Stillbirth rates: delivering estimates in 190 countries

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Summary

Background While information about 4 million neonatal deaths worldwide is limited, even less information is available for stillbirths (babies born dead in the last 12 weeks of pregnancy) and there are no published, systematic global estimates. We sought to identify available data and use these to estimate the rates and numbers of stillbirths for 190 countries for the year 2000, and provide uncertainty estimates.

Methods We assessed three sources of stillbirth data according to specified inclusion criteria: vital registration; demographic and health surveys (DHS), based on a new analysis of contraceptive calendar data; and study reports that include published studies identified through systematic literature searches of more than 30 000 abstracts and unpublished studies. A random effects regression model was developed to predict national stillbirth rates and associated uncertainty intervals.

Findings Data from 44 countries with vital registration (71442 stillbirths), 30 DHS surveys from 16 countries (2989 stillbirths), and 249 study populations from 103 countries (93023 stillbirths) met the inclusion criteria. Model-based estimates were used for 128 countries. For 62 countries, the observed values were adjusted by a correction factor derived from the model. The resultant stillbirth rates ranged from five per 1000 in rich countries to 32 per 1000 in south Asia and sub-Saharan Africa. The estimated number of global stillbirths is 3·2 million (uncertainty range 2·5–4·1 million). In light of the data limitations and the conservative approach taken, the real number might be higher.

Interpretation The numbers of stillbirths are high and there is a dearth of usable data in countries and regions in which most stillbirths occur, with under-reporting being a major challenge. Although our estimates are probably underestimates, they represent a rigorous attempt to measure the numbers of babies dying during the last trimester of pregnancy. Improving stillbirth data is the first step towards making stillbirths count in public-health action.

Introduction Each year 10·6 million children die, yet most child deaths occur uncounted by national health-information systems. This dearth of data leaves the world “stumbling around in the dark” on many critical global-health issues. Until recently, most attempts to improve information about child deaths focused mainly on the postnatal period. Recognition that almost 40% of deaths in children younger than 5 years occur in the first month of life, and that 30% occur in just the first week, has increased global attention on the period immediately after birth. However, stillbirths are yet to be counted in global statistics or indeed in international health policy. Stillbirths are not reported in WHO’s routine mortality data or in most population-based surveys; they are not included in the Millennium Development Goals or in estimates of the global burden of disease. However, novel attempts are underway to develop methods to calculate disability adjusted life years for stillbirths.

There are various epidemiological, programmatic, and rights-based arguments for the measurement of stillbirths. First, counting all births—dead or alive—increases the probability of correctly recording all the important outcomes, including livebirths, stillbirths, and early neonatal deaths. Babies who die very soon after birth are less likely to be registered than are older babies who die, and stillbirths are even less likely to be recorded. Additionally, live-born babies who die early might be misclassified as stillbirths and vice versa for several reasons: lack of knowledge; lack of careful assessment for signs of life; avoidance of blame, extra work, or audit review for the birth attendant; or reasons of perceived gain or loss for the family. For example, the registration of a livebirth could encumber the family with funeral arrangements and costs, and the physician with extensive paperwork, whereas a stillbirth requires no funeral and less paperwork—differences that may promote misclassification towards stillbirths. If both stillbirths and early neonatal deaths are counted, then early neonatal deaths misclassified as stillbirths are at least recorded even if they are misclassified.

Second, decision-making for obstetric and neonatal health programmes might be misguided if monitoring does not include stillbirths. Data suggest that as obstetric care improves, intrapartum stillbirths might decline but early neonatal mortality could initially rise as babies survive birth but die soon after. Hence, if stillbirths are not counted in routine programme monitoring, assessment is incomplete.

Finally, prevention of stillbirths is important. The death of a baby during the last trimester of pregnancy is a source of pain to mothers and fathers, and indeed is reported to be associated with grief reactions more protracted than for early neonatal deaths, partly because of the social taboos associated with open grieving for a stillbirth. There are proven interventions used almost...
Stillbirth rates for 190 countries, applied to total births per country to get numbers of stillbirths

Methods

Data

We used data for stillbirth rates from three sources (figure 1). First, we used available vital registration data from 32 developed and 12 developing countries. We included only countries that reported 90% or greater completeness of recording of adult deaths. These countries consist of those reporting stillbirth data to the Council of Europe and those responding to our direct requests for data from vital registration offices (webtable). Second, we used demographic and health surveys (DHS) data from 30 surveys in 16 countries. We calculated stillbirth rates from DHS using data from the contraceptive calendar in the woman’s questionnaire. This module documents women’s monthly pregnancy and contraceptive use status for the 60-month period before interview, providing data intended primarily for

Universally in rich countries that do not reach enough women in the world’s poorest countries; unfortunately, invisibility contributes to inaction.

Historically, stillbirths and early neonatal deaths were grouped together as perinatal deaths. Perinatal epidemiologists are moving away from this practice. There are two major arguments for reporting stillbirths and neonatal deaths separately. First, there is much confusion over multiple definitions of perinatal mortality, which cover up to ten time periods depending on the definition of fetal deaths used (20, 22, 23, 24, or 28 weeks of gestation) and how much of the neonatal period is included (from early gestation to day seven, or all the gestation period to day 28). There is an absence of comparability even within Europe. Advances in neonatal care have pushed the bounds of fetal viability to around 23 weeks in industrialised countries, forcing changes in definitions of fetal death; however, these issues remain largely irrelevant in most countries with high mortality rates. For international comparison, WHO promotes the definition of stillbirth (or late fetal death) as death occurring at at least 28 weeks of gestation or at least 1000 g birthweight.12,28 We use stillbirth to mean babies born dead during the last trimester of pregnancy. A baby who dies 5 min after birth, or indeed who has a detectable heart rate at birth, counts (at least in principle) in the global estimates of child deaths. A baby who dies even in the process of birth does not count.8

Second, given that under-reporting is a bigger problem for stillbirths than for neonatal deaths,12 combination of the two measures continues to mask the data weakness and to perpetuate the scarcity of quality data available for stillbirth rates. There are few high-quality, population-based data for stillbirths even in industrialised countries,19 and the improved systems for collection of data indicate that stillbirth rates continue to be under-reported.20

WHO produced the first global estimates of perinatal mortality by region for 1983 and again by country for 1995,11 but neither report gave stillbirth rates at national or regional levels. For the first time, the World Health Report, 2005, included stillbirth rates for some countries and gave a global total of 3.3 million.21 Sources and methods are not yet available.

Global statistics groups and WHO are actively promoting a systematic and transparent approach to global estimates with “well-documented, preferably peer-reviewed, and published methods of estimation”.21 Four steps are recommended—accessible databases, transparent methods, an independent advisory group, and overall consistency through clearance procedures.21

We used vital registration, survey, and study-based data that met preset inclusion criteria to estimate stillbirth rates and the numbers of stillbirths with uncertainty estimates for 190 countries, for the year 2000, providing an accessible list of data inputs and applying transparent and replicable methods.

Figure 1: Overview of the identification and inclusion process for the vital registration, survey, and study-based data inputs included in the study
the study of contraceptive continuation. In this analysis, DHS stillbirth rates are defined as the number of pregnancy losses occurring during the seventh month or later of pregnancy for the 5 years preceding interview, divided by the sum of livebirths and pregnancy losses. Third, we used data from studies, mainly subnational, identified via a systematic review of the literature. We undertook systematic searches of the published work in multiple databases, including PubMed, Popline, LILACS, and WHO regional databases (Emro, African Index Medicus, PAHO). Search terms included multiple variants of stillbirth and fetal death, and were restricted to references published after 1980 and to those relating to human beings. No language restrictions were applied during the search. We also made extensive attempts to identify other non-English language publications and unpublished datasets.

Studies that met initial inclusion criteria (reporting stillbirth rate, or data allowing calculation of the rate) were excluded if the population was poorly defined, was specifically selected (for example diabetics or a particular ethnic group), or if they represented republication of a previously included dataset. 33 714 articles were screened, but only 249 study populations met the final inclusion criteria. Included studies were abstracted into a standard database by one investigator and then checked by another. Abstraction from five languages other than English needed additional abstractors. Data abstracted included: stillbirth rate; study variables such as country, characteristics of the sampled population, and median year of data collection; study design; stillbirth case definition; number of stillbirths (although this was not provided for every study); and potential explanatory variables. In the analysis stage, study data were divided into two groups: studies judged to be most likely to be both valid and representative of a given population; and a smaller group of high-quality, hospital-based studies in populations with fewer than 90% of births occurring in institutions, expected to be valid, but unlikely to be representative.

Modelling

We developed a statistical model of stillbirth rates using all 323 observations that met the inclusion criteria for use in the estimation dataset (webtable). The model was fitted to observed stillbirth rates with data source dummy variables to adjust for possible bias and national predictor variables. The estimation dataset included all three sources of stillbirth data (vital registration, DHS, and study-based estimates). The stillbirth rate was modelled by random-effects regression, with country as the clustered unit of analysis because of multiple observations of stillbirth rates in many countries in the dataset. We used the natural logarithms of the dependent variable and all of the continuous predictor variables to improve the fit of the model and to stabilise variance. Three groups of predictor variables were tested for inclusion in the model. The basic model was estimated by the equation:

\[ \ln(SBR_i) = \alpha + \beta \text{Def}_i + \sum_{k=1}^{K} \gamma_k X_{ji} + \sum_{m=1}^{M} \delta_m Y_{im} + \lambda t + \eta_i + \epsilon_{it} \]

where \( SBR_i \) is the stillbirth rate estimated for country \( i \), by source \( j \) and year \( t \); \( \text{Def}_i \) is the stillbirth case definition used by source \( j \), for country \( i \); \( X_{ji} \) is a set of \( K \) data source dummy variables for source \( j \) and country \( i \); \( Y_{im} \) is a set of variables representing biological and demographic factors, health-care use, socioeconomic factors, and world region for country \( i \) and year \( t \); and \( \alpha, \beta, \gamma_k, \delta_m, \lambda, \eta_i, \) and \( \epsilon_{it} \) are vectors of parameters to be estimated. A normally distributed random country effect is represented by \( \eta_i \), and \( \epsilon_{it} \) is a normally distributed error term.

We created a dummy variable to capture differences between stillbirth rates using definitions that varied from the standard definition recommended by the International Classification of Diseases, revision 10 (≥28 weeks gestation or ≥1000 g birthweight). For example, birthweight greater than or equal to 400 g or 500 g, and gestational ages of 20 weeks or 24 weeks or more. Stillbirth rates based on definitions that use lower birthweight or lower gestational age limits would exceed those that use the recommended international definition, so the coefficient on this dummy variable was postulated to be positive.

We defined four categories of data source. First is the “gold standard”, or observations judged most likely to be valid and to be representative of the national population. These observations include, for example, those from high-quality surveillance sites, randomised controlled trials, death-certificate studies, and hospital-based estimates in settings where 90% or more of births occur in institutions. We used this category as the reference in the model. Three dummy variables were created to capture differences between stillbirth rates from a “gold standard” source and those from data sources that were expected to underestimate or overestimate the true stillbirth rate of that population. First, vital registration-based stillbirth rates; research suggests under-reporting of stillbirths via vital registration, thus the coefficient was postulated to be negative. Second, DHS stillbirth rates: these estimates were shown in descriptive analyses to have stillbirth to early neonatal mortality ratios consistently and substantially less than 1, although the expected norm is greater than 1. We interpret this finding as evidence that stillbirths are being under-reported, so the coefficient on this dummy was also postulated to be negative. Third, hospital-based observations from settings where less than 90% of deliveries occur in institutions: we postulated the coefficient for this variable to be positive because of potential selection bias.

Variables thought to be predictors of stillbirth rate were added to the model to test for fit. A key constraint on selecting variables to include in this group of predictors was the need for comparable national-level data for the
reference year of the observations in the estimation dataset and for the year 2000 for all countries for which the model was used for prediction. The group of biological and demographic variables tested for fit in the model included national rates of low birthweight, infant mortality, and general fertility. The group representing health-care use included the national percentage of births with at least one antenatal visit and the percentage of births assisted by a doctor, nurse, midwife, or another medically trained attendant. The group of socioeconomic and geographic variables included gross domestic product per capita, national percentage urban, and dummy variables for the 14 WHO mortality regions (these regions are defined on the basis of both geographic and epidemiological criteria). The reference year for the stillbirth estimate was tested in the model as a continuous variable, without transformation, to assess possible change over time in the association between stillbirth rate and other predictor variables in the model. Certain predictors of interest, such as coverage of emergency obstetric care, early neonatal mortality, prevalence of syphilis, and the percentage of births to women aged 35 years or older could not be tested because of a lack of comparable national data for enough countries.

### Analysis

Once the model had been estimated, we used it to predict stillbirth rates for the year 2000 for all countries. Values of the \( Y_i \), independent variables representing biological and demographic factors, health-care use, socioeconomic factors, and world region for country \( i \) for the year 2000, were inserted in the model, and data source dummy variables were set to zero. SEs were calculated from the summed variance of the predicted stillbirth rate and the variance of the random component (\( \eta \)). Uncertainty is represented by 95% CIs based on these SEs. Regional uncertainty estimates were calculated by summing across the low and high estimate for each country within the region.

We calculated the numbers of stillbirths for each country using the number of livebirths estimated by the UN Population Division\(^4\) for the year 2000, and the estimated stillbirth rate for that country. Regional and global stillbirth rates were obtained by summing the numbers of stillbirths and livebirths at the national level.

This study involved analysis of secondary data with no individual case identification codes and was deemed exempt by the relevant ethics review boards.

### Role of the funding source

The study sponsors had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author and first author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

### Results

The final dataset consisted of 323 observations from 103 countries with data-collection years ranging from 1976 to 2003. All world regions were represented (figure 2). The mean reference year from the study observations was 1995 for developed countries and 4–7 years earlier for all developing country regions, apart from Eurasia for which the mean reference year was 1999. All the vital registration-based estimates were for the years 1999–2001, apart from Denmark (1996) and Bosnia Herzegovina (1998). About 80% of the observations for developed countries and countries within Eurasia were vital registration or other (non-DHS) population-based studies (figure 2). The observations for sub-Saharan Africa, south and east Asia, and Oceania came largely from valid and representative population-based studies. Sub-Saharan Africa and south Asia had more observations than other regions from hospital-based studies unlikely to be representative of the population.

An initial run of our model identified several variables that were not significantly related to the observed stillbirth rate. These variables included: definition of stillbirth; national low-birthweight rate; percentage of births with at least one antenatal visit; percentage of births assisted by a doctor, midwife, or other medically trained attendant; percentage urban; and reference date. Variables that
remained significant were all three data source dummy variables, the infant mortality rate, the general fertility rate, gross domestic product per capita, and some of the WHO regional dummy variables. Inspection of these regional dummies indicated that they fell into three broad groups, within which differences were not statistically significant, but between which differences were significant: a group of generally low mortality countries with low stillbirth rates with observed factors controlled for; a diverse group of countries with stillbirth rates about average given their observed characteristics; and a small group of high-mortality middle eastern countries (including Egypt, Morocco, Pakistan, and Sudan) with stillbirth rates higher than expected.

Table 1 describes the variables and presents the coefficients from the final model, which, after dropping non-significant variables, was as follows:

\[
\ln SBR_{i,j} = a + \beta_1 \times \text{Hospital estimate (with bias)}_{i,j} + \beta_2 \times \text{DHS estimate}_{i,j} + \beta_3 \times \text{Vital registration estimate}_{i,j} + \beta_4 \times \ln \text{IMR}_{i,j} + \beta_5 \times \ln \text{GFR}_{i,j} + \beta_6 \times \ln \text{GDP per capita}_{i,j} + \beta_7 \times \text{Low mortality countries}_{i,j} + \beta_8 \times \text{High mortality or middle eastern countries}_{i,j} + u_{i,j} + e_{i,j}
\]

The coefficients for data source were all highly significant, in the expected direction, and of a plausible size. For example, controlling for other variables in the model, hospital-based estimates with anticipated selection bias were 25% higher, and DHS and vital registration estimates were 30% and 34% lower, respectively, than other population-based observations. As expected, infant mortality rates and general fertility rates were positively related to the stillbirth rate, whereas the coefficient for gross domestic product per capita was negative. The final model explained 83% of the variance.

Figure 3 shows the fitted values of the natural logarithm of the stillbirth rate (ln SBR) plotted against the observed values in the estimation dataset, with a 45-degree line representing equality between the two. Fitted values for high-mortality observations (ln SBR > 3, or a stillbirth rate of ≥20 per 1000) were consistently and substantially underestimated by this model, suggesting that the relation between the independent and dependent variables is systematically different in very high versus lower stillbirth rate settings. Modelling estimates for developing or high-mortality countries separately was unsuccessful because of a weak association between the dependent and independent variables and the small number of observations in countries with high stillbirth rates. For that reason, the model was left as it was and was used for predicting stillbirth rates for all countries, apart from those with an estimate from vital registration data; we adjusted observed vital registration-based stillbirth rates by using the coefficient for data source vital registration—ie, the natural logarithm of all vital registration estimates were increased by 0.340 to account for systematic underreporting of stillbirths in vital registration data implied by this model. We also excluded countries in the estimation dataset that had an observed stillbirth rate of more than 20 per 1000 and had data available in 1995 or later. These countries included those that were highly populated, such as Bangladesh, China, India, Kenya, and Pakistan. For these countries we took the observed stillbirth rate and adjusted it for the coefficient for the data source rather

<table>
<thead>
<tr>
<th>Description</th>
<th>Coefficient</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital estimate (with expected selection bias)</td>
<td>0.2476</td>
<td>0.1330 to 0.3621</td>
</tr>
<tr>
<td>DHS estimate</td>
<td>-0.3012</td>
<td>-0.4481 to -0.1542</td>
</tr>
<tr>
<td>Vital registration estimate</td>
<td>-0.3404</td>
<td>-0.4811 to -0.1990</td>
</tr>
<tr>
<td>ln IMR</td>
<td>0.2209</td>
<td>0.1041 to 0.3378</td>
</tr>
<tr>
<td>ln GFR</td>
<td>0.2922</td>
<td>0.1959 to 0.4475</td>
</tr>
<tr>
<td>ln GDP per capita</td>
<td>-0.1513</td>
<td>-0.2242 to -0.0784</td>
</tr>
<tr>
<td>Low mortality countries</td>
<td>-0.2410</td>
<td>-0.3820 to -0.1000</td>
</tr>
<tr>
<td>High mortality or middle eastern countries</td>
<td>0.2186</td>
<td>0.0121 to 0.4251</td>
</tr>
<tr>
<td>Constant</td>
<td>1.8605</td>
<td>0.9046 to 2.8164</td>
</tr>
</tbody>
</table>

Table 2: Final model used for prediction of the log of the stillbirth rate per 1000 deliveries, by independent variable
than accept the implausibly low estimates predicted by the model. This adjustment was restricted to countries with observations from 1995 or later so that the adjusted estimate for 2000 would be based on more recent observations. For example, if the country input data was based on DHS, we took the natural logarithm of a DHS-based stillbirth rate and increased it by 0·301, the model coefficient for DHS observations. Similarly, the natural logarithm of a hospital-based stillbirth rate with selection bias would be reduced by 0·248—the model coefficient for this data source. If multiple recent observations existed for a specific country, the mean of all adjusted observed values for that country was calculated to generate the predicted stillbirth rate. We calculated the uncertainty interval for countries with an adjusted estimate using the same procedure as for the model-based estimates—ie, the SE calculated for the stillbirth rate that would have been predicted by the model was used to calculate an uncertainty interval surrounding the adjusted observed stillbirth rate.

We undertook sensitivity analyses by eliminating two groups of observations from the estimation dataset; first, the DHS, and then observations from both the DHS and hospitals in settings with institutional birth at less than 90%. The variables in the original model all remained significant in the model excluding DHS observations, and all but the dummy variable for the WHO region for high mortality middle eastern countries remained significant in the model excluding DHS and hospital-based observations with expected bias. The fit of the models changed negligibly in both exercises and the difficulty of underestimation by the model at high stillbirth mortality levels persisted in both. On average, predicted stillbirth rates were 0·03 per 1000 higher (ranging from −0·46 to 0·97) after eliminating observations from the DHS, and 0·29 per 1000 lower (ranging from −6·92 to 1·55) when observations from both sources were eliminated, than the original predictions. In light of the small average effect of excluding these data sources, the original model was kept.

Stillbirth rates for the year 2000 are presented for 190 countries, categorised by the regional classification used in reporting for the Millennium Development Goals (webtable). For 128 countries stillbirth rates were predicted directly from the model. For 44 countries with an observation from vital registration, and 18 countries with observed stillbirth rates in excess of 20 per 1000 and input data after 1995, the rates were adjusted according to the model coefficient for data source. Around 3·2 million annual stillbirths were estimated worldwide (uncertainty interval 2·5–4·1 million), of which 99% occurred in developing regions (table 2). Half (51%) of all stillbirths occurred in four countries: India, China, Pakistan, and Bangladesh. Stillbirth rates were nearly five times higher in developing (25·5 per 1000, uncertainty interval 20·1–32·5) than in developed countries (5·3 per 1000; 4·2–6·8). The highest rates are shown for sub-Saharan Africa and south Asia (32 per 1000 deliveries), in which 28% and 40% of worldwide stillbirths occurred, respectively. The lowest stillbirth rates outside of the developed world were in Eurasia, southeast Asia, and Latin America and the Caribbean (12·2, 12·7, and 13·2 per 1000). Around 3·2 million stillbirths is similar to the World Health Report

### Table 2: Estimated stillbirth rates per 1000 deliveries and uncertainty values, by world region for the year 2000

<table>
<thead>
<tr>
<th>Region</th>
<th>Stillbirth rate per 1000 deliveries</th>
<th>Uncertainty intervals</th>
<th>Number of stillbirths</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>23·9</td>
<td>(18·8–30·5)</td>
<td>3·2 million</td>
</tr>
<tr>
<td>Developed countries</td>
<td>5·3</td>
<td>(4·2–6·8)</td>
<td>57·865</td>
</tr>
<tr>
<td>Developing countries</td>
<td>25·5</td>
<td>(20·1–32·5)</td>
<td>3·16 million</td>
</tr>
<tr>
<td>North Africa</td>
<td>18·6</td>
<td>(14·1–24·7)</td>
<td>66·785</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>32·2</td>
<td>(25·4–40·9)</td>
<td>88·967</td>
</tr>
<tr>
<td>Latin America/Caribbean</td>
<td>13·2</td>
<td>(10·4–16·7)</td>
<td>153·162</td>
</tr>
<tr>
<td>East Asia</td>
<td>23·2</td>
<td>(18·3–29·5)</td>
<td>481·436</td>
</tr>
<tr>
<td>South Asia</td>
<td>31·9</td>
<td>(25·1–40·7)</td>
<td>1286·231</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>12·7</td>
<td>(10·0–16·6)</td>
<td>144·681</td>
</tr>
<tr>
<td>West Asia</td>
<td>18·9</td>
<td>(14·3–24·9)</td>
<td>94·810</td>
</tr>
<tr>
<td>Eurasia</td>
<td>12·2</td>
<td>(9·5–15·5)</td>
<td>39·236</td>
</tr>
<tr>
<td>Oceania</td>
<td>35·8</td>
<td>(22·4–20·3)</td>
<td>35·24</td>
</tr>
</tbody>
</table>

The countries in each subregion are listed in the webtable with the relevant data inputs and country-specific estimates. Stillbirth rates for Timor-Leste, Puerto Rico, and Montenegro and Serbia were not estimated because of missing national covariate data.

### Figure 4: Estimated numbers of stillbirths by world region, for the year 2000

Discussion

We have provided systematic global estimates for stillbirths at country level, detailing inputs and methods and providing uncertainty estimates. The global total of 3·2 million stillbirths is similar to the World Health Report
2005 (3.3 million), but is less than previous WHO global estimates of 4 million in 1999, and 5.3 million in 1995. However, our point estimate of 3.2 million has wide uncertainty estimates with a range of 2.5–4.1 million.

The basic difficulty faced in estimating numbers of stillbirths worldwide is the scarcity of timely and accurate vital registration data, national or otherwise, and data compiled for this exercise, which are fully described elsewhere. Our data inputs are fully described, but even with this broadened net there are still some countries with no usable data. Furthermore, the different types of data available have different biases: vital registration data, although more timely than other sources, are widely reported to underestimate stillbirth rates; DHS data clearly under-estimate stillbirth; and clinical and other studies often draw on unrepresentative populations. Despite efforts to identify the best available data, both the quality and the quantity of data are inadequate, and no modelling technique can overcome the fact that at the global level we are “stumbling around in the dark.”

In reviewing these estimates several strengths and weaknesses should be noted. The strengths of the exercise include the following. Our data inputs are fully described and the data compiled for this exercise, which are fully accessible, resulted from extensive systematic searches of the published work and wide searches for non-English language publications and unpublished data. The combination of vital registration, DHS, and study-based inputs in one model is new. Although the inclusion criteria allowed more facility-based data than similar processes for neonatal and child-death estimates, the sources of the data from health facility and population-based samples were controlled for in the model, as indicated by the highly significant coefficients for the data-source variables and the plausible size and direction of these coefficients. Furthermore, sensitivity analyses showed that elimination of the DHS and hospital-based observations in areas of low institutional birth only slightly changed the predicted rates. No data external to this exercise were used to adjust the estimates.

Important limitations should also be noted, most of which are likely to result in an underestimation of the global total. Stillbirth rates for some high-mortality countries, particularly sub-Saharan and south Asian countries without recent data identified, were probably underestimated by our model because we were only able to adjust stillbirth rates for the high-mortality countries represented with recent observations in our estimation dataset. If early neonatal mortality rates had been available to use instead of infant mortality rates for all observations in the estimation and prediction dataset, then underestimation in high-mortality countries probably would have been reduced.

The need for more and better data regarding stillbirths than currently available is clear. Activities such as the WHO-based Health Metrics Network and the Ellison Institute will hopefully include the improvement of stillbirth data when strengthening health information systems in high-mortality settings. In countries with established vital registration systems, stillbirth data are gathered, and in many cases published, at national level but not routinely collated by the UN statistical system or by WHO. Increasing demand for stillbirth data at national and international level should affect the availability of such data.

Most of the world’s child-death rates are based on surveys, which as yet do not routinely measure stillbirths. Research is needed to improve survey-based measurement of stillbirths. Analysis of pregnancy history data from 40 World Fertility Surveys in 1989, suggested that 50–80% of all pregnancy losses were reported in these interviews. The author emphasised that reporting of induced abortions was weak, but provided little in-depth analysis of the stillbirth data. Unfortunately, this situation has not changed over the past 15 years with no comprehensive assessment of the use of a pregnancy history versus a livebirth history versus a contraceptive calendar to measure all pregnancy outcomes in surveys of women at reproductive age.

Data for the causes of stillbirth, especially largely preventable causes such as syphilis, are needed to prioritise action and reduce stillbirths. However, even in settings with the possibility of extensive investigation, the cause of death might not be established in a third of stillbirths, and recent classifications of causes of stillbirths do not include syphilis and are complex to apply where most deaths occur. For high-mortality settings, verbal autopsy tools that examine child and neonatal deaths could add a stillbirth module, differentiating fresh stillbirths from macerated ones as this is a recognised proxy for intrapartum stillbirths. This process would also improve the quality of data for neonatal cause of death, especially early deaths related to intrapartum events or prematurity.

Better counting of stillbirths and improved cause of death data are only a means to advocating for and prioritising action. Political will is needed to include stillbirths in renewed global interest in maternal newborn and child health. Systematic assessments of the effectiveness of interventions and costs are needed to better inform programmes. Maternal interventions in many cases will also reduce stillbirths but we must count stillbirth rates to ensure effective progress, and that inequity is being addressed. Low income countries, such as Egypt, have credible evidence of a decline in stillbirth rates, closely linked to the halving of maternal mortality ratios in less than a decade. This progress was primarily attributed to a doubling of deliveries taking place in hospitals, and improved quality of facility-based care.

Our estimates suggest that more than 3.2 million babies are born dead every year, and the true figure is probably higher given the limitations of the available data and the fact that stillbirths are under-reported. Better counting is not just for better epidemiology. The deaths of most of...
these babies are avoidable, as evidenced by the low stillbirth rates of four per 1000 total births seen in rich countries relative to stillbirth rates of 40 per 1000 or higher seen in countries with the weakest health systems. In the 21st century we invest in detailing the human genome, but cannot even approximately count this huge number of dead babies. We are left to wonder if stillbirths count.

Contributors
CS coordinated the DHS, vital registration, and Spanish and French language inputs, did the modelling, and shared in writing the manuscript. JL planned the study, coordinated the searches, abstraction, and the data inputs for the study data, collaborated on the modelling approach, and shared in writing the manuscript. HR analysed the DHS data and assisted in the identification of national covariates for DHS, vital registration, and study input datasets. KW-K worked on the searches and data abstraction for the studies and reviewed the manuscript. KH advised on the modelling strategies and shared in writing the manuscript.

Conflict of interest statement
We declare that we have no conflict of interest.

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