statistics amenable to international comparison and to reporting requirements for the data from which they are derived. The definitions adopted by the Health Assembly appear in Vol.1, pp.1233-38. For convenience, they are restated below.

5.7.1 Definitions

Live birth

Live birth is the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered liveborn.

Fetal death [deadborn fetus]

Fetal death is death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.

Birth weight

The first weight of the fetus or newborn obtained after birth.

For live births, birth weight should preferably be measured within the first hour of life before significant postnatal weight loss has occurred. While statistical tabulations include 500 g groupings for birth weight, weights should not be recorded in those groupings. The actual weight should be recorded to the degree of accuracy to which it is measured.

The definitions of “low”, “very low”, and “extremely low” birth weight do not constitute mutually exclusive categories. Below the set limits they are all-inclusive and therefore overlap (i.e. “low” includes “very low” and “extremely low”, while “very low” includes “extremely low”).

Low birth weight

Less than 2500 g (up to and including 2499 g).

Very low birth weight

Less than 1500 g (up to and including 1499 g).

Extremely low birth weight

Less than 1000 g (up to and including 999 g).

Gestational age

The duration of gestation is measured from the first day of the last normal menstrual period. Gestational age is expressed in completed days or completed weeks (e.g. events occurring 280 to 286 completed days after the onset of the last normal menstrual period are considered to have occurred at 40 weeks of gestation).

Gestational age is frequently a source of confusion, when calculations are based on menstrual dates. For the purposes of calculation of gestational age from the date of the first day of the last normal menstrual period and the date of delivery, it should be borne in mind that the first day is day zero and not day one; days 0-6 therefore correspond to "completed week zero"; days 7-13 to "completed week one"; and the 40th week of actual gestation is synonymous with "completed week 39". Where the date of the last normal menstrual period is not available, gestational age should be based on the best clinical estimate. In order to avoid misunderstanding, tabulations should indicate both weeks and days.

Pre-term

Less than 37 completed weeks (less than 259 days) of gestation.

Term

From 37 completed weeks to less than 42 completed weeks (259 to 293 days) of gestation.

Post-term

42 completed weeks or more (294 days or more) of gestation.

Perinatal period

The perinatal period commences at 22 completed weeks (154 days) of gestation (the time when birth weight is normally 500 g), and ends seven completed days after birth.

Neonatal period

The neonatal period commences at birth and ends 28 completed days after birth. Neonatal deaths (deaths among live births during the first 28 completed days of life) may be subdivided into early neonatal deaths, occurring during the first seven days of life, and late neonatal deaths, occurring after the seventh day but before 28 completed days of life.

Age at death during the first day of life (day zero) should be recorded in units of completed minutes or hours of life. For the second (day 1), third (day 2) and through 27 completed days of life, age at death should be recorded in days.

5.7.2 Reporting criteria

The legal requirements for the registration of fetal deaths and live births vary from country to country and even within countries. If possible, all fetuses and infants weighing at least 500 g at birth, whether alive or dead, should be included in the statistics. When information on birth weight is unavailable, the corresponding criteria for gestational age (22 completed weeks) or body length (25 cm crown-heel) should be used. The criteria for deciding whether an event has taken place within the perinatal period should be applied in the order: (1) birth weight, (2) gestational age, (3) crown-heel length. The inclusion of fetuses and infants weighing between 500 g and 1000 g in national statistics is recommended both because of its inherent value and because it improves the coverage of reporting at 1000 g and over.

5.7.3 Statistics for international comparison

In statistics for international comparison, inclusion of the extremely low-birth-weight group disrupts the validity of comparisons and is not recommended. Countries should arrange registration and reporting procedures so that the events and the criteria for their inclusion in the statistics can be easily identified. Less mature fetuses and infants not corresponding to these criteria (i.e. weighing less than 1000 g) should be excluded from perinatal statistics unless there are legal or other valid reasons to the contrary, in which case their inclusion must be explicitly stated. Where birth weight, gestational age and crown-heel length are not known, the event should be included in, rather than excluded from, mortality statistics of the perinatal period. Countries should also present statistics in which both the numerator and the denominator of all ratios and rates are restricted to fetuses

and infants weighing 1000 g or more (weight-specific ratios and rates); where information on birth weight is not available, the corresponding gestational age (28 completed weeks) or body length (35 cm crown-heel) should be used.

In reporting fetal, perinatal, neonatal and infant mortality statistics the number of deaths due to malformations should whenever possible be identified for live births and fetal deaths and in relation to birth weights of 500-999 g and 1000 g or more. Neonatal deaths due to malformations should be subdivided into early and late neonatal deaths. This information enables perinatal and neonatal mortality statistics to be reported with or without the deaths from malformations.

Ratios and rates

Published ratios and rates should always specify the denominator, i.e. live births or total births (live births plus fetal deaths). Countries are encouraged to provide the ratios and rates listed below, or as many of them as their data collection systems permit.

Fetal death ratio

$$\frac{\text{Fetal deaths}}{\text{Live births}} \times 1000$$

Fetal death rate

$$\frac{\text{Fetal deaths}}{\text{Total births}} \times 1000$$

Fetal death rate, weight-specific

$$\frac{\text{Fetal deaths weighing 1000g and over}}{\text{Total births weighing 1000 g and over}} \times 1000$$

Early neonatal mortality rate

$$\frac{\text{Early neonatal deaths}}{\text{Live births}} \times 1000$$

Early neonatal mortality rate, weight-specific

$$\frac{\text{Early neonatal deaths of infants weighing 1000 g and over at birth}}{\text{Live births weighing 1000 g and over}} \times 1000$$

Perinatal mortality ratio

$$\frac{\text{Fetal deaths and early neonatal deaths}}{\text{Live births}} \times 1000$$

Perinatal mortality rate

$$\frac{\text{Fetal deaths and early neonatal deaths}}{\text{Total births}} \times 1000$$

The perinatal mortality rate is the number of deaths of fetuses weighing at least 500 g (or, when birth weight is unavailable, after 22 completed weeks of gestation or with a crown-heel length of 25 cm or more), plus the number of early neonatal deaths, per 1000 total births. Because of the different denominators in each component, this is not necessarily equal to the sum of the fetal death rate and the early neonatal mortality rate.

Perinatal mortality rate, weight-specific

$$\frac{\text{Fetal deaths weighing 1000 g and over, plus early neonatal deaths of infants weighing 1000 g and over at birth}}{\text{Total births weighing 1000 g and over}} \times 1000$$

Neonatal mortality rate

$$\frac{\text{Neonatal deaths}}{\text{Live births}} \times 1000$$

Neonatal mortality rate, weight-specific

$$\frac{\text{Neonatal deaths of infants weighing 1000 g and over at birth}}{\text{Live births weighing 1000 g and over}} \times 1000$$

Infant mortality rate

$$\frac{\text{Deaths under one year of age}}{\text{Live births}} \times 1000$$

Infant mortality rate, weight-specific

$$\frac{\text{Infant deaths among live births weighing 1000 g and over at birth}}{\text{Live births weighing 1000 g and over}} \times 1000$$

5.7.4 Presentation of causes of perinatal mortality

For statistics of perinatal mortality derived from the form of certificate recommended for this purpose (see section 4.3.1), full-scale multiple-cause analysis of all conditions reported will be of greatest benefit. Where such analysis is impracticable, analysis of the main disease or condition in the fetus or infant (part (a)) and of the main maternal condition affecting the fetus or infant (part (c)) with cross-tabulation of groups of these two conditions should be regarded as the minimum. Where it is necessary to select only one condition (for example, when early neonatal deaths must be incorporated into single-cause tables of deaths at all ages), the main disease or condition in the fetus or infant (part (a)) should be selected.

Age classification for special statistics of infant mortality

(i) By single days for the first week of life (under 24 hours, 1, 2, 3, 4, 5, 6 days), 7-13 days, 14-20 days, 21-27 days, 28 days and up to, but not including, 2 months, by single months of life from 2 months to 1 year (2, 3, 4 ... 11 months).

(ii) Under 24 hours, 1-6 days, 7-27 days, 28 days up to, but not including, 3 months, 3-5 months, 6 months but under 1 year.

(iii) Under 7 days, 7-27 days, 28 days but under 1 year.

Age classification for early neonatal deaths

(i) Under 1 hour, 1-11 hours, 12-23 hours, 24-47 hours, 48-71 hours, 72-167 hours.

(ii) Under 1 hour, 1-23 hours, 24-167 hours.

Birth weight classification for perinatal mortality statistics

By weight intervals of 500 g, i.e. 1000-1499 g, etc.

Gestational age classification for perinatal mortality statistics

Under 28 weeks (under 196 days), 28-31 weeks (196-223 days), 32-36 weeks (224-258 days), 37-41 weeks (259-293 days), 42 weeks and over (294 days and over).

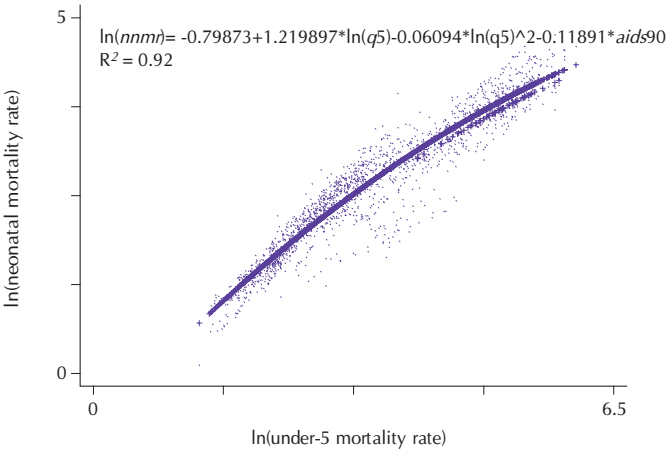
References

1 *International statistical classification of diseases and related health problems, 10th revision, Vol. 2, Instruction manual. Geneva, World Health Organization, 1993.*

Annex 4 Estimating neonatal and early neonatal mortality rates when data were not available

When data on neonatal and early neonatal mortality were not available, estimates were calculated using the regressions and ratios described in sections 5.2.1 and 5.2.2. The results are shown below.

Figure A4.1 Regression analysis of neonatal mortality with WHO under-five mortality estimates adjusted for AIDS prevalence[a]



nnmr = neonatal mortality rate *Number of observation: 1942*
q5 = under-five mortality rate

Figure A4.2 Regression analysis of early neonatal mortality with neonatal mortality using survey data

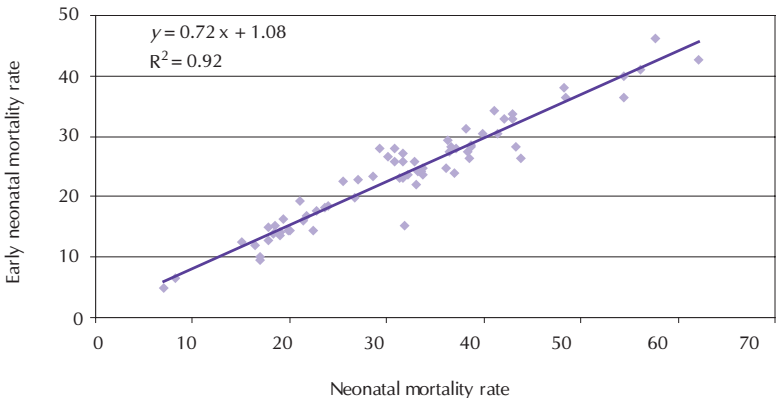
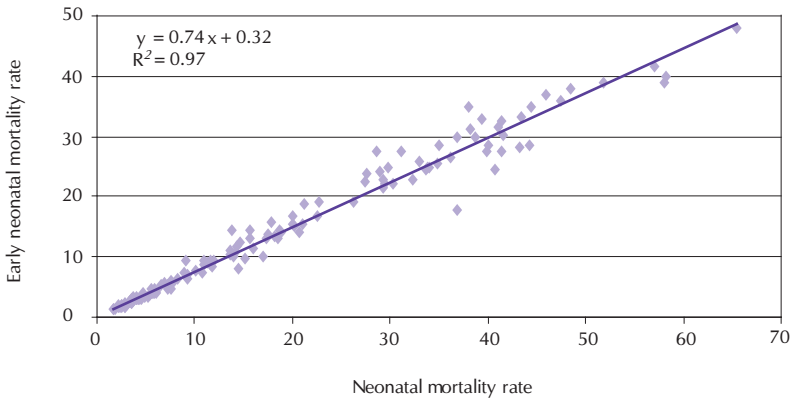


Figure A4.3 Regression analysis of early neonatal mortality with neonatal mortality, combining survey and registration data



a This regression was contributed by the Department of Measurement and Health Information Systems (MHI), Evidence and Information for Policy (EIP) at WHO.

Annex 5 Confidence intervals for neonatal and early neonatal mortality rates

Margins of error for the neonatal and early neonatal mortality estimates were calculated by country and aggregated to arrive at global rates and numbers displayed in Tables A5.1 and A5.2.

Most of the neonatal rates were derived from empirical data (see Table A5.1). Estimates were then calculated in two ways: by adjusting reported rates to WHO under-five mortality estimates or from regression equations (adjusted to WHO under-five mortality estimates). The confidence intervals were calculated as described below.

A5.1 Confidence interval of neonatal and early neonatal mortality rates adjusted to WHO under-five mortality estimates

For rates available from the estimation dataset and adjusted only to WHO under-five mortality, the confidence interval was calculated assuming a binominal distribution:

$$P \pm 2\ SE\ (P^n)$$

where:

$P^n = n/N$

$SE(P^n) = \sqrt{P^n (1 - P^n)/N}$

N is the number of births and n the number of deaths.

It was assumed that the interval around the adjusted mortality rate was the same as the rate of the estimation dataset. For three countries, the confidence interval could not be calculated, as the number of births and/or deaths was not available.

A5.2 Confidence interval of early neonatal mortality rates calculated from regression equations

When early neonatal mortality rates were calculated from regression equations (see Figures A4.2 and A4.3 in Annex 4) the upper and lower bounds of the estimate were arrived at using the regression equations for the upper and lower limits. The equation for the lower regression point is:

$$y_L = b_{0L} + b_{1L} * x$$

where:

y_L is the lower estimated mortality rate

b_{0L} is the lower intercept

b_{1L} is the lower slope

x is the mortality rate from which to estimate.

A5.3 Confidence interval of neonatal mortality rates calculated from regression equations[a]

When neonatal mortality was regressed from WHO under-five mortality estimates, adjusted for AIDS prevalence (Figure A4.1 in Annex 4), the confidence interval around the regressed rates was then calculated, taking both the uncertainty of the regression and the under-five estimate into account. The equation is as follows:

$$SD_{nnmr} = \sqrt{SD_{q5}^2 + SD_{prop}^2}$$

where SD_{45} is the standard deviation of the estimated *q5* and SD_{prop} is the standard deviation of the proportion *prop* defined as *prop* = *nnmr*/*q5.* For , the uncertainty range of the *q5* estimates is taken as a proxy of the confidence interval and the methodology discussed in another paper *(1).*

a Contributed by the Department of Measurement and Health Information Systems (MHI), Evidence and Information for Policy (EIP) at WHO.

The regression gives a standard deviation (SD_{lnnmr}) for each prediction of ln(*nnmr*). From this, it is possible to derive an approximation of the confidence interval for *prop* as described below. The standard deviation confidence interval expressed as ($lower_{prop}$, $upper_{prop}$). ($lower_{prop}$, $upper_{prop}$) is derived from the following:

$lnlower_{prop} = \ln(nnmr) - SD_{lnnmr} - \ln(q5)$

$\Rightarrow lower_{prop} = \exp(lnlower_{prop}) = \exp(\ln(nnmr) - SD_{lnnmr} - \ln(q5))$.

Similarly, if $lnupper_{prop} = \ln(nnmr) + SD_{lnnmr} - \ln(q5)$,

$\Rightarrow upper_{prop} = \exp(lnupper_{prop}) = \exp(\ln(nnmr) + SD_{lnnmr} - \ln(q5))$.

Then SD_{prop} can be approximated by $(upper_{prop} + lower_{prop})/2$.

References

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Table A5.1 Neonatal and early neonatal mortality rates and numbers with their upper and lower bounds by United Nations geographical region

	Early neonatal mortality rate			No. of early neonatal deaths (000)			Neonatal mortality rate			No. of neonatal deaths (000)		
	Rate	Lower bound	Upper bound	No.	Lower bound	Upper bound	Rate	Lower bound	Upper bound	No.	Lower bound	Upper bound
WORLD	**23**	**20**	**26**	**3008**	**2624**	**3401**	**30**	**26**	**34**	**4002**	**3435**	**4563**
More developed regions *	4	4	4	50	47	52	5	5	5	63	61	66
Less developed regions	25	22	28	2959	2576	3349	33	28	38	3938	3375	4497
AFRICA	**31**	**26**	**35**	**927**	**801**	**1052**	**41**	**33**	**49**	**1240**	**991**	**1489**
Eastern Africa	31	27	35	333	288	377	42	36	47	443	382	504
Middle Africa	35	32	37	152	141	163	46	25	68	204	109	298
Northern Africa	16	13	20	75	59	92	22	18	27	103	82	123
Southern Africa	17	14	20	21	17	25	23	18	28	28	23	34
Western Africa	37	32	42	345	297	394	49	42	56	463	395	530
ASIA*	**24**	**21**	**28**	**1892**	**1661**	**2131**	**32**	**29**	**36**	**2517**	**2233**	**2797**
Eastern Asia *	16	13	19	324	270	392	21	19	22	428	398	457
South-central Asia	32	29	35	1278	1156	1398	43	38	48	1716	1522	1910
South-eastern Asia	15	12	18	177	143	211	19	16	23	227	187	267
Western Asia	21	17	25	113	92	130	28	24	31	146	127	163
EUROPE	**4**	**4**	**4**	**30**	**28**	**32**	**5**	**5**	**6**	**38**	**36**	**40**
Eastern Europe	7	6	7	18	17	19	8	8	9	22	22	23
Northern Europe	3	2	3	3	3	3	4	3	4	4	4	4
Southern Europe	3	3	4	5	4	5	4	4	5	6	6	7
Western Europe	2	2	2	4	4	5	3	3	3	6	5	6
LATIN AMERICA AND CARIBBEAN	**12**	**9**	**14**	**135**	**110**	**160**	**15**	**13**	**17**	**175**	**146**	**203**
Caribbean	14	11	17	11	9	13	19	16	22	14	12	17
Central America	11	11	12	39	36	43	16	14	17	53	50	57
South America	11	9	14	85	65	104	14	11	17	107	85	129
NORTHERN AMERICA	**4**	**4**	**4**	**17**	**17**	**18**	**5**	**5**	**5**	**21**	**21**	**22**
OCEANIA *	**19**	**14**	**24**	**5**	**4**	**6**	**26**	**20**	**32**	**7**	**5**	**8**
Australia/New Zealand	3	2	3	1	1	1	3	3	4	1	1	1
Melanesia	21	15	26	5	3	6	28	21	35	6	5	8
Micronesia	6	5	7	0.1	0.1	0.1	8	4	11	0.1	0.1	0.1
Polynesia	9	8	10	0.1	0.1	0.2	12	8	16	0.2	0.1	0.2

Figures may not add exactly to the total owing to rounding.

* Australia/New Zealand and Japan have been excluded from the regional estimates but are included in the total for developed countries.

Table A5.2 Neonatal and early neonatal mortality rates and numbers with their upper and lower bounds by WHO region and subregion[a]

	Early neonatal mortality rate			No. early neonatal deaths (000)			Neonatal mortality rate			No. neonatal deaths (000)		
	Rate	Lower bound	Upper bound	No.	Lower bound	Upper bound	Rate	Lower bound	Upper bound	No.	Lower bound	Upper bound
WHO Member States	**23**	**20**	**26**	**3005**	**2621**	**3398**	**30**	**26**	**34**	**3997**	**3428**	**4553**
AFRO	**33**	**28**	**37**	**845**	**733**	**953**	**44**	**35**	**52**	**1128**	**905**	**1345**
AFRO D	34	29	39	405	348	460	45	37	53	540	440	635
AFRO E	31	28	35	439	386	493	42	33	51	588	465	710
AMRO	**9**	**8**	**11**	**151**	**127**	**177**	**12**	**10**	**14**	**195**	**167**	**224**
AMRO A	4	4	4	18	17	18	5	5	5	22	21	22
AMRO B	11	9	13	103	85	122	14	12	16	132	111	154
AMRO D	15	12	18	30	24	36	20	17	24	41	34	48
EMRO	**28**	**24**	**32**	**426**	**360**	**493**	**40**	**31**	**48**	**603**	**466**	**736**
EMRO B	12	10	15	39	30	48	16	12	18	50	39	58
EMRO D	32	27	37	388	330	445	46	36	56	553	427	678
EURO	**9**	**7**	**11**	**94**	**76**	**112**	**11**	**9**	**13**	**116**	**92**	**137**
EURO A	2	2	3	10	9	11	3	3	3	14	13	15
EURO B	17	13	21	62	48	77	21	15	26	76	57	94
EURO C	10	9	11	22	19	25	12	10	13	26	23	28
SEARO	**29**	**26**	**31**	**1096**	**1004**	**1188**	**38**	**35**	**40**	**1443**	**1328**	**1556**
SEARO B	13	10	15	76	62	91	17	14	19	99	82	116
SEARO D	31	29	34	1020	942	1097	41	38	44	1344	1246	1440
WPRO	**15**	**12**	**18**	**392**	**321**	**476**	**19**	**18**	**21**	**512**	**470**	**554**
WPRO A	2	2	2	3	2	3	2	2	2	4	3	4
WPRO B	15	13	19	389	319	474	20	19	22	509	467	550

Figures may not add exactly to the total owing to rounding.

a WHO regions and mortality subregions are described in Section 6.4.2 and listed in Annex 9.

Annex 6 Estimating stillbirth rates when data were not available

Data on stillbirth rates (SBR) for developing countries are limited, especially for settings with high values of other early mortality indicators. Stillbirths are also more prone to underreporting than other mortality indicators. Stillbirth data were available for 102 of the 192 countries with populations above 300 000 used to calculate global estimates.

Stillbirth rates for the 90 countries lacking the relevant data had to be estimated using a different method from that used to estimate neonatal and early neonatal mortality rates (ENMR), which used regression with other mortality rates (see Annex 4). The estimation of stillbirth takes into account the comments made by reviewers of an earlier step-by-step description of different approaches to stillbirth estimation, including regression analysis *(1)*.

The following review will explore the relationship between SBR and ENMR by WHO mortality strata and regions. WHO subdivides each of its regions into mortality strata, defined by adult and child mortality levels (see Annex 9).

A6.1 Calculating average SBR/ENMR ratios for WHO mortality strata[a] and subregions using current data

The average ratio between stillbirth and early neonatal mortality (SBR/ENMR) was calculated for each of the 14 WHO mortality subregions, using data from 106 countries that could provide both stillbirth and early neonatal mortality rates.[b] This approach assumed that the SBR/ENMR ratio was similar for countries of the same mortality subregion. This ratio is set out in Table A6.1, column 2.

Table A6.1 Mean stillbirth/early neonatal mortality ratios by WHO mortality regions

WHO regions and mortality strata	Mean SBR/ENMR ratio	No. of countries for calculating regional averages
EURO C	1.7	9
WPRO B	1.2	6
SEARO B	-	-
EURO B	1.2	13
EMRO B	1.2	3
AMRO B	1.3	21
AFRO D and E	1.0	9
AMRO D	0.7	5
EMRO D	0.6	3
SEARO D	0.8	3
Number of countries with paired data		106

a For the list of countries by WHO regions and mortality strata, see Annex 9.

b For 102 countries, pairs of national stillbirth and early neonatal mortality rates were available in the dataset. In addition, four pairs of data were used for countries (Albania, Guyana, Jamaica, Tajikistan) that did not meet WHO standards for civil registration reporting, but did have national SBR and ENMR, on the assumption that the relationship between the rates would remain constant. In all, this provided 106 sets of paired data.

The table shows that the SBR/ENMR ratios in strata A and C are 1.9 and 1.7, respectively. These ratios show that technical advances will help secure the survival of the newborn, while stillbirths, even in developing countries, remain a challenge in improving birth outcomes. In the B stratum, the observed average SBR/ENMR ratio was around 1.2 in four of the five mortality subregions, the exception being SEARO B, which consists of only three countries, none of which had any SBR data. The average ratio in the B stratum was 1.2.

We should now consider the lower limit of the SBR/ENMR ratio. For strata D and E, the calculated SBR/ENMR ratios were much lower than those found in strata A, B and C. Stillbirth data were available for only nine countries in the African Region, all in the high-mortality strata D or E. The mortality subregions AFRO D and AFRO E were therefore combined to calculate the mean SBR/ENMR ratio of 1 for the nine countries. The SBR/ENMR ratios in all the other D mortality subregions were below 1, indicating that SBR were lower than ENMR, and in each instance based on data from only a few countries.

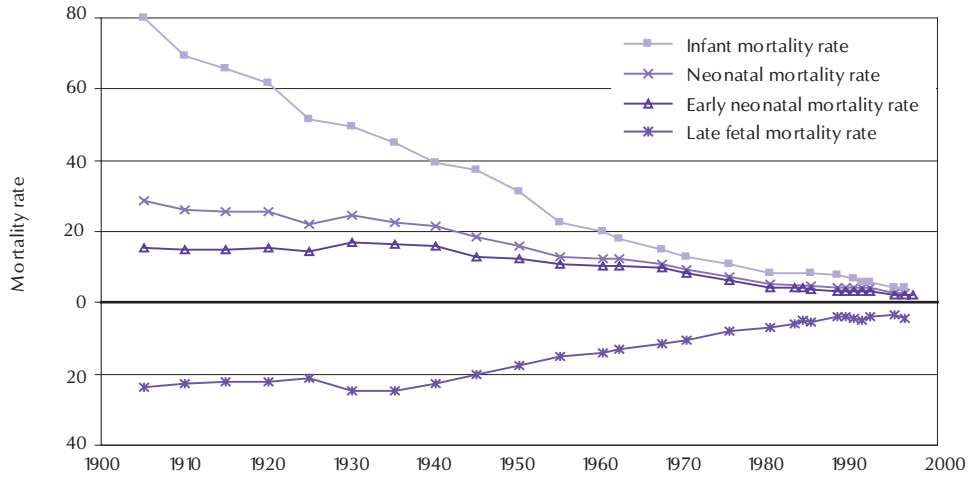
Perinatal epidemiology indicates that stillbirths at least equal, and more likely exceed, early neonatal deaths *(2)*. A thorough investigation of the literature gave no guidance on ways of adjusting low survey stillbirth data in order to align them with epidemiology. The difference between strata is assumed to be the result of underreporting: it is well known that the earlier the death, the higher the underreporting, and stillbirths are underreported more than live births *(3, 4)*. However, it is not clear why the underreporting of stillbirths would be more pronounced in the high-mortality regions (strata D and E) than in stratum B. This could be due to different perceptions of what a stillbirth or a miscarriage is. No validation studies were found on the accuracy of recalling stillbirths in different parts of the world.

In view of the poor data availability for strata D and E and because of inconsistency with perinatal epidemiology, the SBR/ENMR ratio of 1.2 identified for the developing country stratum B was applied, validated by comparison with long-term retrospective data available from the reproductive health database maintained until 2000 in the Department of Reproductive Health and Research at WHO.

A6.2 Exploring SBR/ENMR ratios in retrospective data

The mortality rates in developed countries at the beginning of the last century were similar to those of developing countries around 1995. This is illustrated in Figure A6.1 below, which shows the relationship between early mortality indicators (infant mortality, neonatal mortality and stillbirth rates) over 100 years in Norway and illustrates the changes in stillbirth and early neonatal mortality rates in the country's transition from a high-mortality to a low-mortality scenario *(5)*. Similar patterns were observed in other countries *(6, 7, 8, 9)*. The figure shows SBR as consistently higher than ENMR.

Figure A6.1 Mortality rates in Norway over 100 years.



To analyse the historical pattern of SBR/ENMR ratios, we used long-term vital registration data from the following countries (the first year of data is in parentheses): Chile (1970) *(10, 11, 12, 13, 14, 15, 16, 17, 18, 19)*, Denmark (1901) *(6, 14, 20, 21, 22, 23, 24, 25, 26)*, England and Wales (1930) *(7, 14, 17, 26, 27, 28, 29)*, Hong Kong (1946) *(14, 17, 30, 31, 32, 33)*, Japan (1950) *(14, 17, 25, 34, 35, 36, 37, 38, 39, 40, 41)*, Mexico (1973) *(14, 17, 42, 43, 44, 45)*, the Netherlands (1920) *(8, 14, 17, 46, 47, 48)*, Norway (1900) *(5, 14, 17, 24, 26, 49, 50, 51, 52)*, Scotland (1939) *(2, 17, 53)*, Singapore (1950) *(14, 40, 54, 55, 56, 57, 58)*, *Sweden (1950) (23, 24, 26, 49, 59, 60, 61, 62, 63, 64)*, and the United States of America (1942) *(14, 25, 65, 66, 67, 68, 69, 70, 71)*. This approach was based on the assumption that high-mortality developing countries currently show a pattern of SBR/ENMR similar to that observed in longitudinal data from countries that have moved from a high to a low/moderate mortality.

First of all, longitudinal national early neonatal and stillbirth data from all the above-mentioned countries was used *(1)* to calculate a regression of SBRs with ENMRs. This calculation, for the period 1900-95, gave a regression line with a slope of 1.3 and an R^2 of 0.79. For selected countries with reliable recording systems and similar pregnancy care indicators (Denmark, England and Wales, Netherlands, Norway, Scotland and Sweden) the slope was 1.4 and the R^2 0.92. Direct applicability to developing countries could not be demonstrated,[c] although these relationships show that SBR/ENM ratios well over 1 are indicated by historical evidence.

We further examined the full dataset, as well as two subsets: focusing on data before 1950[d] for all countries and for selected countries,[e] determining the mean, the median and the range of data for different ENMR levels (see Table A6.2). When the ENMR was above 10/1000 births, the SBR/ENMR ratio essentially varied between 1 and 1.5, with the odd exception; when the ENMR was below 10/1000 births SBR/ENMR ratios above 1.5 were observed, similar to current low mortality strata A and C. The mean and the median varied between 1.2 and 1.5 in the different scenarios. At an ENMR level above 20, common in developing-country scenarios, the median points to a SBR/ENMR of 1.2.

Table A6.2 SBR/ENMR ratio at different early neonatal mortality levels from different sources and long-term data series

Early neonatal mortality rate	All long-term data in ENMR range, all countries, *all years*[i] Average; median; (range)	1900-50 long-term data series, *all*[ii] countries. Average; median; (range)	1900-50 long-term data series, *selected*[iii] countries. Average; median; (range)	France (1853 and 1913)
25-	-	-	-	1.4
20-24	1.4; **1.2;** (0.9-1.9)	1.4; **1.2;** (0.9-1.9)	1.5; **1.5;** (1.2-1.9)	-
15-19	1.3; 1.4; (0.8-1.6)	1.4; 1.4; (0.9-1.6)	1.4; 1.4; (1.0-1.6)	2.7
10-14	1.3; 1.3; (0.7-2.6)	1.5; 1.5; (1.4-1.7)	1.4; 1.5; (1.2-1.6)	-

i Most recent entries: Chile 1974, Mexico 1982.

ii Denmark, England, Hong Kong, the Netherlands, Norway, Scotland, Singapore, Sweden and USA.

iii Denmark, England, Netherlands, Norway, Scotland and Sweden.

A review of data from France *(72)* (see Table A6.2, column 5), which showed an SBR/ENMR for ENMR above 25 for 1853, showed that an SBR/ENMR ratio below 1 is probably not accurate for strata D and E countries today. In that year in France, 930 000 births were reported, and the SBR and ENMR were 34/1000 and 28/1000 respectively, giving a SBR/ENMR ratio of 1.4. The same

c Since the longitudinal data included few datapoints where the ENMR was above 30/1000 births – values often still registered nowadays in D and E strata – it was not considered appropriate to use these historical data to estimate stillbirths in the high-mortality countries in strata D and E. Moreover, the relationship between early neonatal mortality and stillbirth in countries with high neonatal mortality could be different from that observed in this historical dataset.

d This period was chosen because at that time many births took place at home, little special technology that would affect early neonatal survival was available, caesarean section rates were low, and antibiotics were not yet used widely in obstetrics and neonatology. After 1950, the rapid institutionalization of birth began to shift the patterns of maternal and neonatal mortality. This period better reflects the level of care and of maternal, early neonatal and neonatal mortality now prevailing in countries of strata D and E.

e Denmark, England, Netherlands, Norway, Scotland and Sweden.

source reported data for the year 1913. Then, for almost 700 000 births, the SBR was 42/1000 and the ENMR 15/1000 – hence an SBR/ENMR ratio of 2.7 – far above those currently reported in surveys in high-mortality settings.

On the basis of the various reviews, we cannot determine the exact SBR/ENMR ratio for high ENMR levels in strata D and E in 2000. However, we are confident that the SBR/ENMR ratio is 1.2 or higher at ENMRs above 20, although we cannot determine exactly by how much.

A6.3 Estimating SBR/ENMR ratios when data is not available

It was decided to apply SBR/ENMR ratios by WHO mortality strata to estimate SBR when data were not available. In conclusion, it was decided:

1. To apply the unweighted average SBR/ENMR ratios by strata to strata A, B and C, as described below.
   (a) SBRs are available in strata A and C for all countries with a population over 300 000 (used to calculate global rates) and there was no need for estimation. However, the average SBR/ENMR ratios for those strata were used to calculate the SBRs for a few WHO Member States with smaller populations that did not have stillbirth data.
   (b) In view of the closeness of estimates for the subregions of stratum B, an average SBR/ENMR ratio of 1.2 was calculated for the stratum and applied to countries that did not have stillbirth data.
2. For countries in strata D and E it was decided to proceed as follows:
   (a) For the 47 countries in Strata D and E with no SBR data, it was decided to use a ratio of 1.2 to calculate SBRs from ENMRs in order to arrive at estimates for the year 2000. Although there is evidence to support a higher ratio of 1.3 or 1.4, it was considered prudent to be conservative when estimating stillbirths in the absence of strong evidence. The ratio of 1.2 corresponds to the lowest of the A, B and C strata; it is also the lowest median SBR/ENMR ratio found in the longitudinal data.
   (b) For the 20 countries in strata D and E that have data on SBR, we used the SBR reported for those countries, even when they appeared to be underestimates.

The SBR/ENMR ratios that are used to estimate stillbirth rates when no data were reported in countries are summarized in Table A6.3 below.

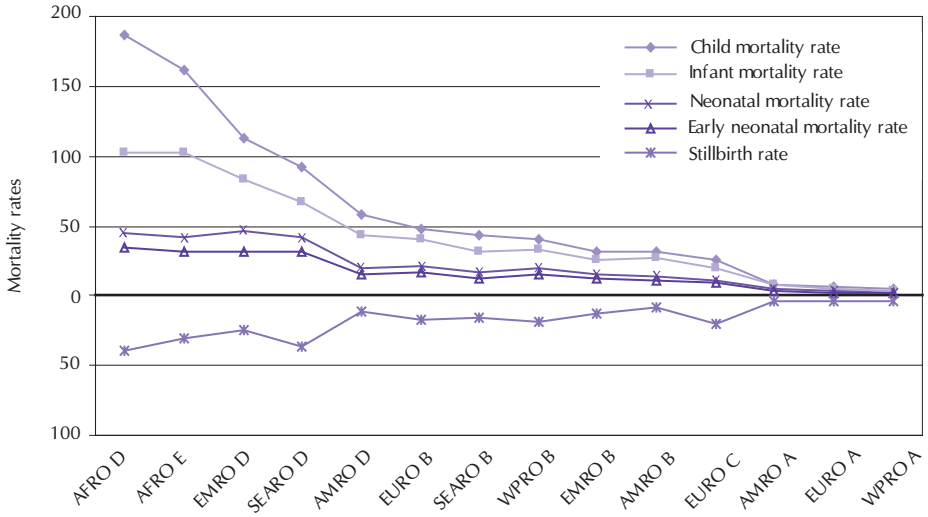
Table A6.3 SBR/ENMR ratios to estimate stillbirth rates for countries with no data

WHO mortality strata	SBR/ENMR ratio
Stratum A	1.9
Stratum B	1.2
Stratum C	1.7
Stratum D	1.2
Stratum E	1.2

Result

Using the methodology described above, we estimated that there were over 3.3 million stillbirths (24/1000 total births) in the year 2000; there were 84 000 (6/1000) stillbirths in developed and 3.2 million (26/1000) in developing countries. Figure A6.2 shows the relationship of SBR with infant and child mortality rates by WHO mortality subregion. A comparison with Figure A6.1 is instructive here.

Figure A6.2 Mortality rates by WHO subregion, 2000



Concluding remarks

The current methodology is likely to provide conservative estimates of SBRs for countries lacking this type of data. For a number of countries in the D and E strata (38% of all births), for which data were not available, we estimated stillbirths using the SBR/ENMR ratio of 1.2. Therefore global estimates are also conservative. However, some reported data from D and E countries were also low, contributing to the overall low stillbirth rates.

As long as national SBR data are weak, global and regional stillbirth estimates will remain weak compared with neonatal mortality and early neonatal mortality estimates. If we are to obtain better stillbirth estimates, the reporting of stillbirth data at the country level must improve and must become more reliable.

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Annex 7 Estimating intrapartum stillbirth rates

Intrapartum stillbirth deaths can be reduced with good obstetric care. We therefore investigated the distribution of antepartum and intrapartum stillbirths, to estimate the proportion of stillbirths that occur during delivery. A search of a departmental reproductive health database (RMN) and the PubMed database of the National Library of Medicine identified 92 populations with data, but only 53 were retained for the analysis.

For inclusion in the review, we focused on the number of births, ensuring that the populations were representative and aiming for national or large studies with well over 1000 births. Data came mostly from hospitals, but also from community studies, one of which had the smallest sample size of 1615 births. Births were reported as a set of consecutive births or birth weights 500g+. Most of the studies were in the tens of thousands, and several above 100 000.

The criteria for excluding studies were e.g. overlapping data, duplicated data, small or specialized studies, referrals only, or other restrictions on the data.

The methodology is based on the assumption that the distribution of antepartum and intrapartum deaths varies between developed and developing countries, and also according to the level of the stillbirth rate. In brief, data were grouped for developed and developing countries; the latter were further divided according to whether the reported stillbirth rate was above or below 20 per 1000 births. The 22 countries with a stillbirth rate of over 20 were mainly represented by WHO mortality strata[1] D and E; only four were from stratum B; in the grouping below 20, all but one (Singapore) belonged to stratum B; one country came from stratum C, all others were from stratum A in the developed-country category.

The mean proportion of antepartum deaths to stillbirth deaths, as a percentage, was calculated for the three groupings (see Table A7.1 below). These proportions were then applied to the estimated stillbirth rates by country, according to the level of the stillbirth rate. Finally, the regional and global rates and numbers of antepartum and intrapartum deaths were calculated. The results are presented in Section 7, Table 7.1, and discussed in Section 7.3.

Table A7.1 Antepartum deaths as a percentage of stillbirths in developed and developing countries

	Developing countries		Developed countries
	Stillbirth rate >20 per 1000 births	Stillbirth rate <20 per 1000 births	Stillbirth rate <10 per 1000 births
Mean	63	76	90
95% CI	7	5	3
Number of data points	22	17	14

CI = confidence interval.

a The WHO mortality strata are described in Annex 9, Section A9.2.

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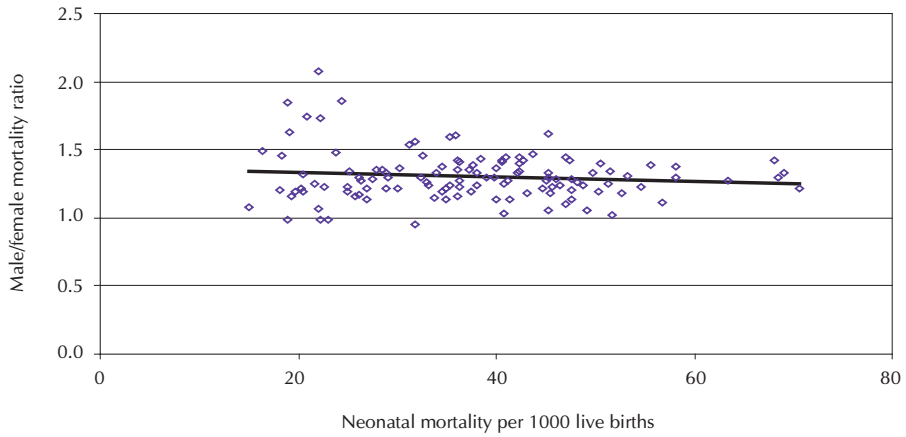
Annex 8 Male-to-female ratio in neonatal, early neonatal and stillbirth mortality

To investigate the sex differential in early mortality, we first analysed male-to-female (M/F) ratios in under-five, infant and neonatal data from the Demographic and Health Surveys (DHS). The data were extracted in February 2004, using the DHS STAT compiler[1]. Data were available from 121 surveys for the 10-year period preceding the surveys. Results showed that the median and the mean coincided in each of the three relationships between mortality rate and M/F ratio. The M/F ratios remained constant at all levels of the mortality rate for the three indicators, with the R^2 of the relationship at, or close to, 0. Here we will focus on neonatal mortality. For neonatal mortality, the ratio varied at low neonatal mortality rates around 20, the trendline through the data points was horizontal and the mean and median were both 1.3 (see Figure A8.1).

Figure A8.1 Regression of neonatal mortality with the corresponding male-to-female mortality ratio for 121 developing-country surveys

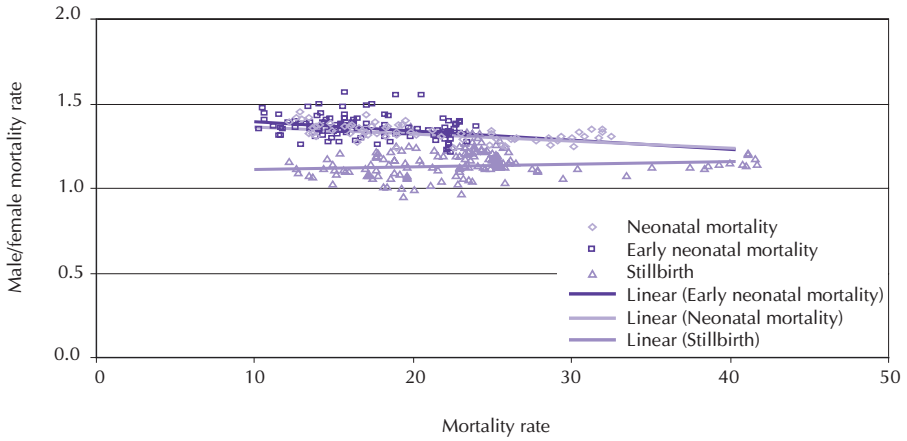


Source: MEASURE DHS STATcompiler, 2004

However, demographic health surveys do not report sex-specific early neonatal mortality or stillbirth rates. An analysis was therefore carried out using sex-specific retrospective data available from a few developed countries (Denmark, England and Wales, Netherlands, Norway, and Scotland) for periods of the 20th century before 1960 *(1, 2, 3, 4, 5)*. This analysis also showed the mean and median of the M/F ratios to coincide, the trendlines through their respective data points were horizontal and therefore the M/F ratios remained quite constant at all levels of the mortality rates with each R at or close to 0 (see Figure A8.2). The male-to-female ratios were 1.3 for neonatal mortality, 1.35 for early neonatal mortality and 1.1 for stillbirths.

a The STAT compiler from MEASURE DHS (http://www.measuredhs.com) is an online tool that allows the user to create customized tables from DHS surveys and indicators.

Figure A8.2 Regression of neonatal, early neonatal and stillbirth mortality with the corresponding male-to-female mortality ratio



Source: Retrospective data, references below.

The male-to-female ratio for neonatal mortality estimated from the retrospective dataset of 1.3 is thus of the same magnitude as the ratio estimated from DHS data. We therefore assume the historical early neonatal and stillbirth ratios of 1.3 and 1.1 respectively to be equally valid for today's developing countries. These results are discussed in Section 7.4.

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Annex 9 Countries and territories grouped by United Nations and WHO regions

A9.1 United Nations country listing by level of development and geographical region

Level of development

More developed regions

Northern America, Europe, Japan, Australia and New Zealand.

Less developed regions

Africa, Americas excluding Canada and United States of America in Northern America, Caribbean, Central America, South America, Asia excluding Japan, Oceania excluding Australia and New Zealand.

Least developed countries

Africa
Angola, Benin, Burkina Faso, Burundi, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, Sudan, Togo, Uganda, United Republic of Tanzania, Zambia.

Asia
Afghanistan, Bangladesh, Bhutan, Cambodia, Lao People's Democratic Republic, Maldives, Myanmar, Nepal, Timor-Leste, Yemen.

Caribbean
Haiti

Oceania
Kiribati, Samoa, Solomon Islands, Tuvalu, Vanuatu.

Geographical regions

Africa

Eastern Africa
Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Réunion, Rwanda, Seychelles, Somalia, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

Middle Africa
Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sao Tome and Principe.

Northern Africa
Algeria, Egypt, Libyan Arab Jamahiriya, Morocco, Sudan, Tunisia, Western Sahara.

Southern Africa
Botswana, Lesotho, Namibia, South Africa, Swaziland.

Western Africa
Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Saint Helena, Senegal, Sierra Leone, Togo.

Asia

Eastern Asia
China, Hong Kong Special Administrative Region, China, Macao Special Administrative Region, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea.

South-central Asia
Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Kazakhstan, Kyrgyzstan, Maldives, Nepal, Pakistan, Sri Lanka, Tajikistan, Turkmenistan, Uzbekistan.

South-eastern Asia
Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam.

Western Asia
Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Occupied Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, Yemen.

Europe

Eastern Europe
Belarus, Bulgaria, Czech Republic, Hungary, Poland, Republic of Moldova, Romania, Russian Federation, Slovakia, Ukraine.

Northern Europe
Channel Islands, Denmark, Estonia, Faeroe Islands, Finland, Iceland, Ireland, Isle of Man, Latvia, Lithuania, Norway, Svalbard and Jan Mayen Islands, Sweden, United Kingdom.

Southern Europe
Albania, Andorra, Bosnia and Herzegovina, Croatia, Gibraltar, Greece, Holy See, Italy, Malta, Portugal, San Marino, Slovenia, Spain, The former Yugoslav Republic of Macedonia, Yugoslavia.

Western Europe
Austria, Belgium, France, Germany, Liechtenstein, Luxembourg, Monaco, Netherlands, Switzerland.

Latin America and the Caribbean

Caribbean
Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, British Virgin Islands, Cayman Islands, Cuba, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Netherlands Antilles, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, Turks and Caicos Islands, United States Virgin Islands.

Central America
Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama.

South America
Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Falkland Islands (Malvinas), French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela.

Northern America

Bermuda, Canada, Greenland, Saint Pierre and Miquelon, United States of America.

Oceania

Australia and New Zealand
Australia, New Zealand, Norfolk Island.

Melanesia
Fiji, New Caledonia, Papua New Guinea, Solomon Islands, Vanuatu.

Micronesia
Guam, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, Northern Mariana Islands, Palau.

Polynesia
American Samoa, Cook Islands, French Polynesia, Niue, Pitcairn, Samoa, Tokelau, Tonga, Tuvalu, Wallis and Futuna Islands.

A9.2 Member States of the World Health Organization, by region and mortality stratum

WHO African Region

Stratum D[d] (AFRO D)
Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Comoros, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome and Principe, Seychelles, Sierra Leone, Togo.

Stratum E[e] (AFRO E)
Botswana, Burundi, Central African Republic, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

WHO Region of the Americas

Stratum A[a] (AMRO A)
Canada, Cuba, United States of America.

Stratum B[b] (AMRO B)
Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela.

Stratum D[d] (AMRO D)
Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru.

WHO Eastern Mediterranean Region

Stratum B[b] (EMRO B)
Bahrain, Iran (Islamic Republic of), Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates.

Stratum D[d] (EMRO D)
Afghanistan, Djibouti, Egypt, Iraq, Morocco, Pakistan, Somalia, Sudan, Yemen.

WHO European Region

Stratum A[a] (EURO A)
Andorra, Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, United Kingdom.

Stratum B[b] (EURO B)
Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Cyprus, Georgia, Kyrgyzstan, Poland, Romania, Serbia and Montenegro, Slovakia, Tajikistan, The former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan.

Stratum C[c] (EURO C)
Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine.

WHO South-East Asia Region

Stratum B[b] (SEARO B)
Indonesia, Sri Lanka, Thailand.

Stratum D[d] (SEARO D)
Bangladesh, Bhutan, Democratic People's Republic of Korea, Dem. Rep. of Timor-Leste, India, Maldives, Myanmar, Nepal.

WHO Western Pacific Region

Stratum A[a] (WPRO A)
Australia, Brunei Darussalam, Japan, New Zealand, Singapore.

Stratum B[b] (WPRO B)
Cambodia, China, Cook Islands, Fiji, Kiribati, Lao People's Democratic Republic, Malaysia, Marshall Islands, Micronesia (Federated States of), Mongolia, Nauru, Niue, Palau, Papua New Guinea, Philippines, Republic of Korea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Viet Nam.

a Mortality stratum A: very low child, very low adult mortality
b Mortality stratum B: low child, low adult mortality
c Mortality stratum C: low child, high adult mortality
d Mortality stratum D: high child, high adult mortality
e Mortality stratum E: high child, very high adult mortality