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Title: Stillbirths: How should its rate be reported, its disability-adjusted-life-years (DALY), and stillbirths adjusted life expectancy

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Abstract

Background

A 2016 study standardized the definition of stillbirths. It estimated the rate as a proportion of total births. A 2015 paper addressed the problem of disability-adjusted life-years (DALY) for stillbirths. There has been no adjustment of life expectancy at birth to account for stillbirths.

Methods and Results

We follow mathematical and computational methods, use algebra to derive relationships, and large databases. We express the rate as a proportion of live births and use this rate to adjust life expectancy at birth for stillbirths. We then use the difference between the traditional life expectancy and stillbirths adjusted life expectancy (SALE) to obtain DALY for stillbirths for 194 countries, the Millennium Development Goal regions, and income groups.

We show defining stillbirths' rate as a proportion of live births enhances stillbirths' importance, especially in poorer countries; negates some of its under-statement vis-a-vis neonatal mortality rate, accentuates its decrease; and permits inference about relative magnitudes of stillbirths and neonatal mortality from the two rates. Using it, we derive stillbirths adjusted life expectancy, and suggest it reflects a more complete and accurate measure of comparative life expectancies of different countries. Its difference from the traditional life expectancy is used to measure DALY for stillbirths that totals 165.3 million years worldwide.

Conclusion

Stillbirths almost equals neonatal mortality yet have not received almost equal attention. We hope highlighting them and adjusting life expectancy for it will spur health interventions so that grand convergence of health outcomes in different countries can be more rapidly achieved. We also believe SALE is a more complete and accurate measure of comparative life expectancies.

Keywords

Different measures of stillbirth rates; Years of life lost due to stillbirths; A more complete measure of life expectancy; Importance of stillbirths in poorer countries.

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Stillbirths: How should its rate be reported, its disability-adjusted-life-years (DALY), and stillbirths adjusted life expectancy

1. Background

Health professionals, social scientists, and international organizations have not given as much attention to stillbirths as to neonatal mortality. The first data-set for stillbirths in almost all countries became available in 2006, and was for 2000, while that on neonatal mortality have been available since 1990.^{1,2} In 2011 stillbirth's data for 2008 and 2009 became available; and were retrospectively estimated to 1995 for about 40% of the sample.³ The first international goal on stillbirths (and neonatal mortality) was adopted in 2014.⁴ Using revised and updated estimates, Blencowe and colleagues estimate 2.60 million stillbirths occur yearly.⁵

The stillborn rate arguably reflects a country's quality of health care system to a greater extent than life expectancy (since the latter is affected more by smoking, diet, exercise, public sanitation and pollution) and can be an independent/supplementary health indicator. Causes of stillbirths are not fully understood. In the US, about one-fourth of stillbirths are unexplained; and stillbirths after 24 weeks of pregnancy are primarily due to pregnancy/birth related causes like placenta/ umbilical cord problems, birth defects, and infection.⁶ In low income countries, where about 98% of the stillbirths globally occur and almost half of the deliveries take place at home, difficult, prolonged and obstructed labor, infections without adequate treatment, and lack of trained obstetric care (compounded by 35-45% absenteeism of health and extension workers) are the primary causes.^{7, 8, 9}

Earlier studies define stillbirth as fetal death in third trimester with birthweight of 1000g or more.^{1,3} When birthweight is unavailable, 28 or more completed weeks of gestation is used (or a length of ≥ 35 cm if the reported gestation age is not judged reliable). Blencowe and colleagues find using birthweight as the primary criterion reduces number of stillbirths in rich

countries by 15%, since fetal growth restriction causes many stillbirths.⁵ They use fetal death at 28 or more completed weeks of gestation as their exclusive definition. In poor countries, famine increases stillbirths and fortifying pregnant women's diet with protein-rich supplements reduces stillbirths by as much as 38%.^{10, 11, 12} If mothers' under-nourishment during pregnancy causes stillbirths, using birthweight lower than 1000g as the primary criterion will undercount stillbirths in poor countries also. Accordingly, we follow fetal death at 28 or more completed gestation-weeks as our exclusive definition. Using it also excludes voluntary abortion from stillbirths, and protects women's choice to terminate their pregnancies, since abortion after 28 weeks is rare and is mostly due to severe fetal abnormality or if pregnancy is threatening mother's life.^{13, 14}

In addition, "[I]n terms of ethics the ethical concept of the fetus as a patient should replace the discourse of "unborn child" when that phrase is used normatively."¹⁵ "In term of science it is well recognized that between 20 and 24 weeks, it is likely that the fetus "experiences" touch and pain."¹⁶ "The inability to communicate does not mean that there is no pain or need of treatment."¹⁷ Although viability in Western countries is between 22 - 24 gestational weeks, it is higher in low income countries; and 28 weeks is chosen as a pragmatic cut-off limit to classify stillbirths.

The World Health Organization (WHO) notes the widespread perception that stillbirths are unavoidable due to congenital abnormalities.¹ It finds it to be untrue - estimating only 7.4% of stillbirths after 28 weeks are due to such factors. Its wide variation among countries (as shown following) also belies the perception of congenital abnormalities being the primary cause.

The aim and purpose of this paper is to i) highlight the stillbirth rate that is defined consistent with neonatal mortality rate, ii) use it to adjust life expectancy at births to account for stillbirths, and iii) use the latter to obtain DALY for stillbirths. As will be clear below, the paper

is a kind of review proposing new aspects for classification.

2.1.A. Methods: Stillbirth rate defined consistent with neonatal mortality rate

There is no consistency among various authors on how they define the stillbirth rate. Some report it (like neonatal mortality) as a proportion of live births.¹⁸ Others, while noting its definition varies among countries and even among states of the US, define it as a proportion of total (= still + live) births.¹⁹

Blencowe and colleagues estimate stillbirth rates based on 2207 data points.⁵ They do not break-up data into whether it reported stillbirth rate as a proportion of total or of live births. Since it is natural to define all rates (stillbirths, neonatal, infant, and child mortality) included in a study similarly, it is unlikely all 2207 data points would report stillbirth rate as a proportion of total births. Their definition is apparently based ultimately on Goldenberg and colleagues.^{20, 21} Goldenberg and colleagues summarize key findings in the previous five reports in Lancet's 2011 Stillbirth Series.^{22, 23, 24, 25, 26} They define stillbirth rate as “per 1000 births,” not as “per 1000 total births,” at eight places, including in their Conclusion and Call to Action. Since the commonly accepted meaning of “births” is “live births,” by “per 1000 births,” they must mean “per 1000 live births.”

International statistical classification of diseases terms stillbirths (*SB*) as a proportion of live births (*LB*) “fetal death ratio;” and calls stillbirths as a proportion of total births ($TB = SB + LB$) “fetal death rate.”²⁷ It encourages both to be reported and requires the denominator to be always specified. Specifying the denominator in the definition itself, we term the two as still live birth rate ($SLBR = SB/LB$) and still total birth rate ($STBR = SB/TB$), respectively.

Using our nomenclature, Blencowe and colleagues provide data for *STBR*.⁵ Mortality after live birth with 22 to 27 weeks and six days' gestational age are included in the neonatal

mortality rates ($NMR = NM/LB$) while fetal deaths with the same gestational age are excluded from $STBR$ - since it includes stillbirths only after 28 weeks gestational age. That understates stillbirth rate's magnitude vis-à-vis NMR . Dividing stillbirths by a bigger number (total births) and neonatal mortality by a smaller number (live births) compounds its understatement.

We can show the difference between $SLBR$ and $STBR$ is

$$SLBR - STBR = SLBR \times STBR/1000 > 0 \quad (1),$$

the two rates either both decrease or both increases, and when they decrease, the rate of decline in $SLBR$ must be greater than that in $STBR$ (see, Additional file 1).

(1) tells us greater the $SLBR$, greater is its excess over $STBR$. For richer countries where the stillbirth rates are low, $SLBR$ and $STBR$ will be quite close; but for poorer countries where they are high, the excess of $SLBR$ over $STBR$ will be significant.

To infer about the relative numbers of stillbirths and neonatal mortality from their relative rates requires that both adverse events be divided by the same number. That requirement is met when $SLBR = SB/LB$ is used in the stillbirth rate to NMR ratio but not when $STBR = SB/TB$ is used.

$$\text{Stillbirth rate to } NMR \text{ ratio when } SLBR \text{ is used} = (SB/LB) \div (NM/LB) = SB/NM \quad (2),$$

while

$$\text{Stillbirth rate to } NMR \text{ ratio when } STBR \text{ is used} = (SB/TB) \div (NM/LB) = (SB/NM) \times (LB/TB) \quad (3).$$

Since $(LB/TB) < 1$, stillbirth rate to NMR ratio when $STBR$ is used is smaller than when $SLBR$ is used in the ratio instead.

Blencowe and colleagues use $STBR:NMR$ ratio of less than 0.33 to exclude 156 data points on grounds that a ratio so low is implausible; and use this ratio of greater than 0.5 as one criterion to classify data from national routine information systems as high quality.⁵ But,

STBR:NMR ratio does not equal *SB: NM*, as Blencowe and colleagues mistakenly imply; *SLBR:NMR* does. This distinction needs to be recognized.

2.1.B. Results of defining stillbirth rate consistent with neonatal mortality rate

Table 1 compares *SLBR* to *STBR* for countries with the ten highest stillbirth rates in 2015. Results for all countries are given in Additional file 2. They show excess of *SLBR* over *STBR* is approximately two for Pakistan and Nigeria and between one and two for 12 other countries. *SLBR* is higher than 30 for 14 countries (compared to 13 for *STBR*); its decrease is greater than that in *STBR* by about one percentage point for some countries. See, Additional file 2.

<Place Table 1 here.>

Table 2 provides *SLBR* and *SLBR:NMR* ratio for 2000 and 2015 by Millennium Development Goal (MDG) regions and two income groupings: 1) high and upper mid income (richer) and 2) lower mid and low income (poorer). It also provides within region/group standard deviation and dispersion measured as standard deviation/mean (i.e., coefficient of variation), because the means are different. Table 2 shows *SLBR* declined for each region, signifying success. The failure is the increase in its dispersion everywhere (except one region). The increased dispersion is not accounted for anywhere in the recent stillbirth study.⁵

<Place Table 2 here.>

Table 2 shows *SLBR:NMR* ratio has increased in every region/income group and shows great variation both among regions and over time. E.g., in 2015, in the Caucasus and Central Asia, there were approximately 75 stillbirths for every 100 neonatal deaths; whereas in Eastern Asia, the corresponding number was approximately 130. Eastern Asia also experienced almost doubling of the *SLBR:NMR* ratio from 2000 to 2015. This variation across regions and over time needs further investigation.

Comparing progress by two country-income groups, the absolute reduction in poorer (i.e., lower-middle and lower income) countries' stillborn rate from 2000 to 2015 (ignoring the negative signs) is 8.69 (= 25.28 - 33.97) and proportionate/percentage reduction is 25.6% (= 8.69/33.97); while the corresponding numbers for richer (i.e., high and upper-middle income) countries are 3.93 (= 7.40 - 11.33) and 34.7% (= 3.93/11.33), respectively. That is, the percentage reduction, or the rate of decrease, in poorer countries' stillborn rate is smaller than that in richer countries.

The *SLBR:NMR* ratio for both groups increase; but that for the richer group increases by 25.6 (= 101.5 - 75.1) and 35.1% (= 25.6/75.1) versus 12.1 (= 97.0 - 84.9) and 14.3% (= 12.1/84.9) for poorer countries. That is, the percentage increase, or the rate of increase, in this ratio is greater for richer countries than for poorer countries.

Let, $g(SLBR: NMR)$, $g(SLBR)$ and $g(NMR)$ represent the rates of change in *SLBR: NMR*, *SLBR*, and *NMR*, respectively. Then, we can show that

$$g(SLBR: NMR) = g(SLBR) - g(NMR) \quad (4), \text{ or}$$

$$g(NMR) = g(SLBR) - g(SLBR: NMR) \quad (4')$$

Using the above relationship, we can see the richer countries' *NMR* also decreases by a greater percentage, disregarding the negative sign, of 69.8 (= - 34.7% - 35.1%), or at a greater rate, than for poorer countries' 39.9 (= - 25.6% - 14.3%). The richer countries, where the 2000 rates were already much lower, achieve a greater proportionate reduction in both rates.

The Newborn Action Plan notes encouragingly that 11 poorer countries have reduced their *NMR* by more than 40% since 2000.⁴ By 2015, a total of 25 (not 11) such countries had passed the 40% threshold (average reduction 46.7%). At the same time, 49 richer countries had also achieved that feat (average reduction 53.5%). See, Additional file 2. Almost twice as many

richer countries have achieved a greater than 40% reduction in their *NMR* than poorer countries; and achieved a greater reduction. The poorer countries have taken on and made some progress in an immense task. Yet, richer countries have made even more of a progress - indicating great scope of progress that is possible for poorer countries.

2.2.A. Methods: adjusting life expectancy to account for stillbirths and using it to obtain DALY for stillbirths

The traditional life expectancy at birth (*LE*), also called life expectancy of live births (*LELB*) here, includes premature births and neonates who may live no longer than an hour or a day. The stillborn can occur either antepartum (before labor or delivery) or intrapartum (during labor or delivery); and are highly sensitive to access to timely high-quality antenatal and intrapartum monitoring and care.⁵ 40-45% of stillbirths, namely 1.17 million of 2.60 million total stillbirths, are intrapartum.^{20, 28} This number is greater than 1.01 million live newborns who die within the first 24 hours (36% of total neonatal deaths).²⁹ These deaths occur rapidly, and the first minute after an infant is born—the so-called golden minute—is the crucial window for neonatal resuscitation for the 10 million non-breathing infants born annually.²⁰ The implications are: i) millions of non-breathing neonates are successfully resuscitated; ii) which death is stillbirth and which is neonatal can be subject to considerable error. These errors are more likely when births take place at home—as is common in rural areas of South Asia and Sub-Saharan Africa (the primary regions where most stillbirths occur).²⁹

Variation in classification of neonatal mortality and stillbirths at the local level impacts the reported stillbirths and infant mortality rates.³⁰ Dearth of females in population cohorts since the late 1930s in China has been ascribed to female losses occurring very early in life.³¹ Such female live births are simply not reported or reported as stillborn. The Helping Babies Breathe program in Tanzania reduced stillbirths by 24%; and resuscitation training in six poorer

countries, reduced stillbirth rates by 31%.^{32, 33} We are not proposing that population, that includes all premature live births, include the stillborn. Nevertheless, millions of stillborn, who, by definition, are after 28 weeks of gestation, are simply ignored in the life expectancy measure. We include stillbirths in vital statistics of life expectancy by adjusting it for stillbirths - calling the result stillbirths adjusted life expectancy, *SALE*.

Life expectancy of 1000 live births is $1000 \times LELB$. Dividing this product by 1000 plus the still live-birth rate, *SLBR*, gives us the life expectancy of total (= still + live) births, *LETB*, or stillbirths adjusted life expectancy, *SALE*.

$$SALE = LETB = (1000 \times LELB) / (1000 + SLBR) \quad (5)$$

For a country with no stillbirths, *SLBR* is zero and $SALE = LE$. For almost every country, stillbirths are positive, and $SALE < LE$. The difference between the two reflects decrease in life expectancy when stillbirths are also considered. Suppose *LELB* is 71 years, and *SLBR* is 13. Then, (5) would mean dividing 71,000 (life expectancy of 1000 live births) by 1013, rather than by 1000. The resulting number being approximately 70 years, the reduction in life expectancy by 1 year is solely due to dividing 71,000 by 1013; i.e., by including the number of stillbirths per 1000 live births in the denominator.

Now we discuss why stillbirths should be include in DALY, and how we obtain DALY for stillbirths.

DALY, while estimating life years lost due to mortality and morbidity, is also used for prioritizing health care spending.³⁵ Stillbirths are neither included in it nor in the global tracking mechanism such as the Global Burden of Disease estimates. Part of this reluctance may have been due to lack of reliable data on stillbirths in poorer and middle-income countries. Data on its cousin, neonatal mortality, for almost all countries has been available since 1990, while similar

data for stillbirths became available only in 2006.^{1, 2} The protein-supplemental study cited above found it decreased low-weight live births by 32% also (in addition to reducing stillbirths by 38%).¹² If stillbirths are included in DALY, nutrition and medical interventions focused on pregnant mothers may yield benefits in potential DALY reduction that are two to ten times, and potential cost per DALY reduction one-half to one-tenth.³⁶ Since DALY is an important population health measure, not counting stillbirth's reduction in DALY estimates will also yield anomalous situations where a population with a neonatal mortality reduction, whether or not achieved by moving prenatal care resources to post-natal, is considered healthier even if its incidence of late-gestation stillbirths increases.

Other substantive arguments for including stillbirths in DALY estimates are as follows. The current practice violates one of the four general principles underlying DALYs, namely "treating like outcomes as like."³⁴ A 28 gestational-age fetus that is stillborn and one that dies ten minutes after live birth are essentially like outcomes. Yet, the former is not included in DALY estimates while the latter is. We have discussed above how following fetal death at 28 or more completed gestation-weeks as our exclusive definition of stillbirths protects women's rights and choice to terminate their pregnancies. Including stillbirths in DALY estimates will spur interventions to reduce it - interventions that predominantly focus on pregnant mother's health, wellbeing, and prenatal and partum care - and will enhance women's rights and condition.³⁷

Normally, DALY for premature mortality, or Years of Life Lost (YLL) due to premature mortality in the population, corresponds to the number of deaths multiplied by the life expectancy at the age at which death occurs.³⁸ This method cannot be used for stillbirths since life expectancy of stillbirths is zero. Therefore, we obtain DALY of stillbirths by multiplying

decrease in life expectancy when stillbirths are also considered by the number of live births.

That is,

$$\text{DALY or YLL of stillbirths} = LE - SALE = |SALE - LE| \times LB \quad (6)$$

Additional file 1 shows the following:

$$|SALE - LE| = SLBR \times LE / (1000 + SLBR) > 0 \quad (7),$$

and greater is the *SLBR* and/or greater is the *LE*, greater is *LE*'s excess over *SALE*. Both factors in (7) are important: a) Greater the stillbirth rate, more life-years are lost due to stillbirths; b) greater the life expectancy (of live births), the more life-years are lost because a birth is still rather than live.

A recent study (as far as I know the only paper so far suggesting how DALY for stillbirths should be estimated), implicitly assuming life expectancy of a still birth equals that of a live birth, has suggested “the disvalue attached to a fetal death should gradually increase from zero, at 28 weeks gestational age, to a value equaling that of the death of a [fully developed] newborn infant, at the time of birth,”³⁶ That is, DALY of stillbirths should be zero, or let us say 0.01, at 28 weeks gestational age increasing to 1.00 at full-term; or increasing 100 times. Since a fetus does not develop 100 times from 28 weeks to full-term, this proposal is counter-intuitive and against medical evidence. At 28 weeks gestational age, survival without major morbidity for infants surviving to discharge is closer to one (it is 0.59) than to zero.³⁹ In a situation where most of the stillbirths (and pre-term neonatal mortality) take place in poor countries where the gestation age at mortality between 28 to 39 weeks are not certain, attempting precision in DALY estimation (which perforce has to make bold assumptions in valuing vastly disparate morbidity) more than in our proposal above will not be productive. In addition, this proposal suffers from its implicit assumption equating life expectancy of a still birth - that is zero - to that of a live birth.

Stillbirths (like neonatal mortality) also cause parental suffering and psychological distress and may affect parents' life spans. Data for these effects is limited, especially in low income countries.⁴⁰ If available, it will be challenging to add it to measure like DALY of stillbirths. Nevertheless, this effect needs to be recognized.

2.2.B. Results: adjusting life expectancy to account for stillbirths and using it to obtain DALY for stillbirths

Table 3, Panel A summarizes results (from Additional file 3) for 10 countries with largest decrease in life expectancy due to stillbirths. Its Panel B summarizes results for countries with ten largest DALY of stillbirths that are not included in Panel A. Decrease in life expectancy due to stillbirths is as high as approximately 3 years for Pakistan and approximately 2 (between 1.69 and 2.28) years for 17 other countries. Panel B shows India, with 39.2 million years, has the highest DALY of stillbirths. Its loss exceeds the sum of the next two countries, Nigeria and Pakistan, and is more than four times that in China. Other countries in the top 10 DALY group are Ethiopia, Bangladesh, Congo, Indonesia, Tanzania, and Egypt.

<Place Table 3 here.>

Table 4 presents results by MDG region and by two country-income groups, richer and poorer. The worldwide mean decreases in life expectancy due to considering stillbirths is 0.85 years. Regions with mean decrease significantly higher and lower than the world average are, for higher: Southern Asia (1.30 years) and Sub-Saharan Africa (1.41 years), and for lower: developed region (0.27 years) and Eastern Asia (0.54 years). The variability of this decrease, measured by standard deviation of the decrease scaled by the mean (since the means are different), among countries in a region is the lowest in the Caucasus and Central Asia (25.8) and Sub-Saharan Africa (30.8), and highest in Southern Asia (60.2) and Eastern Asia (57.9) - suggesting efforts to reduce it may be more successful in the latter two regions. The worldwide

DALY = years of lost life due to stillbirths was 165.3 million years in 2015. Of this, 122.3 million (74%) are in Southern Asia and Sub-Saharan Africa. By income, 138 million (83.5 %) of DALY due to stillbirths are in poorer countries.

<Place Table 4 here.>

The gap between average life expectancies between the developed region (rich) and Sub Saharan Africa (poor) is 18.98 years (= 79.31 - 60.33) for *LE*; and 20.12 years for *SALE* (= 79.04 - 58.92). We can describe the health convergence objective in two alternative ways: i) poor countries need to increase their life expectancy of live births by approximately 19 years and decrease their still live-birth rate from 29.50 to 3.44 (see, Table 2); or ii) they need to increase their stillbirths adjusted life expectancy by approximately 20.1 years. In some sense, the second may be preferred since it directly incorporates the stillbirth objective in the life expectancy measure. Because many neonatal deaths, 40% of which occur on the first day of life, are misreported as stillbirths, incorporating stillbirths may also reflect a more accurate (and complete) measure of life expectancy.

3. Conclusion

Main Findings: Stillbirths almost equals neonatal mortality yet have not received almost equal attention. Defining stillbirths' rate as a proportion of live births enhances stillbirths' importance, especially in poorer countries; and negates some of its under-statement vis-a-vis neonatal mortality rate. We employ this definition to adjust life expectancy for stillbirths; and propose the latter to get stillbirths' DALY that equal 165.3 million years.

Meaning of the Findings, Research Implications: Stillbirth rate arguably reflects a country's quality of health care system to a greater extent than life expectancy; and stillbirths adjusted life expectancy reflects a more complete and accurate measure of comparative life

expectancies. Including it in DALY will lead to better priorities in health care spending. Highlighting stillbirths and adjusting life expectancy for it will spur research on stillbirths whose causes are not well understood.

Clinical and Health Implications: Some key interventions such as syphilis treatment in pregnancy, fetal heart monitoring, and labor surveillance could be crucial in preventing intrapartum stillbirths.³ In low income countries, only a minority of deliveries occur in health facilities or with the assistance of a trained personnel. This is due to both inadequate resources and absenteeism of health workers.^{9, 10} The implication is need for both more resources and better governance. Further, resuscitation training of health care workers in poorer countries is sorely needed.

Strength and Weaknesses: The paper's strengths are a) highlighting that having different divisors for stillbirths and neonatal mortality rates may give inconsistent results. and b) traditional life expectancy suffers from the limitation that what is stillbirth and what is a live birth is subject to considerable error. Its weakness is that data on stillbirths are not estimated by UN Inter-agency Group for Child Mortality Estimation, childmortality.org. If the latter estimates stillbirths while appraising its neonatal mortality numbers, the estimates of both are likely to improve.

In 2016, the definition of stillbirths was standardized to mean fetal loss after 28 weeks of gestation.⁵ It defined stillbirth rate as a proportion of total (still + live) births. We are proposing it be called still total birth rate, and what international statistical classification of diseases terms "fetal death ratio," (stillbirths as a proportion of live births) be called still live birth rate.²⁷ The latter accentuates its decline and makes the stillbirth rate comparable to NMR. Using it, we

derive stillbirths adjusted life expectancy. Its difference from the traditional life expectancy reflects DALY for stillbirths that totals 165.3 million years worldwide.

There has been a call for better prenatal, natal, and neonatal health monitoring and improved data definitions/methods with consistent metrics.²¹ There are triple benefits from such attention: benefits i) for stillbirths, ii) for neonatal deaths, and iii) for mothers; life complications and disability may also be reduced.²¹ Stillbirths in poorer countries are another dimension of health that needs to be addressed when seeking, hopefully rapid, grand convergence to health outcomes in richer countries. A stillbirth-incorporated definition of the widely used life expectancy measure will attract more attention to stillbirth. Life expectancy at birth ignores morbidity and is a “very imperfect measure of health.”⁴¹ Adjusting it for stillbirths will also remove some of its imperfections.

List of abbreviations

DALY = Disability-adjusted life-years

SALE = Stillbirths adjusted life expectancy

MDG = Millennium development goals

SB = Number of still births

LB = Number of live births

TB = Number of total (= still + live) births

SLBR = Still live birth rate (= SB/LB)

STBR = Still total (= still + live) birth rate (= SB/TB)

NMR = Neonatal mortality rate

NM = Number of neonatal mortalities

LE = LELB = Life expectancy of live births

LETB = Life expectancy of total (= still + live) births = SALE

YLL = Years of life lost

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

The datasets analyzed during the current study are available (and no (administrative) permission is required to use/reuse them) in the

a) Supplementary Material to Blencowe et al. (2016) Blencowe H, Cousens S, Jassir F-B, et al. (2016) National, regional, and worldwide estimates of stillborn rates in 2015, with trends from 2000: a systematic analysis. *Lancet Globl Health* 4: e98–108.

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c) UN Inter-agency Group for Child Mortality Estimation (UNICEF, WHO, World Bank, UN DESA Population Division) - for neonatal mortality rate and numbers for Cook Islands

childmortality.org

d) U.S. Census Bureau: International Database - for life expectancy numbers for Marshall Islands and Palau

<https://www.census.gov/programs-surveys/international-programs/about/idb.html>

Competing interests

The author declares that he has no competing interests

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Authors' contributions

CK is the sole author of this article, he alone is responsible for the content and the views expressed in this article

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Endnotes

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Table 1: Countries with ten highest stillbirth rates

Country name	SLBR	STBR	SLBR-STBR
Pakistan	45.09	43.15	1.94
Nigeria	44.81	42.89	1.92
Chad	41.58	39.92	1.66
Guinea-Bissau	38.10	36.70	1.40
Niger	38.07	36.67	1.40
Somalia	36.80	35.49	1.31
Djibouti	35.85	34.61	1.24
Central African Republic	35.59	34.37	1.22
Togo	35.36	34.15	1.21
Mali	33.63	32.53	1.10

Notes: SLBR and STBR stand for stillbirth rates defined with respect for live births and total (still + live) births, respectively; and are for 2015 above. Data for STBR is from Blencowe et al. (2016), reference 5. SLBR is derived by using the number stillborn from Blencowe et al. (2016) and number of live births as calculated by using the neonatal mortality number and rate from World Development Indicators.

Table 2: SLBR & SLBR: NMR by region & income-group

Region/ income-group	SLBR		SLBR: NMR= SB: NM	
	2000	2015	2000	2015
DR Rate/Ratio	4.51	3.44	83.5	107.0
SD	2.21	1.63	54.7	68.4
SD/Mean	45.3	46.9	50.9	49.1
SA Rate/Ratio	36.76	26.16	81.1	89.7
SD	15.8	12.8	14.9	27.1
SD/Mean	53.7	65.2	18.8	28.2
CCA Rate/Ratio	17.14	12.02	63.3	74.5
SD	4.85	3.53	26.3	45.4
SD/Mean	25.9	27.5	34.1	43.9
EA Rate/Ratio	14.47	7.21	69.7	128.9
SD	7.14	4.73	27.7	31.6
SD/Mean	57.3	62.3	36.3	29.2
LAC Rate/Ratio	11.4	8.28	77.8	89.3
SD	5.64	4.77	37.3	42.3
SD/Mean	42.9	46.2	39.2	39.1
NAME Rate/Ratio	20.28	14.75	94.6	114.1
SD	8.91	6.86	36.9	95.7
SD/Mean	54.9	57.7	33.2	61.0
SEA Rate/Ratio	17.28	12.37	81.6	90.9
SD	7.22	5.31	37.6	42.7
SD/Mean	44.2	41.9	38.1	39.6
SSA Rate/Ratio	36.92	29.50	90.5	103.2
SD	10.2	8.45	19.7	22.8
SD/Mean	32.9	34.7	23.0	24.2
World Rate/Ratio	25.37	18.73	83.1	97.7
SD	12.5	9.86	38.5	58.8
SD/Mean	72.3	75.5	40.3	50.3
H & Up-Mid-Y Rate/Ratio	11.33	7.40	75.1	101.5
SD	6.43	5.03	46.5	70.9
SD/Mean	66.4	69.7	45.3	54.4
Low-Mid & L-Y Rate/Ratio	33.97	25.28	84.9	97.0
SD	11.1	9.15	19.5	26.1
SD/Mean	40.2	43.2	22.7	26.7

Notes: SLBR stands for stillbirth rates defined with respect for live births. It is derived by using the number stillborn from Blencowe et al. (2016), reference 5 and number of live births as calculated by using the neonatal mortality number and rate from World Development Indicators. SB, NM and NMR stand for the number stillborn, neonatal mortality, and its rate, respectively. The abbreviations for the regions and income-groups are DR = developed region, SA = Southern Asia, CCA = Caucasus and Central Asia, EA = Eastern Asia, LA = Latin America & Caribbean, NAME = North Africa and Middle East, SEA = South-eastern Asia, SSA = Sub-Saharan Africa, H & Up-Mid-Y = high and upper middle income, Low-Mid & L-Y = lower middle and low income. Rate/ratio are for the whole region or income-group. SD and mean are of individual countries' rates/ratios in the region or income-group given in Additional file 2. SD/mean is expressed as a % (with % sign not written).

Table 3: Countries with highest i) decrease in life expectancy due to stillbirths, and ii) DALY of stillbirths

Country name	LE	SALE	 SALE-LE 	DALY = YLL (in 100,000)
Pakistan	66.38	63.52	2.86	152.4
Nigeria	53.05	50.77	2.28	159.1
Niger	61.97	59.70	2.27	21.6
Djibouti	62.29	60.13	2.16	0.5
Chad	51.87	49.80	2.07	12.5
Togo	60.12	58.07	2.05	5.1
Guinea-Bissau	55.47	53.43	2.04	1.3
Somalia	55.69	53.71	1.98	8.8
Comoros	63.55	61.61	1.94	0.5
Ethiopia	64.58	62.66	1.92	60.3
India	68.35	66.78	1.57	392.0
China	75.99	75.45	0.54	91.8
Bangladesh	72.00	70.17	1.83	58.1
Congo, Dem. Rep.	59.02	57.41	1.61	50.4
Indonesia	69.07	68.16	0.91	50.0
Tanzania	65.49	64.02	1.47	30.1
Egypt, Arab Rep.	71.32	70.45	0.87	24.4

Notes: LE and SALE stand for the traditional life expectancy and stillbirths adjusted life expectancy, respectively, and are for 2015 above. Traditional life expectancy data is from World Development Indicators (WDI). Difference between the two measures decrease in life-expectancy due to considering stillbirths. In the first ten rows, countries are ranked by this difference; in the last seven by DALY = YLL (years of life lost) of stillbirths.

Table 4: Stillbirth-caused decrease in life expectancy and DALY or years of life lost by region & income-group

Region/ income-group	LE	SALE	 SALE- LE 	DALY=YLL (in 100,000)
DR Mean/Total	79.31	79.04	0.27	3.6
SD	3.7	3.7	0.11	
SD/Mean	4.6	4.7	41.8	
SA Mean/Total	70.53	69.23	1.30	63.4
SD	5.1	5.7	0.79	
SD/Mean	7.2	8.2	60.2	
CCA Mean/Total	70.89	69.99	0.89	1.6
SD	3.1	3.1	0.23	
SD/Mean	4.3	4.5	25.8	
EA Mean/Total	74.58	74.03	0.54	9.7
SD	5.8	6.0	0.32	
SD/Mean	7.7	8.1	57.9	
LAC Mean/Total	74.14	73.40	0.75	6.7
SD	3.8	4.0	0.45	
SD/Mean	5.1	5.4	41.6	
NAME Mean/Tot	74.06	73.21	0.85	10.4
SD	3.7	4.0	0.45	
SD/Mean	5.0	5.5	52.3	
SEA Mean/Total	71.22	70.34	0.88	10.6
SD	4.7	5.0	0.34	
SD/Mean	6.6	7.0	38.9	
SSA Mean/Total	60.33	58.92	1.41	59.4
SD	5.8	6.0	0.43	
SD/Mean	9.7	10.1	30.8	
World Mean/Tot	71.18	70.33	0.85	165.3
SD	8.38	8.82	0.56	
SD/Mean	11.8	12.5	65.2	
H & Up-Mid-Y				
Mean/Total	76.14	75.63	0.51	27.2
SD	5.6	5.9	0.32	
SD/Mean	7.4	7.7	62.5	
Low-Mid & L-Y				
Mean/Total	64.69	63.39	1.30	138.1
SD	6.83	7.07	0.48	
SD/Mean	10.6	11.1	37.0	

Notes: LE and SALE stand for the traditional life expectancy and stillbirths adjusted life expectancy, respectively, and are for 2015 above. Traditional life expectancy data is from World Development Indicators (WDI). Difference between the two measures decrease in life-expectancy due to considering stillbirths. SD and mean are of corresponding numbers of individual countries' in the region or income-group given in Additional file 3. The abbreviations for the regions and income-group are DR = developed region, SA = Southern Asia, CCA = Caucasus and Central Asia, EA = Eastern Asia, LA = Latin America & Caribbean, NAME = North Africa and Middle East, SEA = South-eastern Asia, SSA = Sub-Saharan Africa,

H & Up-Mid-Y = high and upper middle income, Low-Mid & L-Y = lower middle and low income. SD/mean is expressed as a % (with % sign not written).

Additional file list

Additional file 1: Mathematical derivations; format: .pdf

Additional file 2: Still live-birth and total-birth rates, and SLBR:NMR ratio, 2000 and 2015, by country; format: .pdf

Additional file 3: Life expectancy & stillbirths adjusted life expectancy, 2000 & 2015, and
i) decrease in life expectancy due to stillbirths, and ii) DALY = YLL of stillbirths, 2015,
by country; format: .pdf

Additional file 1: Mathematical derivations

The equations for the two stillbirth rates are:

$$STBR = SB \times 1000 / (LB + SB) \quad (A1)$$

$$SLBR = SB \times 1000 / LB \quad (A2)$$

Multiplying and dividing the right-hand side of (A1) by LB , we have

$$STBR = SB \times 1000 \times LB / (LB + SB) \times LB, \text{ or}$$

$$STBR = SLBR \times LB / (LB + SB) \quad (A1')$$

Subtracting the RHS of (A1'), that equals $STBR$, from $SLBR$, we get

$$SLBR - STBR = SLBR - [SLBR \times LB / (LB + SB)], \text{ or}$$

$$SLBR - STBR = SLBR [1 - LB / (LB + SB)], \text{ or}$$

$$SLBR - STBR = SLBR [(LB + SB) - LB] / (LB + SB), \text{ or}$$

$$SLBR - STBR = SLBR \times SB / (LB + SB) = SLBR \times STBR / 1000 > 0 \quad (A3)$$

We now derive expressions for the changes in the two stillbirth rates. Let $SLBR_1$, $STBR_1$, $SLBR_2$, and $STBR_2$ represent the two stillbirth rates, and LB_1 , SB_1 , LB_2 , and SB_2 the number of live and stillbirths for years 1 and 2, respectively. Let

$$SB_2 = kSB_1, \text{ where } k > 0. \quad (A4).$$

When $k > 1$, the number of stillbirths in year 2 is greater than that in year 1; when it is < 1 , the number in year 2 is smaller.

Let $\Delta SLBR$ and $\Delta STBR$ denote the change in the two rates from year 1 to year 2. Then,

$$\Delta SLBR = (1000 \times kSB_1 / LB_2) - (1000 \times SB_1 / LB_1), \text{ or}$$

$$\Delta SLBR = (1000 \times SB_1) (k / LB_2 - 1 / LB_1), \text{ or}$$

$$\Delta SLBR = (1000 \times SB_1) \times (kLB_1 - LB_2) / (LB_2 \times LB_1) \quad (A5),$$

and

$$\Delta STBR = (1000 \times kSB_1 / (LB_2 + kSB_1)) - (1000 \times SB_1 / (LB_1 + SB_1)), \text{ or}$$

$$\Delta STBR = (1000 \times SB_1) ((k / (LB_2 + kSB_1)) - 1 / (LB_1 + SB_1)), \text{ or}$$

$$\Delta STBR = (1000 \times SB_1) (((k \times (LB_1 + SB_1)) - (LB_2 + kSB_1)) / (LB_2 + kSB_1) (LB_1 + SB_1)), \text{ or}$$

$$\Delta STBR = (1000 \times SB_1) ((kLB_1 - LB_2) / (LB_2 + kSB_1) (LB_1 + SB_1)) \quad (A6).$$

Examining the right hand sides of (A5) and (A6), we get

$$\text{sign } \Delta SLBR = \text{sign } \Delta STBR = \text{sign } (kLB_1 - LB_2) \quad (A7).$$

Thus, the two rates change in the same direction: They either both decrease or they both increase.

The proportionate (i.e., ignoring the 100) rate of change (= growth or reduction) in the two stillbirth rates are

$$\Delta SLBR / SLBR_1 = (1000 \times SB_1) \times (kLB_1 - LB_2) / (LB_2 \times LB_1) \div (1000 \times SB_1 / LB_1), \text{ or}$$

$$\Delta SLBR / SLBR_1 = (kLB_1 - LB_2) / LB_2 \quad (A8)$$

and

$$\Delta STBR / STBR_1 = (1000 \times SB_1) ((kLB_1 - LB_2) / (LB_2 + kSB_1) (LB_1 + SB_1)) \div (1000 \times SB_1 / (LB_1 + SB_1))$$

or

$$\Delta STBR / STBR_1 = ((kLB_1 - LB_2) / (LB_2 + kSB_1)) \quad (A9)$$

Dividing (A8) by (A9), we have

$$[(\Delta SLBR / SLBR_1) / (\Delta STBR / STBR_1)] = [(LB_2 + kSB_1) / LB_2] > 1. \quad (A10)$$

(A10) implies the absolute rate of change in SLBR must be greater than that in STBR. When the two rates are falling, it means the rate of fall in SLBR must be greater than that in STBR. When they are increasing, the rate of increase in SLBR must be greater than that in STBR.

The two life expectancies:

Subtracting the RHS of (5) in the text from $LE = LELB$, we have

$$LELB - LETB = LELB (1 - (1000 / (1000 + SLBR))), \text{ or}$$

$$LELB - LETB = LE - SALE = S LBR \times LE / (1000 + SLBR) > 0. \quad (A11),$$

Let ΔLE represent the excess of LE over $SALE$ (that equals the shortfall of $SALE$ from LE).

The partial derivative of ΔLE with respect to $SLBR$ is positive. That and (A11) tell us that greater is the $SLBR$ and/or greater is the LE , greater is LE 's excess over $SALE$ (or, greater is $SALE$'s shortfall from LE).

Additional file 2: Still live-birth and total-birth rates, and SLBR:NMR ratio, 2000 and 2015, by country

Country name	MDG region	Income group	2000		2015		% Δ 2000-2015				SLBR:NMR=SB:NM		
			SLBR	STBR	SLBR	STBR	SLBR-STBR	SLBR	STBR	SLBR-STBR	NMR	2000	2015
Afghanistan	Southern Asia	Low income	37.01	35.69	27.48	26.75	0.73	-25.75	-25.05	0.70	-21.37	81.6	77.1
Albania	Developed region	Upper middle income	5.79	5.76	4.00	3.98	0.02	-30.92	-30.90	0.02	-45.12	51.4	64.7
Algeria	North Africa and Middle East	Upper middle income	26.70	26.01	19.70	19.32	0.38	-26.22	-25.72	0.50	-26.04	127.6	127.3
Andorra	Developed region	High income:	1.10	1.10	1.40	1.40	0.00	27.27	27.27	0.00	-59.62	42.3	133.3
Angola	Sub-Saharan Africa	Upper middle income	35.49	34.27	28.08	27.31	0.77	-20.88	-20.31	0.57	-16.46	60.6	57.4
Antigua and Barbuda	Latin America and the Caribbean	High income:	8.77	8.70	7.00	6.95	0.05	-20.18	-20.11	0.07	-52.07	93.2	155.2
Argentina	Latin America and the Caribbean	High income:	7.37	7.32	4.60	4.57	0.03	-37.58	-37.57	0.01	-44.24	65.3	73.1
Armenia	Caucasus and Central Asia	Lower middle income	21.48	21.03	13.96	13.77	0.19	-35.01	-34.52	0.49	-53.40	135.4	188.9
Australia	Developed region	High income: OECD	3.37	3.36	2.72	2.71	0.01	-19.29	-19.35	-0.06	-37.14	96.3	123.6
Austria	Developed region	High income: OECD	4.67	4.65	3.64	3.63	0.01	-22.06	-21.94	0.12	-32.26	150.6	173.3
Azerbaijan	Caucasus and Central Asia	Upper middle income	25.85	25.20	16.74	16.47	0.27	-35.24	-34.64	0.60	-45.56	77.1	91.7
Bahamas, The	Latin America and the Caribbean	High income:	11.27	11.15	10.35	10.24	0.11	-8.16	-8.16	0.00	-19.84	130	148.9
Bahrain	North Africa and Middle East	High income:	9.48	9.39	5.55	5.52	0.03	-41.46	-41.21	0.25	-76.43	201.3	500.0
Bangladesh	Southern Asia	Lower middle income	44.22	42.35	26.02	25.36	0.66	-41.16	-40.12	1.04	-45.47	103	111.1
Barbados	Latin America and the Caribbean	High income:	9.28	9.20	8.59	8.52	0.07	-7.44	-7.39	0.05	-7.49	108.7	108.7
Belarus	Developed region	Upper middle income	5.66	5.63	2.97	2.96	0.01	-47.53	-47.42	0.11	-74.29	76.6	156.3
Belgium	Developed region	High income: OECD	3.55	3.54	3.02	3.01	0.01	-14.93	-14.97	-0.04	-26.67	118.3	137.3
Belize	Latin America and the Caribbean	Upper middle income	11.29	11.16	9.84	9.75	0.09	-12.84	-12.63	0.21	-33.76	90.3	118.8
Benin	Sub-Saharan Africa	Low income	37.46	36.11	31.24	30.30	0.94	-16.6	-16.09	0.51	-19.59	94.5	98.0
Bhutan	Southern Asia	Lower middle income	27.59	26.85	16.19	15.94	0.25	-41.32	-40.63	0.69	-44.16	84	88.2
Bolivia	Latin America and the Caribbean	Lower middle income	18.06	17.74	13.04	12.87	0.17	-27.8	-27.45	0.35	-34.41	60.2	66.3
Bosnia and Herzegovina	Developed region	Upper middle income	6.74	6.70	5.48	5.45	0.03	-18.69	-18.66	0.03	-39.70	102.1	137.7
Botswana	Sub-Saharan Africa	Upper middle income	17.84	17.53	15.46	15.22	0.24	-13.34	-13.18	0.16	-8.49	74.2	70.3
Brazil	Latin America and the Caribbean	Upper middle income	12.24	12.09	8.65	8.58	0.07	-29.33	-29.03	0.30	-44.23	76.8	97.3
Brunei Darussalam	Southeastern Asia and Oceania	High income:	6.98	6.93	6.52	6.47	0.05	-6.59	-6.64	-0.05	-12.60	141.9	151.6
Bulgaria	Developed region	Upper middle income	8.54	8.46	5.77	5.73	0.04	-32.44	-32.27	0.17	-50.44	75.7	103.2
Burkina Faso	Sub-Saharan Africa	Low income	30.25	29.36	21.70	21.24	0.46	-28.26	-27.66	0.60	-37.07	71.2	81.2
Burundi	Sub-Saharan Africa	Low income	37.27	35.93	27.36	26.63	0.73	-26.59	-25.88	0.71	-27.22	94.5	95.4
Cabo Verde	Sub-Saharan Africa	Lower middle income	19.76	19.38	14.49	14.29	0.20	-26.67	-26.26	0.41	-29.55	114.3	119.0
Cambodia	Southeastern Asia and Oceania	Low income	21.27	20.83	12.08	11.94	0.14	-43.21	-42.68	0.53	-58.99	58.8	81.5
Cameroon	Sub-Saharan Africa	Lower middle income	24.70	24.10	19.96	19.57	0.39	-19.19	-18.80	0.39	-25.74	71.3	77.6
Canada	Developed region	High income: OECD	3.54	3.53	3.15	3.14	0.01	-11.02	-11.05	-0.03	-13.51	95.7	98.4
Central African Republic	Sub-Saharan Africa	Low income	38.80	37.35	35.59	34.37	1.22	-8.27	-7.98	0.29	-12.94	79.1	83.3
Chad	Sub-Saharan Africa	Low income	43.19	41.40	41.58	39.92	1.66	-3.73	-3.57	0.16	-15.80	92.3	105.6
Chile	Latin America and the Caribbean	High income: OECD	3.91	3.89	3.07	3.06	0.01	-21.48	-21.34	0.14	-14.21	68.6	62.8
China	Eastern Asia	Upper middle income	14.73	14.52	7.20	7.15	0.05	-51.12	-50.76	0.36	-74.05	69.6	131.1
Colombia	Latin America and the Caribbean	Upper middle income	11.00	10.88	8.14	8.08	0.06	-26	-25.74	0.26	-36.97	81.7	95.9
Comoros	Sub-Saharan Africa	Low income	35.69	34.46	31.51	30.55	0.96	-11.71	-11.35	0.36	-18.70	84.9	92.2
Congo, Dem. Rep.	Sub-Saharan Africa	Low income	35.40	34.19	28.03	27.27	0.76	-20.82	-20.24	0.58	-22.03	91.7	93.2
Congo, Rep.	Sub-Saharan Africa	Lower middle income	21.49	21.04	15.29	15.06	0.23	-28.85	-28.42	0.43	-45.71	64.7	84.8
Cook Islands	Southeastern Asia and Oceania	Upper middle income	11.36	11.24	6.59	6.55	0.04	-41.99	-41.73	0.26	-28.05	118.5	95.5
Costa Rica	Latin America and the Caribbean	Upper middle income	6.14	6.10	6.02	5.99	0.03	-1.95	-1.80	0.15	-19.38	79.8	97.1
Cote d'Ivoire	Sub-Saharan Africa	Lower middle income	32.87	31.82	27.42	26.69	0.73	-16.58	-16.12	0.46	-23.99	65.6	71.9
Croatia	Developed region	High income:	3.61	3.60	1.99	1.99	0.00	-44.88	-44.72	0.16	-52.46	65.8	76.2
Cuba	Latin America and the Caribbean	Upper middle income	11.11	10.99	6.18	6.15	0.03	-44.37	-44.04	0.33	-45.24	264.5	268.7

Cyprus	Developed region	High income:	5.12	5.09	3.71	3.70	0.01	-27.54	-27.31	0.23	-54.32	158	250.7
Czech Republic	Developed region	High income: OECD	3.31	3.30	2.51	2.50	0.01	-24.17	-24.24	-0.07	-53.85	84.9	139.4
Denmark	Developed region	High income: OECD	3.42	3.41	1.74	1.74	0.00	-49.12	-48.97	0.15	-29.06	97.4	69.9
Djibouti	Sub-Saharan Africa	Lower middle income	45.71	43.71	35.85	34.61	1.24	-21.57	-20.82	0.75	-24.36	103	106.8
Dominica	Latin America and the Caribbean	Upper middle income	10.27	10.17	11.93	11.79	0.14	16.16	15.93	-0.23	38.24	89.5	75.2
Dominican Republic	Latin America and the Caribbean	Upper middle income	13.49	13.31	11.19	11.06	0.13	-17.05	-16.90	0.15	-9.77	56.1	51.5
Ecuador	Latin America and the Caribbean	Upper middle income	11.03	10.91	7.74	7.68	0.06	-29.83	-29.61	0.22	-37.51	63.9	71.8
Egypt, Arab Rep.	North Africa and Middle East	Lower middle income	18.31	17.99	12.38	12.23	0.15	-32.39	-32.02	0.37	-42.46	82.4	96.9
El Salvador	Latin America and the Caribbean	Lower middle income	17.61	17.31	12.30	12.15	0.15	-30.15	-29.81	0.34	-42.26	122.8	148.6
Equatorial Guinea	Sub-Saharan Africa	High income:	21.62	21.16	16.44	16.18	0.26	-23.96	-23.53	0.43	-26.00	48.2	49.5
Eritrea	Sub-Saharan Africa	Low income	28.59	27.80	23.04	22.52	0.52	-19.41	-18.99	0.42	-29.97	108.6	124.9
Estonia	Developed region	High income: OECD	4.25	4.24	2.67	2.66	0.01	-37.18	-37.26	-0.08	-76.40	67.8	180.4
Ethiopia	Sub-Saharan Africa	Low income	40.70	39.11	30.59	29.68	0.91	-24.84	-24.11	0.73	-42.80	83.6	109.8
Fiji	Southeastern Asia and Oceania	Upper middle income	14.36	14.16	12.06	11.92	0.14	-16.02	-15.82	0.20	-31.05	103.7	126.3
Finland	Developed region	High income: OECD	2.65	2.65	1.85	1.85	0.00	-30.19	-30.19	0.00	-48.00	106	142.3
France	Developed region	High income: OECD	5.49	5.46	4.74	4.72	0.02	-13.66	-13.55	0.11	-21.43	196.1	215.5
Gabon	Sub-Saharan Africa	Upper middle income	17.15	16.86	14.15	13.96	0.19	-17.49	-17.20	0.29	-22.13	57.3	60.8
Gambia, The	Sub-Saharan Africa	Low income	31.72	30.74	24.44	23.86	0.58	-22.95	-22.38	0.57	-28.50	75.5	81.3
Georgia	Caucasus and Central Asia	Lower middle income	18.95	18.59	11.36	11.24	0.12	-40.05	-39.54	0.51	-65.65	90.4	157.8
Germany	Developed region	High income: OECD	2.67	2.66	2.43	2.43	0.00	-8.99	-8.65	0.34	-25.00	95.4	115.7
Ghana	Sub-Saharan Africa	Lower middle income	30.56	29.65	23.22	22.69	0.53	-24.02	-23.47	0.55	-22.23	83.5	81.6
Greece	Developed region	High income: OECD	4.74	4.71	3.57	3.56	0.01	-24.68	-24.42	0.26	-48.39	84.6	123.5
Grenada	Latin America and the Caribbean	Upper middle income	9.06	8.98	8.00	7.94	0.06	-11.7	-11.58	0.12	-19.97	117.5	129.7
Guatemala	Latin America and the Caribbean	Lower middle income	17.16	16.87	12.08	11.94	0.14	-29.6	-29.22	0.38	-35.98	82.2	90.4
Guinea	Sub-Saharan Africa	Low income	27.83	27.08	21.59	21.13	0.46	-22.42	-21.97	0.45	-35.19	57.4	68.8
Guinea-Bissau	Sub-Saharan Africa	Low income	55.43	52.52	38.10	36.70	1.40	-31.26	-30.12	1.14	-28.65	98.9	95.3
Guyana	Latin America and the Caribbean	Lower middle income	20.13	19.74	17.55	17.25	0.30	-12.82	-12.61	0.21	-12.20	77	76.4
Haiti	Latin America and the Caribbean	Low income	29.43	28.59	25.56	24.92	0.64	-13.15	-12.84	0.31	-16.83	96.2	100.4
Honduras	Latin America and the Caribbean	Lower middle income	18.06	17.74	12.77	12.61	0.16	-29.29	-28.92	0.37	-37.40	103	116.3
Hungary	Developed region	High income: OECD	4.19	4.18	3.68	3.67	0.01	-12.17	-12.20	-0.03	-50.00	59.9	105.1
Iceland	Developed region	High income: OECD	2.89	2.88	1.13	1.12	0.01	-60.9	-61.11	-0.21	-56.04	139.6	124.2
India	Southern Asia	Lower middle income	34.46	33.31	23.57	23.03	0.54	-31.6	-30.86	0.74	-38.76	75.7	84.6
Indonesia	Southeastern Asia and Oceania	Lower middle income	17.99	17.67	13.41	13.23	0.18	-25.46	-25.13	0.33	-39.24	81.1	99.6
Iran, Islamic Rep.	Southern Asia	Upper middle income	9.53	9.44	6.48	6.44	0.04	-32	-31.78	0.22	-50.47	49.7	68.3
Iraq	North Africa and Middle East	Upper middle income	19.99	19.60	15.78	15.54	0.24	-21.06	-20.71	0.35	-24.37	81.9	85.4
Ireland	Developed region	High income: OECD	4.68	4.66	2.73	2.73	0.00	-41.67	-41.42	0.25	-42.36	117.3	118.7
Israel	Developed region	High income: OECD	4.82	4.80	4.21	4.19	0.02	-12.66	-12.71	-0.05	-41.67	133.9	200.5
Italy	Developed region	High income: OECD	3.98	3.96	3.35	3.34	0.01	-15.83	-15.66	0.17	-38.24	117.1	159.5
Jamaica	Latin America and the Caribbean	Upper middle income	21.39	20.95	19.15	18.79	0.36	-10.47	-10.31	0.16	-31.69	125.7	164.8
Japan	Developed region	High income: OECD	3.07	3.06	2.08	2.07	0.01	-32.25	-32.35	-0.10	-50.00	170.6	231.1
Jordan	North Africa and Middle East	Upper middle income	13.14	12.97	10.60	10.48	0.12	-19.33	-19.20	0.13	-36.13	79.3	100.1
Kazakhstan	Caucasus and Central Asia	Upper middle income	11.18	11.06	6.52	6.48	0.04	-41.68	-41.41	0.27	-65.21	55.5	93.0
Kenya	Sub-Saharan Africa	Lower middle income	27.16	26.44	23.02	22.50	0.52	-15.24	-14.90	0.34	-23.48	93.2	103.3
Kiribati	Southeastern Asia and Oceania	Lower middle income	18.88	18.53	16.63	16.35	0.28	-11.92	-11.76	0.16	-18.47	64.8	70.0
Korea, Dem People's Rep	Eastern Asia	Low income	19.80	19.42	13.69	13.50	0.19	-30.86	-30.48	0.38	-50.39	72.9	101.6
Korea, Rep.	Eastern Asia	High income: OECD	2.76	2.75	2.14	2.13	0.01	-22.46	-22.55	-0.09	-33.33	115	133.8
Kuwait	North Africa and Middle East	High income:	6.65	6.61	5.10	5.08	0.02	-23.31	-23.15	0.16	-50.62	102.6	159.4
Kyrgyz Republic	Caucasus and Central Asia	Lower middle income	13.95	13.76	10.33	10.22	0.11	-25.95	-25.73	0.22	-47.00	64.4	90.0

Lao PDR	Southeastern Asia and Oceania	Lower middle income	32.68	31.64	24.30	23.72	0.58	-25.64	-25.03	0.61	-30.50	75.1	80.4
Latvia	Developed region	High income:	5.31	5.28	3.61	3.60	0.01	-32.02	-31.82	0.20	-49.90	51.3	69.6
Lebanon	North Africa and Middle East	Upper middle income	14.14	13.95	9.97	9.87	0.10	-29.49	-29.25	0.24	-59.25	120	207.7
Lesotho	Sub-Saharan Africa	Lower middle income	24.77	24.17	19.91	19.52	0.39	-19.62	-19.24	0.38	-13.19	65.6	60.7
Liberia	Sub-Saharan Africa	Low income	32.51	31.49	21.88	21.42	0.46	-32.7	-31.98	0.72	-44.58	74.7	90.7
Libya	North Africa and Middle East	Upper middle income	12.64	12.49	8.87	8.79	0.08	-29.83	-29.62	0.21	-52.26	83.9	123.4
Lithuania	Developed region	High income:	5.82	5.78	3.24	3.23	0.01	-44.33	-44.12	0.21	-54.55	105.8	129.6
Luxembourg	Developed region	High income: OECD	3.88	3.86	2.85	2.84	0.01	-26.55	-26.42	0.13	-62.66	161	316.7
Macedonia, FYR	Developed region	Upper middle income	10.91	10.79	7.72	7.66	0.06	-29.24	-29.01	0.23	-61.81	118.7	219.9
Madagascar	Sub-Saharan Africa	Low income	21.96	21.49	18.54	18.20	0.34	-15.57	-15.31	0.26	-37.80	69.2	93.9
Malawi	Sub-Saharan Africa	Low income	29.57	28.72	22.30	21.82	0.48	-24.59	-24.03	0.56	-38.77	82.9	102.1
Malaysia	Southeastern Asia and Oceania	Upper middle income	8.05	7.98	5.88	5.85	0.03	-26.96	-26.69	0.27	-26.28	152.2	150.8
Maldives	Southern Asia	Upper middle income	19.56	19.18	7.87	7.80	0.07	-59.76	-59.33	0.43	-81.24	75.7	162.3
Mali	Sub-Saharan Africa	Low income	45.98	43.96	33.63	32.53	1.10	-26.86	-26.00	0.86	-33.53	80.6	88.6
Malta	Developed region	High income:	4.98	4.96	3.58	3.56	0.02	-28.11	-28.23	-0.12	-15.69	97.6	83.3
Marshall Islands	Southeastern Asia and Oceania	Upper middle income	17.60	17.29	15.25	15.02	0.23	-13.35	-13.13	0.22	-7.05	96.1	89.6
Mauritania	Sub-Saharan Africa	Lower middle income	33.60	32.51	27.82	27.07	0.75	-17.2	-16.73	0.47	-17.11	77.7	77.6
Mauritius	Sub-Saharan Africa	Upper middle income	13.31	13.14	9.60	9.51	0.09	-27.87	-27.63	0.24	-31.63	108.2	114.1
Mexico	Latin America and the Caribbean	Upper middle income	7.03	6.98	5.52	5.49	0.03	-21.48	-21.35	0.13	-30.52	69.9	79.0
Micronesia, Fed. Sts.	Southeastern Asia and Oceania	Lower middle income	21.11	20.68	18.39	18.06	0.33	-12.88	-12.67	0.21	-27.33	82.8	99.2
Moldova	Developed region	Lower middle income	10.44	10.33	7.93	7.87	0.06	-24.04	-23.81	0.23	-42.53	50.5	66.7
Monaco	Developed region	High income:	5.60	5.57	5.70	5.67	0.01	1.79	1.80	0.01	-66.67	133.3	407.1
Mongolia	Eastern Asia	Upper middle income	12.58	12.42	7.34	7.29	0.05	-41.65	-41.30	0.35	-56.87	48.8	66.0
Montenegro	Developed region	Upper middle income	6.00	5.96	3.99	3.97	0.02	-33.5	-33.39	0.11	-66.59	66.6	132.6
Morocco	North Africa and Middle East	Lower middle income	34.99	33.81	25.13	24.52	0.61	-28.18	-27.48	0.70	-36.07	126.6	142.2
Mozambique	Sub-Saharan Africa	Low income	27.85	27.09	19.50	19.13	0.37	-29.98	-29.38	0.60	-38.34	63.3	71.8
Myanmar	Southeastern Asia and Oceania	Lower middle income	30.69	29.78	20.36	19.96	0.40	-33.66	-32.98	0.68	-29.33	81.8	76.7
Namibia	Sub-Saharan Africa	Upper middle income	13.42	13.25	11.38	11.25	0.13	-15.2	-15.09	0.11	-18.73	68.5	71.5
Nauru	Southeastern Asia and Oceania	East Asia & Pacific	18.63	18.29	15.15	14.93	0.22	-18.68	-18.37	0.31	-1.44	83.8	69.2
Nepal	Southern Asia	Low income	28.77	27.97	18.72	18.38	0.34	-34.93	-34.29	0.64	-43.66	72.7	83.9
Netherlands	Developed region	High income: OECD	5.31	5.28	1.83	1.82	0.01	-65.54	-65.53	0.01	-36.84	139.7	76.3
New Zealand	Developed region	High income: OECD	3.46	3.45	2.26	2.25	0.01	-34.68	-34.78	-0.10	-11.71	98.9	73.1
Nicaragua	Latin America and the Caribbean	Lower middle income	11.02	10.90	7.50	7.44	0.06	-31.94	-31.74	0.20	-42.90	64.4	76.8
Niger	Sub-Saharan Africa	Low income	40.62	39.04	38.07	36.67	1.40	-6.28	-6.07	0.21	-38.19	93.5	141.8
Nigeria	Sub-Saharan Africa	Lower middle income	55.17	52.29	44.81	42.89	1.92	-18.78	-17.98	0.80	-28.87	114.1	130.3
Norway	Developed region	High income: OECD	3.72	3.71	2.19	2.19	0.00	-41.13	-40.97	0.16	-44.61	138.3	147.0
Oman	North Africa and Middle East	High income:	9.99	9.90	8.51	8.44	0.07	-14.81	-14.75	0.06	-30.67	133.2	163.7
Pakistan	Southern Asia	Lower middle income	56.35	53.34	45.09	43.15	1.94	-19.98	-19.10	0.88	-24.91	92.1	98.2
Palau	Southeastern Asia and Oceania	Upper middle income	10.95	10.83	9.01	8.93	0.08	-17.72	-17.54	0.18	-30.32	71.7	84.7
Panama	Latin America and the Caribbean	Upper middle income	8.77	8.69	6.18	6.14	0.04	-29.53	-29.34	0.19	-34.56	59.8	64.4
Papua New Guinea	Southeastern Asia and Oceania	Lower middle income	19.21	18.85	16.17	15.91	0.26	-15.83	-15.60	0.23	-18.62	63.6	65.8
Paraguay	Latin America and the Caribbean	Upper middle income	19.19	18.83	13.57	13.39	0.18	-29.29	-28.89	0.40	-38.36	108.7	124.7
Peru	Latin America and the Caribbean	Upper middle income	13.92	13.73	9.03	8.95	0.08	-35.13	-34.81	0.32	-47.93	88.5	110.3
Philippines	Southeastern Asia and Oceania	Lower middle income	14.53	14.33	10.99	10.87	0.12	-24.36	-24.15	0.21	-24.97	86.8	87.5
Poland	Developed region	High income: OECD	4.69	4.67	2.35	2.35	0.00	-49.89	-49.68	0.21	-46.55	80.9	75.8
Portugal	Developed region	High income: OECD	3.70	3.69	2.18	2.17	0.01	-41.08	-41.19	-0.11	-41.18	108.8	109.0
Qatar	North Africa and Middle East	High income:	7.58	7.53	5.75	5.72	0.03	-24.14	-24.04	0.10	-41.18	117.3	151.3
Romania	Developed region	Upper middle income	6.80	6.76	4.15	4.13	0.02	-38.97	-38.91	0.06	-51.84	52.1	66.0

Russian Federation	Developed region	High income:	7.75	7.69	4.49	4.47	0.02	-42.06	-41.87	0.19	-59.94	62.1	89.8
Rwanda	Sub-Saharan Africa	Low income	27.82	27.07	17.59	17.29	0.30	-36.77	-36.13	0.64	-55.60	65.8	93.8
Samoa	Southeastern Asia and Oceania	Lower middle income	12.10	11.95	11.05	10.93	0.12	-8.68	-8.54	0.14	-18.26	104.2	116.4
San Marino	Developed region	High income:	4.90	4.88	2.60	2.59	0.01	-46.94	-46.93	0.01	-46.15	376.9	371.4
Sao Tome and Principe	Sub-Saharan Africa	Lower middle income	24.88	24.28	16.47	16.21	0.26	-33.8	-33.24	0.56	-29.71	101.6	95.6
Saudi Arabia	North Africa and Middle East	High income	19.22	18.86	14.13	13.93	0.20	-26.48	-26.14	0.34	-36.27	155.3	179.1
Senegal	Sub-Saharan Africa	Lower middle income	35.89	34.65	25.09	24.47	0.62	-30.09	-29.38	0.71	-46.73	91.7	120.4
Serbia	Developed region	Upper middle income	7.84	7.78	5.98	5.95	0.03	-23.72	-23.52	0.20	-45.45	101.8	142.4
Seychelles	Sub-Saharan Africa	High income	11.32	11.20	9.83	9.73	0.10	-13.16	-13.13	0.03	-12.96	120.3	120.0
Sierra Leone	Sub-Saharan Africa	Low income	40.71	39.12	24.96	24.36	0.60	-38.69	-37.73	0.96	-30.04	81.6	71.6
Singapore	Southeastern Asia and Oceania	High income:	3.53	3.52	2.58	2.58	0.00	-26.91	-26.70	0.21	-38.13	220.6	260.6
Slovak Republic	Developed region	High income: OECD	3.91	3.89	2.94	2.93	0.01	-24.81	-24.68	0.13	-42.68	53.5	70.2
Slovenia	Developed region	High income: OECD	2.70	2.70	2.85	2.84	0.01	5.56	5.19	-0.37	-57.10	81.6	200.7
Solomon Islands	Southeastern Asia and Oceania	Lower middle income	20.04	19.65	17.91	17.59	0.32	-10.63	-10.48	0.15	-15.71	139.3	147.7
Somalia	Sub-Saharan Africa	Low income	40.82	39.22	36.80	35.49	1.31	-9.85	-9.51	0.34	-10.62	91.7	92.5
South Africa	Sub-Saharan Africa	Upper middle income	22.94	22.42	17.76	17.45	0.31	-22.58	-22.17	0.41	-31.16	143.8	161.7
South Sudan	Sub-Saharan Africa	Low income	37.28	35.94	30.98	30.05	0.93	-16.9	-16.39	0.51	-31.60	64.4	78.3
Spain	Developed region	High income: OECD	3.31	3.30	2.88	2.87	0.01	-12.99	-13.03	-0.04	-30.00	82.8	102.9
Sri Lanka	Southern Asia	Lower middle income	7.60	7.54	4.91	4.89	0.02	-35.39	-35.15	0.24	-46.48	75.3	90.9
St. Kitts and Nevis	Latin America and the Caribbean	High income:	9.67	9.58	7.58	7.53	0.05	-21.61	-21.40	0.21	-47.50	80.6	120.3
St. Lucia	Latin America and the Caribbean	Upper middle income	13.18	13.00	12.16	12.01	0.15	-7.74	-7.62	0.12	-18.42	117.3	132.6
St Vincent & Grenadines	Latin America and the Caribbean	Upper middle income	12.57	12.41	10.90	10.78	0.12	-13.29	-13.13	0.16	-13.99	92.6	93.3
Sudan	Sub-Saharan Africa	Lower middle income	30.09	29.21	24.99	24.38	0.61	-16.95	-16.54	0.41	-16.20	84.2	83.4
Suriname	Latin America and the Caribbean	Upper middle income	24.64	24.05	19.82	19.43	0.39	-19.56	-19.21	0.35	-38.26	133	173.3
Swaziland	Sub-Saharan Africa	Lower middle income	16.20	15.94	12.50	12.35	0.15	-22.84	-22.52	0.32	-33.08	76.6	88.3
Sweden	Developed region	High income: OECD	3.81	3.80	2.86	2.85	0.01	-24.93	-25.00	-0.07	-30.13	166.4	178.8
Switzerland	Developed region	High income: OECD	3.25	3.24	2.82	2.81	0.01	-13.23	-13.27	-0.04	-22.86	92.9	104.4
Syrian Arab Republic	North Africa and Middle East	Lower middle income	14.75	14.53	11.27	11.15	0.12	-23.59	-23.26	0.33	-43.54	119.1	161.2
Tajikistan	Caucasus and Central Asia	Lower middle income	19.36	18.99	14.18	13.98	0.20	-26.76	-26.38	0.38	-31.70	64.3	69.0
Tanzania	Sub-Saharan Africa	Low income	32.68	31.65	22.94	22.42	0.52	-29.8	-29.16	0.64	-41.09	102.2	121.8
Thailand	Southeastern Asia and Oceania	Upper middle income	7.74	7.68	5.00	4.97	0.03	-35.4	-35.29	0.11	-47.24	61	74.7
Timor-Leste	Southeastern Asia and Oceania	Lower middle income	27.01	26.30	18.10	17.78	0.32	-32.99	-32.40	0.59	-40.32	72.1	81.0
Togo	Sub-Saharan Africa	Low income	46.24	44.20	35.36	34.15	1.21	-23.53	-22.74	0.79	-25.82	128.1	132.1
Tonga	Southeastern Asia and Oceania	Upper middle income	9.60	9.51	8.93	8.85	0.08	-6.98	-6.94	0.04	-10.05	130.4	134.9
Trinidad and Tobago	Latin America and the Caribbean	High income:	17.94	17.62	11.24	11.11	0.13	-37.35	-36.95	0.40	-29.50	96	85.3
Tunisia	North Africa and Middle East	Upper middle income	15.01	14.78	9.25	9.16	0.09	-38.37	-38.02	0.35	-55.42	81.7	112.9
Turkey	North Africa and Middle East	Upper middle income	12.91	12.75	7.05	7.00	0.05	-45.39	-45.10	0.29	-64.62	64.4	99.4
Turkmenistan	Caucasus and Central Asia	Upper middle income	22.96	22.45	17.31	17.02	0.29	-24.61	-24.19	0.42	-25.74	76	77.1
Tuvalu	Southeastern Asia and Oceania	Upper middle income	18.05	17.73	13.22	13.04	0.18	-26.76	-26.45	0.31	-23.82	75.3	72.4
Uganda	Sub-Saharan Africa	Low income	30.25	29.36	21.48	21.02	0.46	-28.99	-28.41	0.58	-42.23	93.3	114.7
Ukraine	Developed region	Lower middle income	12.50	12.34	8.88	8.81	0.07	-28.96	-28.61	0.35	-50.85	111.7	161.5
United Arab Emirates	North Africa and Middle East	High income:	8.98	8.90	7.42	7.37	0.05	-17.37	-17.19	0.18	-37.39	160.6	212.0
United Kingdom	Developed region	High income: OECD	3.67	3.66	2.95	2.94	0.01	-19.62	-19.67	-0.05	-36.84	96.6	122.9
United States	Developed region	High income: OECD	3.12	3.11	2.96	2.95	0.01	-5.13	-5.14	-0.01	-21.74	67.8	82.2
Uruguay	Latin America and the Caribbean	High income	8.57	8.50	6.59	6.55	0.04	-23.1	-22.94	0.16	-39.02	102.3	129.0
Uzbekistan	Caucasus and Central Asia	Lower middle income	15.88	15.63	12.19	12.04	0.15	-23.24	-22.97	0.27	-29.42	55.2	60.0
Vanuatu	Southeastern Asia and Oceania	Lower middle income	14.37	14.17	14.10	13.90	0.20	-1.88	-1.91	-0.03	-4.36	118.3	121.3
Venezuela, RB	Latin America and the Caribbean	High income	9.03	8.95	7.18	7.13	0.05	-20.49	-20.34	0.15	-25.79	75.4	80.8

Vietnam	Southeastern Asia and Oceania	Lower middle income	15.25	15.02	10.25	10.15	0.10	-32.79	-32.42	0.37	-27.28	97.4	90.1
West Bank and Gaza	North Africa and Middle East	Lower middle income	9.72	9.62	7.54	7.48	0.06	-22.43	-22.25	0.18	-28.04	59.4	64.0
Yemen, Rep.	North Africa and Middle East	Lower middle income	38.01	36.62	29.87	29.00	0.87	-21.42	-20.81	0.61	-40.94	101.2	134.6
Zambia	Sub-Saharan Africa	Lower middle income	27.02	26.31	21.30	20.86	0.44	-21.17	-20.71	0.46	-37.67	78.5	99.3
Zimbabwe	Sub-Saharan Africa	Low income	20.35	19.94	21.04	20.61	0.43	3.39	3.36	-0.03	12.41	97.1	89.3

Notes: SLBR and STBR stand for still live and total birth rates, SB for the number stillborn, and NM and NMR for the number and rate of neonatal mortality. The STBR is from Blencowe et al. (2016), SLBR is derived by using the number stillborn from Blencowe et al. (2016) and number of live births as calculated by using the neonatal mortality number and rate from World Development Indicators. Niue (population 1,190 in July 2014 per CIA World Fact Book) for which Blencowe et al. (2016) give the rate but not the number stillborn is excluded from the above table. The neonatal mortality rate and numbers for Cook Islands were obtained from Child Mortality Estimates by the UN Inter-agency Group. Income groups are as defined by the World Bank

Additional file 3: Life expectancy & stillbirths adjusted life expectancy, 2000 & 2015, and i) decrease in life expectancy due to stillbirths, and ii)

DALY = YLL of stillbirths, 2015, by country

Country name	SLBR		2000		2015		DALY=YLL	% Δ 2000-2015				
	2000	2015	LE	SALE	LE	SALE		SALE-LE	2015	LE	SALE	SALE-LE
Afghanistan	37.01	27.48	55.13	53.16	60.72	59.10	1.62	1646853	10.14	11.17	-17.77	
Albania	5.79	4.00	74.27	73.84	78.01	77.70	0.31	13987	5.04	5.23	-27.91	
Algeria	26.70	19.70	70.18	68.35	75.04	73.59	1.45	1383723	6.93	7.67	-20.77	
Angola	35.49	28.08	45.2	43.65	52.67	51.23	1.44	1564366	16.53	17.37	-7.10	
Antigua & Barbuda	8.77	7.00	73.4	72.76	76.1	75.57	0.53	823	3.68	3.86	-17.19	
Argentina	7.37	4.60	73.76	73.22	76.33	75.98	0.35	266883	3.48	3.77	-35.19	
Armenia	21.48	13.96	71.28	69.78	74.8	73.77	1.03	41935	4.94	5.72	-31.33	
Australia	3.37	2.72	79.23	78.96	82.45	82.23	0.22	65707	4.06	4.14	-18.52	
Austria	4.67	3.64	78.13	77.77	81.84	81.54	0.30	24724	4.75	4.85	-16.67	
Azerbaijan	25.85	16.74	66.76	65.08	70.85	69.68	1.17	273378	6.13	7.07	-30.36	
Bahamas, The	11.27	10.35	72.25	71.44	75.4	74.63	0.77	4434	4.36	4.47	-4.94	
Bahrain	9.48	5.55	74.6	73.90	76.82	76.40	0.42	9113	2.98	3.38	-40.00	
Bangladesh	44.22	26.02	65.35	62.58	72	70.17	1.83	5810578	10.18	12.13	-33.94	
Barbados	9.28	8.59	73.22	72.55	75.66	75.02	0.64	2187	3.33	3.40	-4.48	
Belarus	5.66	2.97	68.91	68.52	73.62	73.40	0.22	27694	6.84	7.12	-43.59	
Belgium	3.55	3.02	77.72	77.45	81.29	81.05	0.24	30327	4.59	4.65	-11.11	
Belize	11.29	9.84	68.42	67.66	70.19	69.51	0.68	5747	2.59	2.73	-10.53	
Benin	37.46	31.24	55.19	53.20	59.72	57.91	1.81	678582	8.21	8.85	-9.05	
Bhutan	27.59	16.19	60.65	59.02	69.83	68.72	1.11	13671	15.14	16.44	-31.90	
Bolivia	18.06	13.04	60.69	59.61	68.74	67.86	0.88	215802	13.26	13.84	-18.52	
Bosnia and Herze.	6.74	5.48	74.26	73.76	76.59	76.17	0.42	13094	3.14	3.27	-16.00	
Botswana	17.84	15.46	48.69	47.84	64.49	63.51	0.98	56519	32.45	32.76	15.29	
Brazil	12.24	8.65	70.04	69.19	74.68	74.04	0.64	2060055	6.62	7.01	-24.71	
Brunei Darussalam	6.98	6.52	75.29	74.77	79.04	78.53	0.51	3914	4.98	5.03	-1.92	
Bulgaria	8.54	5.77	71.66	71.05	74.47	74.04	0.43	25754	3.92	4.21	-29.51	
Burkina Faso	30.25	21.70	50.35	48.87	58.93	57.68	1.25	858169	17.04	18.03	-15.54	
Burundi	37.27	27.36	51.49	49.64	57.11	55.59	1.52	701167	10.91	11.99	-17.84	
Cabo Verde	19.76	14.49	69.72	68.37	73.36	72.31	1.05	11464	5.22	5.76	-22.22	
Cambodia	21.27	12.08	58.35	57.13	68.66	67.84	0.82	291967	17.67	18.75	-32.79	
Cameroon	24.70	19.96	51.94	50.69	55.93	54.84	1.09	892654	7.68	8.19	-12.80	
Canada	3.54	3.15	79.24	78.96	82.14	81.88	0.26	95958	3.66	3.70	-7.14	
Central African Republic	38.80	35.59		44.6	42.93	51.42	49.65	1.77	289797	15.29	15.65	5.99
Chad	43.19	41.58	47.58	45.61	51.87	49.80	2.07	1250158	9.02	9.19	5.08	
Chile	3.91	3.07	76.82	76.52	81.79	81.54	0.25	58429	6.47	6.56	-16.67	
China	14.73	7.20	71.73	70.69	75.99	75.45	0.54	9182935	5.94	6.73	-48.08	
Colombia	11.00	8.14	70.99	70.22	74.18	73.58	0.60	449250	4.49	4.78	-22.08	
Comoros	35.69	31.51	59.44	57.39	63.55	61.61	1.94	50454	6.91	7.35	-5.37	
Congo, Dem. Rep.	35.40	28.03	50	48.29	59.02	57.41	1.61	5042628	18.04	18.89	-5.85	
Congo, Rep.	21.49	15.29	50.59	49.53	62.87	61.92	0.95	155262	24.27	25.02	-10.38	
Costa Rica	6.14	6.02	77.42	76.95	79.59	79.11	0.48	32583	2.80	2.81	2.13	
Cote d'Ivoire	32.87	27.42	46.7	45.21	51.92	50.53	1.39	1147856	11.18	11.77	-6.71	
Croatia	3.61	1.99	72.81	72.55	77.28	77.13	0.15	5625	6.14	6.31	-42.31	
Cuba	11.11	6.18	76.64	75.80	79.55	79.06	0.49	57452	3.80	4.30	-41.67	
Cyprus	5.12	3.71	77.97	77.57	80.31	80.01	0.30	3840	3.00	3.15	-25.00	
Czech Republic	3.31	2.51	74.97	74.72	79.47	79.27	0.20	18714	6.00	6.09	-20.00	
Denmark	3.42	1.74	76.59	76.33	81.1	80.96	0.14	7241	5.89	6.07	-46.15	
Djibouti	45.71	35.85	57.01	54.52	62.29	60.13	2.16	47425	9.26	10.29	-13.25	
Dominican Republic	13.49	11.19	70.63	69.69	73.68	72.86	0.82	177783	4.32	4.55	-12.77	
Ecuador	11.03	7.74	72.94	72.14	76.1	75.52	0.58	189981	4.33	4.69	-27.50	
Egypt, Arab Rep.	18.31	12.38	68.59	67.36	71.32	70.45	0.87	2439171	3.98	4.59	-29.27	
El Salvador	17.61	12.30	68.72	67.53	73	72.11	0.89	93265	6.23	6.78	-25.21	
Equatorial Guinea	21.62	16.44	52.11	51.01	57.96	57.02	0.94	26739	11.23	11.78	-14.55	
Eritrea	28.59	23.04	56.03	54.47	64.1	62.66	1.44	238677	14.40	15.04	-7.69	
Estonia	4.25	2.67	70.42	70.12	77.13	76.92	0.21	2557	9.53	9.70	-30.00	
Ethiopia	40.70	30.59	51.93	49.90	64.58	62.66	1.92	6026527	24.36	25.57	-5.42	
Fiji	14.36	12.06	67.61	66.65	70.26	69.42	0.84	14425	3.92	4.16	-12.50	
Finland	2.65	1.85	77.47	77.27	81.39	81.24	0.15	8684	5.06	5.14	-25.00	
France	5.49	4.74	79.06	78.63	82.67	82.28	0.39	306094	4.57	4.64	-9.30	
Gabon	17.15	14.15	59.34	58.34	64.89	63.98	0.91	46685	9.35	9.67	-9.00	
Gambia, The	31.72	24.44	55.58	53.87	60.47	59.03	1.44	118387	8.80	9.58	-15.79	
Georgia	18.95	11.36	71.62	70.29	74.82	73.98	0.84	47626	4.47	5.25	-36.84	
Germany	2.67	2.43	77.93	77.72	81.09	80.89	0.20	138065	4.05	4.08	-4.76	
Ghana	30.56	23.22	56.99	55.30	61.49	60.09	1.40	1249892	7.90	8.66	-17.16	
Greece	4.74	3.57	77.89	77.52	81.59	81.30	0.29	30772	4.75	4.88	-21.62	
Grenada	9.06	8.00	70.25	69.62	73.52	72.94	0.58	1128	4.65	4.77	-7.94	

Guatemala	17.16	12.08	67.74	66.60	71.96	71.10	0.86	382859	6.23	6.76	-24.56
Guinea	27.83	21.59	51.24	49.85	59.19	57.94	1.25	568791	15.52	16.23	-10.07
Guinea-Bissau	55.43	38.10	51.45	48.75	55.47	53.43	2.04	131872	7.81	9.60	-24.44
Guyana	20.13	17.55	64.97	63.69	66.51	65.36	1.15	19586	2.37	2.62	-10.16
Haiti	29.43	25.56	57.68	56.03	63.07	61.50	1.57	403237	9.34	9.76	-4.85
Honduras	18.06	12.77	70.49	69.24	73.33	72.41	0.92	149738	4.03	4.58	-26.40
Hungary	4.19	3.68	71.25	70.95	75.96	75.68	0.28	24355	6.61	6.67	-6.67
Iceland	2.89	1.13	79.65	79.42	82.86	82.77	0.09	394	4.03	4.22	-60.87
India	34.46	23.57	62.63	60.54	68.35	66.78	1.57	39200456	9.13	10.31	-24.88
Indonesia	17.99	13.41	66.25	65.08	69.07	68.16	0.91	4995741	4.26	4.73	-22.22
Iran, Islamic Rep.	9.53	6.48	70.14	69.48	75.59	75.10	0.49	660659	7.77	8.09	-25.76
Iraq	19.99	15.78	69.18	67.82	69.59	68.51	1.08	1314666	0.59	1.02	-20.59
Ireland	4.68	2.73	76.54	76.18	81.5	81.28	0.22	14740	6.48	6.69	-38.89
Israel	4.82	4.21	78.95	78.57	82.05	81.71	0.34	59606	3.93	4.00	-10.53
Italy	3.98	3.35	79.78	79.46	83.49	83.21	0.28	133048	4.65	4.72	-12.50
Jamaica	21.39	19.15	72.31	70.80	75.8	74.38	1.42	56695	4.83	5.06	-5.96
Japan	3.07	2.08	81.08	80.83	83.84	83.67	0.17	177905	3.40	3.51	-32.00
Jordan	13.14	10.60	71.78	70.85	74.2	73.42	0.78	160863	3.37	3.63	-16.13
Kazakhstan	11.18	6.52	65.52	64.80	72	71.53	0.47	184083	9.89	10.39	-34.72
Kenya	27.16	23.02	50.79	49.45	62.13	60.73	1.40	2119678	22.33	22.81	4.48
Kiribati	18.88	16.63	63.95	62.76	66.15	65.07	1.08	3047	3.44	3.68	-9.24
Korea, Dem. P. Rep	19.80	13.69	64.98	63.72	70.34	69.39	0.95	358782	8.25	8.90	-24.60
Korea, Rep.	2.76	2.14	75.84	75.63	82.16	81.98	0.18	82490	8.33	8.40	-14.29
Kuwait	6.65	5.10	73.31	72.83	74.7	74.32	0.38	26392	1.90	2.05	-20.83
Kyrgyz Republic	13.95	10.33	68.56	67.62	70.65	69.93	0.72	124522	3.05	3.42	-23.40
Lao PDR	32.68	24.30	58.88	57.02	66.54	64.96	1.58	272714	13.01	13.92	-15.05
Latvia	5.31	3.61	70.31	69.94	74.12	73.85	0.27	4265	5.42	5.59	-27.03
Lebanon	14.14	9.97	74.43	73.39	79.63	78.84	0.79	80781	6.99	7.43	-24.04
Lesotho	24.77	19.91	47.18	46.04	49.96	48.98	0.98	61136	5.89	6.39	-14.04
Liberia	32.51	21.88	52.41	50.76	61.16	59.85	1.31	197840	16.70	17.91	-20.61
Libya	12.64	8.87	70.57	69.69	71.83	71.20	0.63	78363	1.79	2.17	-28.41
Lithuania	5.82	3.24	72.02	71.60	75.12	74.88	0.24	7782	4.30	4.58	-42.86
Luxembourg	3.88	2.85	77.87	77.57	82.23	82.00	0.23	1533	5.60	5.71	-23.33
Macedonia, FYR	10.91	7.72	73.24	72.45	75.5	74.92	0.58	14379	3.09	3.41	-26.58
Madagascar	21.96	18.54	58.47	57.21	65.48	64.29	1.19	975501	11.99	12.38	-5.56
Malawi	29.57	22.30	44.08	42.81	63.8	62.41	1.39	873074	44.74	45.78	9.45
Malaysia	8.05	5.88	72.87	72.29	74.88	74.44	0.44	242587	2.76	2.97	-24.14
Maldives	19.56	7.87	70.06	68.72	76.98	76.38	0.60	4703	9.88	11.15	-55.22
Mali	45.98	33.63	48.9	46.75	58.46	56.56	1.90	1374120	19.55	20.98	-11.63
Malta	4.98	3.58	78.2	77.81	81.95	81.66	0.29	1080	4.80	4.95	-25.64
Marshall Islands	17.60	15.25	65.24	64.11	73.0	71.90	1.10	1486	11.89	12.15	-2.65
Mauritania	33.60	27.82	60.02	58.07	63.2	61.49	1.71	223877	5.30	5.89	-12.31
Mauritius	13.31	9.60	71.66	70.72	74.35	73.64	0.71	10049	3.75	4.13	-24.47
Mexico	7.03	5.52	74.3	73.78	76.92	76.50	0.42	996849	3.53	3.69	-19.23
Micronesia, Fed. Sts.	21.11	18.39	67.28	65.89	69.23	67.98	1.25	3104	2.90	3.17	-10.07
Moldova	10.44	7.93	66.89	66.20	71.63	71.07	0.56	24171	7.09	7.36	-18.84
Mongolia	12.58	7.34	62.91	62.13	69.82	69.31	0.51	36183	10.98	11.56	-34.62
Montenegro	6.00	3.99	73.18	72.74	76.34	76.04	0.30	2093	4.32	4.54	-31.82
Morocco	34.99	25.13	68.5	66.18	74.29	72.47	1.82	1308787	8.45	9.50	-21.55
Mozambique	27.85	19.50	48.69	47.37	55.37	54.31	1.06	1124273	13.72	14.65	-19.70
Myanmar	30.69	20.36	62.08	60.23	66.04	64.72	1.32	1208919	6.38	7.45	-28.65
Namibia	13.42	11.38	55.12	54.39	64.92	64.19	0.73	54461	17.78	18.02	0.00
Nepal	28.77	18.72	62.33	60.59	69.97	68.68	1.29	708360	12.26	13.35	-25.86
Netherlands	5.31	1.83	77.99	77.58	81.71	81.56	0.15	27000	4.77	5.13	-63.41
New Zealand	3.46	2.26	78.64	78.37	81.46	81.28	0.18	10723	3.59	3.71	-33.33
Nicaragua	11.02	7.50	69.66	68.90	75.1	74.54	0.56	67051	7.81	8.19	-26.32
Niger	40.62	38.07	50.7	48.72	61.97	59.70	2.27	2155744	22.23	22.54	14.65
Nigeria	55.17	44.81	46.62	44.18	53.05	50.77	2.28	15912954	13.79	14.92	-6.56
Norway	3.72	2.19	78.63	78.34	82.1	81.92	0.18	10980	4.41	4.57	-37.93
Oman	9.99	8.51	72.36	71.64	77.32	76.67	0.65	52788	6.85	7.02	-9.72
Pakistan	56.35	45.09	62.77	59.42	66.38	63.52	2.86	15238844	5.75	6.90	-14.63
Palau	10.95	9.01	70.49	69.73	73.0	72.35	0.65	183	3.56	3.76	-14.47
Panama	8.77	6.18	75.1	74.45	77.77	77.29	0.48	36066	3.56	3.81	-26.15
Papua New Guinea	19.21	16.17	58.8	57.69	62.78	61.78	1.00	208629	6.77	7.09	-9.91
Paraguay	19.19	13.57	70.07	68.75	73.03	72.05	0.98	132496	4.22	4.80	-25.76
Peru	13.92	9.03	70.51	69.54	74.78	74.11	0.67	417548	6.06	6.57	-30.93
Philippines	14.53	10.99	66.68	65.73	68.41	67.67	0.74	1743333	2.59	2.95	-22.11
Poland	4.69	2.35	73.75	73.41	78.2	78.02	0.18	65160	6.03	6.28	-47.06
Portugal	3.70	2.18	76.31	76.03	81.52	81.34	0.18	15060	6.83	6.98	-35.71
Qatar	7.58	5.75	76.5	75.92	78.76	78.31	0.45	12904	2.95	3.15	-22.41
Romania	6.80	4.15	71.16	70.68	74.96	74.65	0.31	51582	5.34	5.62	-35.42
Russian Federation	7.75	4.49	65.48	64.98	70.91	70.59	0.32	623961	8.29	8.63	-36.00
Rwanda	27.82	17.59	48.19	46.89	64.52	63.40	1.12	376154	33.89	35.21	-13.85

Samoa	12.10	11.05	69.49	68.66	73.76	72.95	0.81	3672	6.14	6.25	-2.41	
San Marino	4.90	2.60	80.62	80.23	83.3	83.08	0.22	85	3.32	3.55	-43.59	
Sao Tome & Principe	24.88	16.47	63.29	61.75	66.51	65.43	1.08	6835	5.09	5.96	-29.87	
Saudi Arabia	19.22	14.13	72.53	71.16	74.49	73.45	1.04	641306	2.70	3.22	-24.09	
Senegal	35.89	25.09	57.77	55.77	66.8	65.17	1.63	942937	15.63	16.85	-18.50	
Serbia	7.84	5.98	71.58	71.02	75.49	75.04	0.45	41720	5.46	5.66	-19.64	
Seychelles	11.32	9.83	72.4	71.59	73.23	72.52	0.71	1213	1.15	1.30	-12.35	
Sierra Leone	40.71	24.96	38.69	37.18	51.31	50.06	1.25	272876	32.62	34.64	-17.22	
Singapore	3.53	2.58	77.95	77.68	82.6	82.39	0.21	11200	5.97	6.06	-22.22	
Slovak Republic	3.91	2.94	73.05	72.77	77.21	76.98	0.23	12452	5.69	5.79	-17.86	
Slovenia	2.70	2.85	75.41	75.21	81.08	80.85	0.23	5038	7.52	7.50	15.00	
Solomon Islands	20.04	17.91	62.84	61.61	68.15	66.95	1.20	20084	8.45	8.67	-2.44	
Somalia	40.82	36.80	50.88	48.88	55.69	53.71	1.98	880191	9.45	9.88	-1.00	
South Africa	22.94	17.76	55.84	54.59	57.44	56.44	1.00	1014226	2.87	3.39	-20.00	
South Sudan	37.28	30.98	49.22	47.45	56.11	54.42	1.69	727065	14.00	14.69	-4.52	
Spain	3.31	2.88	78.97	78.71	83.38	83.14	0.24	89074	5.58	5.63	-7.69	
Sri Lanka	7.60	4.91	71.11	70.57	74.95	74.58	0.37	115405	5.40	5.68	-31.48	
St. Lucia	13.18	12.16	71.42	70.49	75.18	74.28	0.90	2552	5.26	5.38	-3.23	
St Vincent & the Grenadines	12.57	10.90		70.58	69.70	73.05	72.26	0.79	1285	3.50	3.67	-10.23
Sudan	30.09	24.99	57.97	56.28	63.71	62.16	1.55	1995625	9.90	10.45	-8.28	
Suriname	24.64	19.82	67.93	66.30	71.29	69.90	1.39	13607	4.95	5.43	-14.72	
Swaziland	16.20	12.50	48.66	47.88	48.87	48.27	0.60	21991	0.43	0.81	-23.08	
Sweden	3.81	2.86	79.64	79.34	82.55	82.31	0.24	27100	3.65	3.74	-20.00	
Switzerland	3.25	2.82	79.68	79.42	83.2	82.97	0.23	19685	4.42	4.47	-11.54	
Syrian Arab Republic	14.75	11.27	72.72	71.66	70.09	69.31	0.78	330832	-3.62	-3.28	-26.42	
Tajikistan	19.36	14.18	63.7	62.49	69.77	68.79	0.98	262004	9.53	10.08	-19.01	
Tanzania	32.68	22.94	50.47	48.87	65.49	64.02	1.47	3009700	29.76	31.00	-8.13	
Thailand	7.74	5.00	70.63	70.09	74.6	74.23	0.37	274082	5.62	5.91	-31.48	
Timor-Leste	27.01	18.10	59.35	57.79	68.53	67.31	1.22	63429	15.47	16.47	-21.79	
Togo	46.24	35.36	53.47	51.11	60.12	58.07	2.05	512578	12.44	13.62	-13.14	
Tonga	9.60	8.93	70.76	70.09	72.94	72.29	0.65	1670	3.08	3.14	-2.99	
Trinidad and Tobago	17.94	11.24	68.6	67.39	70.56	69.78	0.78	14743	2.86	3.55	-35.54	
Tunisia	15.01	9.25	73.26	72.18	74.98	74.29	0.69	145185	2.35	2.92	-36.11	
Turkey	12.91	7.05	70	69.11	75.43	74.90	0.53	745884	7.76	8.38	-40.45	
Turkmenistan	22.96	17.31	63.9	62.47	65.74	64.62	1.12	128762	2.88	3.44	-21.68	
Uganda	30.25	21.48	46.42	45.06	59.18	57.94	1.24	1968738	27.49	28.58	-8.82	
Ukraine	12.50	8.88	67.86	67.02	71.19	70.56	0.63	272536	4.91	5.28	-25.00	
United Arab Emirates	8.98	7.42	74.45	73.79	77.54	76.97	0.57	55165	4.15	4.31	-13.64	
United Kingdom	3.67	2.95	77.74	77.46	81.6	81.36	0.24	182057	4.97	5.03	-14.29	
United States	3.12	2.96	76.64	76.40	78.74	78.51	0.23	875684	2.74	2.76	-4.17	
Uruguay	8.57	6.59	74.69	74.06	77.14	76.63	0.51	24562	3.28	3.47	-19.05	
Uzbekistan	15.88	12.19	66.94	65.89	68.45	67.63	0.82	550803	2.26	2.64	-21.90	
Vanuatu	14.37	14.10	67.56	66.60	72.16	71.16	1.00	6797	6.81	6.85	4.17	
Venezuela, RB	9.03	7.18	72.35	71.70	74.41	73.88	0.53	318246	2.85	3.04	-18.46	
Vietnam	15.25	10.25	73.15	72.05	75.78	75.01	0.77	1212550	3.60	4.11	-30.00	
West Bank and Gaza	9.72	7.54	70.76	70.08	73.07	72.52	0.55	82653	3.26	3.48	-19.12	
Yemen, Rep.	38.01	29.87	60.46	58.25	64.03	62.17	1.86	1528448	5.90	6.73	-15.84	
Zambia	27.02	21.30	43.46	42.32	60.79	59.52	1.27	781240	39.88	40.64	11.40	
Zimbabwe	20.35	21.04	41.69	40.86	59.16	57.94	1.22	664926	41.90	41.80	46.99	

Notes: LE and SALE stand for traditional life expectancy and stillbirths adjusted life expectancy, respectively. Out of 194 countries in App. 2, life expectancy data are unavailable for Andorra, Cook Islands, Dominica, Monaco, Nauru, St. Kitts and Nevis, and Tuvalu. Traditional Life expectancy data is from World Development Indicators (WDI). WDI does not have 2015 life expectancy numbers for Marshall Islands and Palau. These numbers as estimated by U.S. Census Bureau: International Database are used. SLBR numbers are from App. 2. $|\text{SALE}-\text{LE}|$ measures decrease in life expectancy due to considering stillbirths. The last column gives its % change.