



Midwifery 2

The projected effect of scaling up midwifery

Caroline S E Homer, Ingrid K Friberg, Marcos Augusto Bastos Dias, Petra ten Hoope-Bender, Jane Sandall, Anna Maria Speciale, Linda A Bartlett

Lancet 2014; 384: 1146–57

Published Online
June 23, 2014

[http://dx.doi.org/10.1016/S0140-6736\(14\)60790-X](http://dx.doi.org/10.1016/S0140-6736(14)60790-X)

This online publication has been corrected. The corrected version first appeared at [thelancet.com](http://www.thelancet.com) on Sept 19, 2014

See [Comment](#) page 1075

See [Perspectives](#) page 1089

This is the second in a [Series](#) of four papers about midwifery

Faculty of Health, University of Technology Sydney, NSW, Australia

(Prof C S E Homer PhD);

Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

(I K Friberg PhD,

L A Bartlett MD); Department of Obstetrics, Instituto

Fernandes Figueira-FIOCRUZ, Rio de Janeiro, Brasil

(M A B Dias PhD); Instituto de Cooperación Social Integrare, Barcelona, Spain

(P ten Hoope-Bender MBA);

Autonomous University of Barcelona, Barcelona, Spain

(A M Speciale CNM); and Division of Women's Health,

We used the Lives Saved Tool (LiST) to estimate deaths averted if midwifery was scaled up in 78 countries classified into three tertiles using the Human Development Index (HDI). We selected interventions in LiST to encompass the scope of midwifery practice, including prepregnancy, antenatal, labour, birth, and post-partum care, and family planning. Modest (10%), substantial (25%), or universal (95%) scale-up scenarios from present baseline levels were all found to reduce maternal deaths, stillbirths, and neonatal deaths by 2025 in all countries tested. With universal coverage of midwifery interventions for maternal and newborn health, excluding family planning, for the countries with the lowest HDI, 61% of all maternal, fetal, and neonatal deaths could be prevented. Family planning alone could prevent 57% of all deaths because of reduced fertility and fewer pregnancies. Midwifery with both family planning and interventions for maternal and newborn health could avert a total of 83% of all maternal deaths, stillbirths, and neonatal deaths. The inclusion of specialist care in the scenarios resulted in an increased number of deaths being prevented, meaning that midwifery care has the greatest effect when provided within a functional health system with effective referral and transfer mechanisms to specialist care.

Introduction

Midwifery is one effective means to promote the health and wellbeing of women of childbearing age and their newborn infants and families, with a potentially rapid and sustained effect on population health outcomes¹ through the provision of maternal and newborn interventions. The interventions known to be effective in improving health outcomes, such as antenatal corticosteroids for women in preterm labour² and midwife-led care,³ have been detailed in the *Cochrane Library* and the *Essential interventions, commodities and guidelines for reproductive, maternal, newborn and child health*.⁴ This last review⁴ identified 56 essential interventions that, when implemented in packages relevant to local settings, were most likely to save lives, especially in low-income and middle-income

populations. As part of this *Lancet* Series about Midwifery, Mary Renfrew and colleagues¹ re-examined the effective interventions that have been shown to improve maternity-related outcomes for women and newborn infants, and showed that midwifery, as delivered by midwives and others with midwifery skills, can deliver most effective maternal and newborn health interventions, including the elements (also known as signal functions) for basic emergency obstetrics and neonatal Care (BEmONC; ie, assisted delivery, removal of retained products, manual removal of the placenta, administration of oxytocic drugs, antibiotics, and anticonvulsants, and neonatal resuscitation).¹ Interventions, including blood transfusions or caesarean section capacity (indicative of comprehensive EmONC [CEmONC]), are classified as specialist (ie, that require the input of a medical practitioner with advanced skills in obstetrics and advanced medical equipment and medicines). Renfrew and colleagues¹ definition of midwifery is used in this and all other articles in this Series.

The practice of midwifery is defined as “skilled, knowledgeable, and compassionate care for childbearing women, newborn infants and families across the continuum from pre-pregnancy, pregnancy, birth, post partum and the early weeks of life. Core characteristics include optimising normal biological, psychological, social, and cultural processes of reproduction and early life, timely prevention, and management of complications, consultation with and referral to other services, respecting women’s individual circumstances and views, and working in partnership with women to strengthen women’s own capabilities to care for themselves and their families”.¹

The effect of scaling-up midwifery and the associated interventions provided by midwifery services is not presently known. We used the Lives Saved Tool (LiST)

Key messages

- Midwifery can deliver most effective maternal and newborn health interventions, and can enable access to specialist and comprehensive emergency care when necessary.
- Universal coverage of these interventions will result in reductions in maternal deaths, stillbirths, and neonatal deaths in 78 countries classified according to the HDI.
- In countries in the lower HDI tertile, maternal mortality would decrease by 27% with a modest (10%) increase in coverage of the interventions delivered by midwifery, including family planning, over a 15-year period (2% per year on present baseline estimates), by 50% with a substantial coverage increase (25%), and by 82% with universal coverage (95%). We noted similar reductions on stillbirths and neonatal deaths.
- Family planning alone also contributed to substantially decreasing deaths, since fewer women are exposed to the risk of maternal death. The full scope of midwifery practice should include family planning.
- In addition to the estimation of mortality, morbidity, quality of life, and wellbeing should also be measured to provide more detailed evidence on the full effect of midwifery.
- At all HDI levels, about 30% of maternal deaths could be averted by midwifery, with an additional 30% averted with the addition of specialist medical care.

HDI=human development index.

to estimate deaths averted if midwifery was scaled-up in 78 countries classified by Human Development Index (HDI).

Measurement of maternal and child health outcomes

An estimated 15–20 million women are affected every year by substantial morbidity as a result of childbirth,^{5,6} affecting not only the woman, but also her baby, other children, and members of the broader community. To determine the full effect of midwifery on women and newborn infants, biological (ie, morbidity and mortality), financial, social, and psychological outcomes would need to be measured.¹ Poor maternal health contributes to economic hardship, with potentially longer-term outcomes, including violence, stigmatisation, isolation, and divorce.^{5,7} Additionally, mental health disorders in women have long-term implications for children,^{8,9} and the effects of maternal depression might affect children's lives as they grow up, in the form of behavioural disorders, anxiety, depression, and impaired cognitive development.^{10–14} These morbidity outcomes are often not measured or available, and thus difficult to account for at a population level.^{5,3} Indexes of optimality have been proposed that count the frequency of optimum rather than suboptimum events during childbirth,^{15–20} although these are not widely used. Our analysis focuses on changes in maternal, fetal, and neonatal mortality estimated by scaling-up midwifery and specialist care.

Coverage of maternal and newborn health interventions

Regardless of the challenges associated with measurement, to improve outcomes, sufficient coverage of maternal and newborn interventions is required. The *Countdown to 2015 for maternal and child survival* tracks progress towards achievement of Millennium Development Goals (MDGs) 4 and 5 in 75 high-burden countries^{21–26} and has shown that the overall coverage of several components of midwifery is low, such as satisfaction of family planning needs (54%), four or more antenatal care visits (50%), skilled birth attendance (54%), and early initiation of breastfeeding (47%). Midwifery is one means by which to deliver the effective maternal and newborn interventions as a package of care,¹ which is likely to be more effective than individual interventions alone.^{4,27}

Renfrew and colleagues¹ developed the framework for quality maternal and newborn care in this Series that offers a mechanism for analysing the scope and contribution of skilled birth attendants. Midwives are the core group that have the skills, knowledge, and competencies to deliver the full scope of quality midwifery care described in this framework if they are regulated and educated to international standards, such as the International Confederation of Midwives (ICM)'s *Essential competencies for basic midwifery practice*,²⁸ which include family planning. However, in areas where there

are insufficient midwives, other providers with midwifery skills can provide some or many of the effective interventions.¹

Will an increase in coverage of midwifery avert deaths?

Renfrew and colleagues¹ have shown that midwifery is an effective and probably cost-effective means to provide reproductive, maternal, and newborn services. Therefore, we sought to establish the effect of scaling-up such services on maternal and neonatal deaths. We aimed to estimate the effect of midwifery, as defined in this Series,¹ on maternal and newborn outcomes. The two objectives to achieve this aim were to estimate maternal, fetal, and neonatal deaths averted using the Lives Saved Tool (LiST)^{29,30} under different scenarios of coverage of midwifery from 2010 to 2025 in 78 low-income and middle-income countries, classified into three groups using the human development index (HDI); and to estimate the value of the incremental addition of specialist care to midwifery on maternal, fetal, and neonatal lives saved.

The Lives Saved Tool

LiST is one module in the Spectrum Policy Modeling Software.³¹ Other Spectrum modules include HIV, demography, and family planning. LiST was selected as one tool that has the proven capacity to estimate the effect of discrete midwifery interventions, rather than a package of care as in the quality maternity framework, in *The State of the World's Midwifery 2014 Report*.³² In brief, the LiST model starts with a given population's current health and mortality status, and coverage of health interventions. The model then links those values to changes in coverage of health interventions with the effectiveness estimates to calculate the number of lives saved through changes in coverage (appendix). We used the Spectrum version 4.51 of LiST for all analyses.

LiST was developed by the Child Health Epidemiology Reference Group for the 2003 Child Survival Series³³ and has since expanded to include interventions from the *Lancet's* 2005 Neonatal Series,³⁴ the 2008 Nutrition Series,³⁵ the 2011 Stillbirth Series,³⁶ and the 2013 Child Nutrition Series.³⁷ It has been updated by two supplements of effectiveness information^{38–50} and also now includes effects on maternal mortality,⁵¹ results of which were presented in *The Lancet* Stillbirths Series.³⁶ Full details of effectiveness estimates and validation are available elsewhere.^{30,43,44,52,53}

LiST can only estimate cause-specific changes in mortality (maternal, fetal, and neonatal), calculated by combining the best available evidence of health intervention effectiveness with population-specific health intervention coverage changes, mortality rates,^{29,43,48,54} and causes of death.^{21,48,55} Stillbirths are classified as either antepartum or intrapartum,⁵⁵ with interventions affecting each type separately. LiST has only been used to estimate mortality effects in low-income and some middle-income countries, and cannot calculate indirect effects or all-cause

King's College London,
Women's Health Academic
Centre King's Health Partners,
St Thomas' Hospital, London,
UK (Prof J Sandall PhD)

Correspondence to:
Prof Caroline S E Homer, Faculty
of Health, University of
Technology Sydney, PO Box 123,
Broadway, NSW 2007, Australia
caroline.homer@uts.edu.au

For the *Cochrane Library* see
<http://www.thecochranelibrary.com/view/0/index.html>

For the *Countdown to 2015
for maternal and child survival*
see [http://www.
countdown2015mnch.org](http://www.countdown2015mnch.org)

See Online for appendix

effects that have no known biological mechanism. LiST is limited to modelling effects on mortality and does not model effects on experience of care; morbidity; other potential benefits, such as wellbeing, empowerment, and self-reliance; or intergenerational issues. As far as we are aware, there are no other methods that would allow for a similar quantitative analysis of non-mortality effects.

Effective interventions and estimation of their baseline coverage

The effective maternal and newborn health interventions were those identified in the *Essential interventions, commodities and guidelines for reproductive, maternal, newborn and child health*,⁴ and in the study by Renfrew and colleagues,¹ as being able to be delivered as part of midwifery services, particularly by midwives educated to international standards and who are integrated into the health system. Specialist medical interventions were those requiring medical assistance such as blood transfusions or caesarean sections (indicative of CEmONC).¹

We obtained data for baseline coverage of maternal and newborn health interventions from the most recent Demographic and Health Surveys or Multiple Indicator Cluster Surveys (MICS). If no data were available for an indicator, we used the average for similar countries in terms of HDI. We identified assumptions or indicators used in the LiST model in *The Lancet Neonatal Series*,³⁴ which are described in the LiST manual too.⁵⁶ These assumptions include the association between four or more antenatal care visits and activities, such as access to syphilis detection and treatment; between skilled attendance at birth, facility delivery, and access to emergency obstetric care and signal functions (including neonatal resuscitation); and between birth care and hospital-based care for severe newborn infections³⁴ (table 1). For many indicators, no standard LiST proxy is available so we selected unique ones for this analysis, aiming for consistency with the standard proxies.

Interventions

We modelled the effect of increasing coverage of maternal and newborn health interventions by calculating effect sizes for every intervention and outcome linkage (see appendix for a full list of estimates used). Whenever an individual effect size could be established, we separated the specific interventions from the larger package and used them separately in the model. For example, we estimated the individual effect sizes of interventions, such as administration of magnesium sulphate for the management of severe pre-eclampsia or eclampsia, active management the third stage of labour, and neonatal resuscitation, from literature reviews of the evidence, and included them as individual effect sizes. When effect sizes were not known for individual interventions, we included them in the intervention of labour and birth care by a skilled attendant at birth. When we modelled this intervention

at the level of an adequate CEmONC, we assumed it included caesarean sections and blood transfusions. When we modelled skilled attendant at birth at the level of an adequate BEmONC, we excluded caesarean sections, blood transfusions, or any interventions that would require these two CEmONC activities, but included other interventions that could be deemed to be BEmONC (eg, clean birth and management of post-partum haemorrhage and post-partum sepsis). For this analysis, we used all standard effect sizes available in LiST, except in a few cases, in which no published effect sizes were available—eg, maternal sepsis case management. We therefore estimated that 80% of all maternal sepsis deaths could be prevented with appropriate case management, including parenteral antibiotics, based on a Delphi analysis⁵⁷ and additional historical data.⁵⁸

Construction of the standard populations

We included 78 countries, incorporating all 58 countries in *The State of the World's Midwifery 2011 Report*³² and extending to all additional *Countdown 2015* countries.¹ These 78 countries are high-burden, low-income and middle-income countries, which account for 97% of maternal and 94% of neonatal mortality.^{59,60}

We used the HDI⁶¹ to classify the countries. The HDI is a composite statistic of life expectancy, education, and income indexes. We selected the HDI after examining several other databases that contained more women-focused indicators, including the Social Institutions and Gender Index⁶² and the Gender Inequality Index.⁶³ These databases did not contain complete data for our countries of interest and we therefore excluded them. We also examined other possible social determinants, including women's status, inequality, water and sanitation, and proportion of urban population. These searches resulted in country groupings similar to those obtained using HDI.

We used the HDI to categorise the 78 countries into three equal groups of 26 countries (table 2). We did this to generate estimates of deaths averted within every group. Group A includes the lowest HDI countries, group B includes low-to-moderate HDI countries and group C includes moderate-to-high HDI countries. Within every tertile (groups A, B, and C), we generated the average mortality rates and ratios, health intervention coverage values, HIV prevalence, contraceptive prevalence rate, and total fertility rates. For a baseline for every group, we applied the coverage of the effective interventions on a hypothetical standardised baseline population of 1 million people for the year 2010, using the UN population projections for 2010⁶⁴ built into the modelling software (appendix).

Modelling scale-up of interventions on the standardised populations

Using the standardised baseline populations, we developed several scenarios between 2010 and 2025.

For more on MICS see <http://www.childinfo.org>

The first scenario shows the numbers of deaths that are likely to be noted in 2025 with no change in coverage of the interventions and no change in present fertility rates, overriding the UN Population Division-projected secular trends in fertility and mortality (scenario 0; table 3).

Indicator or proxy indicator and translation formula if no standard indicator is available	
Before conception (family planning)	
Contraceptive prevalence rate	Percentage of women at risk of getting pregnant using any method of contraception
Around the time of conception	
Folic acid supplementation	Proxy: ANC4+; formula: 5% of women who have ANC4+ receive folic acid (ie, assumes that 5% of women receiving four antenatal visits will receive folic acid supplementation)
Ectopic pregnancy case management	Proxy: access to EmONC; formula: if facility delivery is >50%, 0.75 × facility delivery; if facility delivery is 30–50%, 0.50 × facility delivery; if facility delivery is <30%, 0.10 × facility
Safe abortion services	Percentage of women getting an abortion who have a safe abortion (ie, medical or surgical)
Post-abortion care	Proxy: access to EmONC; formula: if facility delivery is >50%, 0.75 × facility delivery; if facility delivery is 30–50%, 0.50 × facility delivery; if facility delivery is <30%, 0.10 × facility delivery
After conception (antenatal care)	
Tetanus toxoid	Protected by tetanus toxoid at birth
IPTp	Percentage of pregnant women protected against malaria with two or more doses of sulfadoxine-pyrimethamine (treatment options)
Multiple micronutrient supplementation	Percentage receiving iron-folate during pregnancy for ≥90 days
Calcium supplementation	Proxy: ANC4+; formula: 5% of women who have ANC4+ receive calcium supplementation
Balanced energy supplementation	Proxy: ANC 4+; formula: ANC4+ × the proportion of children aged 6–23 months appropriately fed (included as effects on prematurity and neonatal death)
Syphilis detection and treatment if needed	Proxy: ANC4+; formula if ANC4+ is >75, 0.70×ANC4+; if ANC is 40–75%, 0.5 × ANC4+; if ANC4+ is <40%, 0.2 × ANC4+
Diabetes case management	Proxy: ANC 4+; formula: 5% of women who have ANC4+ have diabetes requiring and receiving management
Screening for and management of pre-eclampsia with MgSO ₄	Proxy: ANC 4+; formula: 5% of women who have ANC4+ are screened for pre-eclampsia and managed with MgSO ₄
Case management of malaria in pregnancy	Proxy: ANC 4+; formula: 5% of women who have ANC4+ are managed for malaria in pregnancy
Screening and management of fetal growth restriction	Proxy: ANC 4+; formula: 5% women who have ANC4+ are screened and managed for fetal growth restriction
PMTCT	Percentage of pregnant women who are HIV positive receiving option A
During labour and birth	
Clean birth practices	Formula: 50% skilled birth attendance at home; 60% essential care; 85% BEmONC; 95% CEmONC
Immediate assessment and stimulation	Formula: 25% skilled birth attendance at home; 50% essential care; 80% BEmONC; 90% CEmONC
Skilled birth attendant at birth	Formula: 100% of skilled birth attendance
Neonatal resuscitation	Formula: 20% BEmONC; 70% CEmONC
Antenatal corticosteroids for preterm labour	Formula: 20% essential care; 85% BEmONC; 95% CEmONC
Antibiotics for pPRoM	Formula: 20% essential care; 85% BEmONC; 95% CEmONC
MgSO ₄ for eclampsia	Formula: 20% essential care; 85% BEmONC; 95% CEmONC
Active management of the third stage of labour	Formula: 20% essential care; 85% BEmONC; 95% CEmONC
Induction of post-term labour	Formula: 20% CEmONC
Post-partum and newborn care	
Thermal care and clean postnatal practices	Proxy: 100% of a postnatal visit within 48 h of birth
Kangaroo mother care	Proxy: facility delivery; formula 5% of facility delivery
Maternal sepsis case management	Proxy: facility delivery; formula: if facility delivery is >50%, 0.5 × facility delivery; if facility delivery is between 30–50%, 0.2 × facility delivery; if facility delivery is <30%, 0.1 × facility delivery
Breastfeeding promotion	Proxy: Percentage of newborn infants being breastfed exclusively, predominantly, partly, and not at all
Hospital-based care for severe newborn infections	Proxy: facility delivery; formula: if facility delivery is >50%, 0.5×facility delivery; if facility delivery is between 30% and 50%, 0.2 × facility delivery; if facility delivery is <30%, 0.1 × facility delivery

ANC4+=four or more antenatal care visits. EmONC=emergency obstetrics and newborn care. IPTp=intermittent preventive treatment of malaria in pregnancy. SP=sulfamethoxazole-pyridine. PMTCT=prevention of mother-to-child transmission of HIV. BEmONC=basic emergency obstetrics and newborn care. CEmONC=comprehensive emergency obstetrics and newborn care. pPRoM=premature prelabour rupture of membranes. *In the absence of data, we used formulas to estimate the proportion of indicated cases that receive management. For example, we estimated the proportion of ectopic pregnancy patients that obtain treatment with the assumption that when facility-based deliveries are more than 50%, 75% of women who give birth in a facility who need the intervention receive ectopic management or post abortion care if required.

Table 1: Health indicators modelled and proxies used for estimating baseline coverage of health interventions

Countries included*

Group A: low HDI†	Afghanistan, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Liberia, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Somalia‡, Sudan§, Zambia, Zimbabwe
Group B: low-to-moderate HDI	Angola, Bangladesh, Bhutan, Cambodia, Cameroon, Congo (Brazzaville), Haiti, Kenya, Laos, Lesotho, Madagascar, Mauritania, Myanmar, Nepal, Nigeria, Pakistan, Papua New Guinea, Sao Tome and Principe, Senegal, Solomon Islands, Swaziland, Tanzania, Timor-Leste, Togo, Uganda, Yemen
Group C: high HDI	Azerbaijan, Bolivia, Botswana, Brazil, China, Equatorial Guinea, Egypt, Gabon, Ghana, Guatemala, Guyana, India, Indonesia, Iraq, Kyrgyzstan, North Korea¶, Mexico, Morocco, Nicaragua, Peru, Philippines, South Africa, Tajikistan, Turkmenistan, Uzbekistan, Vietnam

HDI=human development index. *78 countries included in Countdown 2015 and *The State of the World's Midwifery 2014 Report*.²² †The terminology of low, low-moderate, and moderate-high reflects the human development index category. ‡Somalia was moved from its other country category into low HDI. §Sudan was included before disaggregation into South Sudan and Sudan. ¶North Korea was moved from its other country category into moderate-high HDI.

Table 2: Countries included in the three standardised populations (per 1 million population) based on HDI category

Description	Percentage change
0 No change from current	No change in current coverage rates
1 Modest scale-up in coverage	10% increase in each of 3 5-year periods
2 Substantial scale-up in coverage	25% increase in each of 3 5-year periods
3 Universal coverage of all interventions	95% coverage of each intervention
4 Attrition back from current status	2% reduction in each of 3 5-year periods

Table 3: Scenarios used in modelling the impact of midwifery

The remaining scenarios estimated the effect of different increases in coverage. The first estimated a modest increase for each of the health interventions (scenario 1). We defined modest as a relative 10% increase above baseline coverage rates for every intervention for every 5-year period between 2010 and 2025. The next scenario was a substantial scale-up (scenario 2), which we defined as a relative 25% increase above the baseline coverage rate for each intervention for every 5-year period between 2010 and 2025. In the third scenario, we postulated universal coverage to be 95% of all interventions by the year 2025 (scenario 3; appendix).

To highlight the risks of a deteriorating system (ie, population growth, but no additional resources, access, or staffing), we included a negative scenario, which estimated the deaths averted with a 2% decrease below baseline coverage of the interventions over every 5-year period between 2010 and 2025 (scenario 4). We analysed all four scenarios in three ways. The first analysis included all maternal and child health interventions, along with family planning (scaled-up contraceptive prevalence rates), whereas the second only included the maternal and child health interventions, with no change in contraceptive prevalence rate. The third analysis only looked at the changes in family planning through scaling-up contraceptive prevalence rate (data not shown for all analyses).

Quality of care cannot be modelled as a direct input into LiST. However, LiST was designed to assume that as

coverage of delivery care services increases, there will be a corresponding increase in quality.³⁴ This means that the model assumes that as coverage increases, services become more complete, moving from minimum access to skilled delivery care provision, and then through BEmONC to CEmONC, a full package of care including referral to specialist care. In the model, quality increases substantially faster when institutional delivery is greater than 95% than when it is between 50% and 95%. Similarly, quality increases faster between 30% and 50% than between 0% and 30%.

Deaths averted under different increased coverage scenarios

A modest increase in coverage of midwifery, including family planning, by 10% every 5 years (scenario 1) could result in a 27.4% reduction in maternal deaths in the group A countries, a 35.9% reduction in the group B countries, and a 62.7% reduction in the group C countries (table 4). Given the lower number of maternal deaths in the group C countries than in the other groups, a reduction in the absolute number of maternal deaths resulted in a larger proportional effect in group C than in group A countries. Similar reductions were seen for stillbirths and neonatal deaths. Using our standardised population sizes, the reduction in absolute numbers of deaths was largest in the group A countries, smaller in group B, and the smallest in group C (table 4). In the lowest levels (group A), the very basic facility delivery care is increased, with a minimal increase in emergency care. At the highest level (group C), basic care is available to all people, so the scale-up results in substantial quality improvement. We noted similar results relative to the mortality rates and ratios (appendix). This is because quality, in terms of availability of CEMONC versus BEMONC, increases at a greater rate at higher levels of coverage.

A substantial increase in coverage every 5 years (scenario 2) resulted in a similar pattern, with the greatest reductions in numbers of maternal deaths, neonatal deaths, and stillbirths in 2025 being noted in group A countries (table 4). However, the greatest percentage reduction of maternal deaths was found in the group B countries, at 75.4% (table 4, figure 1).

In group A countries, stillbirths decreased by 26.3% from no change in coverage (scenario 0) to a modest increase in coverage (scenario 1). In scenario 2, with substantial increase in coverage, stillbirths reduced by 49.7%, whereas with universal (95%) coverage (scenario 3), there was a 75.9% reduction. By contrast with this was scenario 4 (attrition), where stillbirths had a marginal increase. We noted similar substantial reductions in neonatal deaths (table 4). The analyses in figure 1 included family planning as an integral part of midwifery as a package of care because family planning utilisation reduces fertility, which reduces the number of women at risk of maternal death and stillbirth or neonatal death.

	Scenario 0: no change (deaths [n])	Scenario 1: modest scale-up*		Scenario 2: substantial scale-up†		Scenario 3: universal coverage‡		Scenario 4: attrition§		
		Deaths (n)	Reduction (%)	Deaths (n)	Reduction (%)	Deaths (n)	Reduction (%)	Deaths (n)	Reduction (%)	
Group A: low HDI¶										
Maternal deaths	300	200	27.4%	150	49.7%	50	81.5%	300	-2.3%	
Stillbirths	1850	1350	26.3%	900	49.7%	450	75.9%	1900	-2.4%	
Neonatal deaths	2000	1450	26.8%	950	52.6%	200	90.3%	2100	-4.0%	
Group B: low-to-moderate HDI 										
Maternal deaths	150	100	35.9%	40	75.4%	30	77.5%	150	-5.5%	
Stillbirths	1200	800	32.1%	400	67.2%	350	69.4%	1300	-4.1%	
Neonatal deaths	1300	850	34.9%	350	73.9%	150	87.9%	1400	-5.8%	
Group C: moderate-to-high HDI**										
Maternal deaths	50††	20	62.7%	15	68.0%	15	69.8%	50	-11.1%	
Stillbirths	800	400	50.1%	400	51.0%	400	52.9%	900	-9.9%	
Neonatal deaths	550	250	52.5%	200	63.6%	100	77.4%	600	-12.7%	

See appendix for mortality rates and ratios. HDI=human development index. *10% increase in coverage every 5 years (2010–25). †25% increase in coverage every 5 years (2010–25). ‡95% coverage by 2025. §2% decrease in coverage every 5 years (2010–25). ¶156 000 births. ||46 500 births. **29 000 births. ††All numbers were rounded to portray the precision of model assumptions. The percentage reduction calculations were done on unrounded numbers of deaths; see appendix for raw data.

Table 4: Reductions of maternal, fetal, and neonatal deaths by 2025 in four scale-up scenarios of midwifery care and three HDI categories, per 1 million people

To assess the effect that midwifery has on maternal, fetal, and newborn outcomes, we assessed the reduction in the number of deaths caused by the maternal and newborn health interventions separately from the increase in family planning use. With universal coverage of maternal and newborn health interventions only, excluding family planning, for group A countries, 60.9% of all maternal, fetal, and neonatal deaths could be prevented (appendix).

We did an additional analysis to examine the reduction with universal coverage (scenario 4), but excluding family planning. In the three HDI groups, 29.9% of maternal deaths are averted by midwifery care. Similarly, at all HDI levels, 23.8–31.0% of stillbirths can be averted with midwifery care. Alternatively, more than half of neonatal deaths can be prevented through midwifery care. If family planning was included as part of midwifery, 44.7–80.6% of maternal, fetal, and neonatal deaths would be prevented (figure 2A). In particular, in Group C countries, family planning alone could avert 57.2% of all deaths because of reduced fertility and fewer pregnancies. In combination, the full package of midwifery care with both family planning and maternal and newborn health interventions could avert a total of 83.3% of all maternal deaths, stillbirths, and neonatal deaths (appendix).

Estimation of the additive value of specialist care

The second aim of this study was to estimate the value of adding specialist (obstetrician) care to midwifery on maternal, fetal, and neonatal lives saved. To do this, we included all activities that could reasonably be delivered by a midwife to be midwifery care,²⁸ covering activities ranging from community-based to BEmONC-level care; these are included in the first four boxes in the

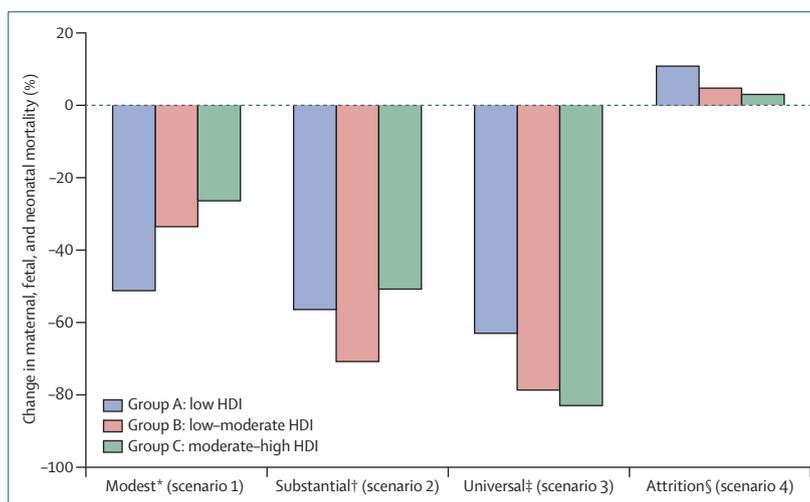


Figure 1: Total percentage changes in maternal, neonatal, and fetal mortality, by level of HDI, under 4 different intervention scenarios, per 1 million population.

HDI=human development index. *10% increase in coverage every 5 years (2010–25). †25% increase in coverage every 5 years (2010–25). ‡95% coverage by 2025. §2% decrease in coverage every 5 years (2010–25).

framework for quality maternal and newborn care' in this Series.

We included additional interventions deemed to be CEmONC or that require medical care as specialist care. These activities included safe abortion services, ectopic pregnancy case management, diabetes case management, labour and delivery at the CEmONC level (including caesarean section and blood transfusion), antenatal corticosteroids for preterm labour, induction of labour for post-term pregnancies, and hospital-based case management of severe newborn infection. We deemed antenatal corticosteroids for preterm labour and induction

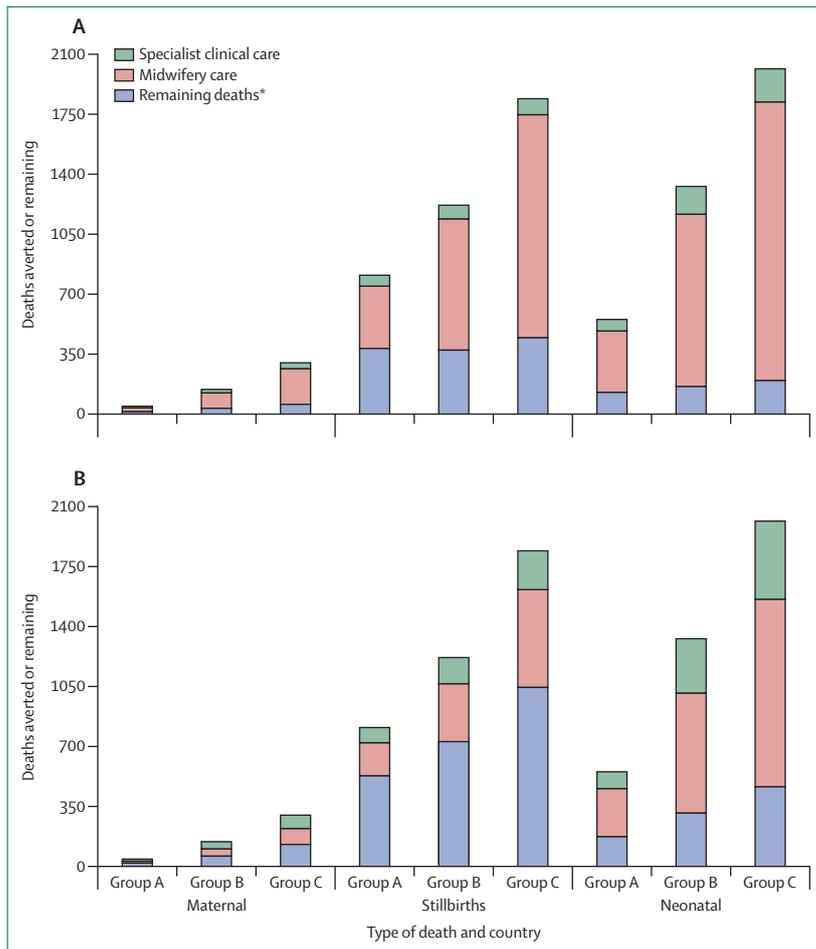


Figure 2: Number of maternal, fetal, and neonatal deaths averted by midwifery care and specialist care of deaths that would have occurred in 2025 with no scale-up, per 1 million population
 (A) Including family planning. (B) Excluding family planning. *Deaths that would not necessarily be averted by the achieved coverage of the specific interventions in the model.

of labour to be part of specialist care as they required obstetric and newborn service provision. This analysis allowed us to examine the effect of midwifery as a package of care, with the cumulative effect of linking to specialist medical care.

We noted an additional effect on deaths averted when specialist care is included in the model for scenario 3 (universal coverage). However, this effect is far less pronounced than that of midwifery care (both maternal and child health, and family planning), regardless of the inclusion of family planning (figure 2).

Interpretation

Even modest increases in coverage can save lives

Even at the lowest level of scale-up, of 10% per 5 years relative to baseline, we noted a noticeable reduction in the number of maternal and neonatal deaths, with the greatest absolute reduction in the low-HDI countries. The largest percentage reduction was seen in the

moderate-to-high HDI category, possibly because the overall coverage was already high (75% of institutional births), so quality was most likely to be affected.

Analyses and reports in the past two decades^{25,26,65} have highlighted the need to scale-up coverage of maternal and newborn interventions. In many countries, this has not occurred because of a range of political, social, cultural, and resource constraints.¹ The challenge facing health policy makers and planners is how to scale up high-quality midwifery services while addressing the complexity of the underlying issues.⁶⁶ For the most part, scaling up is a political decision that includes the allocation of resources, along with the buy-in of professional groups and the views and demands or needs of the population,⁶⁶ with countries trying to make decisions that provide the best outcomes for the lowest cost.

We recognise that our best-case scenario (universal coverage by 2025) assumes that efficacious, quality interventions are effectively delivered within a functional health system by a team of fully-competent midwifery and specialist medical staff linking from community to primary, secondary, and tertiary services. In view of the current worldwide challenges associated with competencies and quality of care, and the insufficient attention to life-saving functions in many midwifery curricula, this is probably an overestimation of the effect. The best-case scenario will be challenging for many countries to achieve; nonetheless, it shows the possible effects if political will and substantial planning and resources were in place. Some countries have managed to show important improvements in maternal mortality with substantial scale-up of access to effective interventions.^{67,68} For example, Eritrea, Bangladesh, and Egypt are low-resource countries that are deemed on track to reaching the MDGs with a greater than 5·5% reduction in maternal mortality rates every year since 1990.⁶⁹

Contribution of family planning

Midwifery includes community-based interventions such as family planning. In a combined model of care that included maternal and newborn infant interventions, and family planning, family planning has the most substantial effect on deaths averted because of a reduction in the number of pregnancies that are of potential risk for mother, foetus, and newborn infant. The importance of family planning in preventing deaths has been well articulated.⁷⁰ The Series on family planning in *The Lancet*^{71,72} again emphasised the importance of a focus on family planning to improve the health of communities. It has been estimated that increasing contraceptive use in developing countries has reduced the number of maternal deaths by 40% over the past 20 years because of a reduction in the number of unintended pregnancies.^{71,73}

The full scope of midwifery includes family planning, highlighting the substantial contribution that midwives

can make to averting deaths through enabling access to family planning. Another modelling analysis⁷⁴ using *Spectrum* in two small island nations in the South Pacific showed that meeting family planning needs would substantially reduce the number of unintended pregnancies, high-risk births, and maternal and infant deaths. Furthermore, preventing unintended pregnancies would have substantial economic benefits for the health and education sectors.⁷²

In practice, scaling up of maternal and newborn interventions, and family planning, as part of midwifery as a package of care has to occur in parallel, since both are dependent on a functional workforce and health service. Family planning is an integral part of midwifery²⁸ and so midwifery could be a means to gain access to family planning. Countries that have increased family planning coverage have shown reductions in maternal mortality.⁷⁵ For example, the total fertility rate in Bangladesh has fallen from 6.3 to 2.7 between 1975 and 2007; the contraceptive prevalence rate increased from 8% to 56% between 1975 and 2007, and the maternal mortality ratio has decreased from 800 in 1990 to 240 in 2010.⁷⁶

Effect of specialist care

In our second analysis, we estimated the lives saved based on an incremental increase from midwifery alone to midwifery with specialist medical care. Regardless of the inclusion of family planning, the effect of specialist medical services is less pronounced than the initial effect noted from activities deemed to be part of midwifery as a package of care. In our analysis, we found the incremental benefit of specialist medical care to be most substantial on maternal mortality, where up to 20% of maternal deaths are able to be prevented by activities that require CEmONC. We recognise that, just like medical and surgical care, midwifery must be situated within a functional health system with an effective referral system, including communications and transportation equipment, and readily-accessible, equipped, and staffed health facilities that can provide specialist medical care.¹ We also assumed in this analysis that specialist medical skills are available in a functional health system. In countries that do not have sufficient obstetricians and gynaecologists, the ability to provide specialist medical care will be restricted and the potential benefits therefore less.

Investing in improved outcome measurement for the future

We used maternal, fetal, and neonatal mortality as the primary outcomes of our analysis because they are the most readily available. Most clinical outcomes in maternal and newborn infant health take a negative rather than positive perspective, such as the measurement of death or disability. Future analyses should focus on broader outcomes, particularly morbidity, mental health,

and quality of life, as these can also be affected by midwifery.¹ Substantial investments in the development of standardised methods and the implementation of strategies to collect and collate data need to occur. Measurement strategies for mortality and morbidity should be suited to the needs and resources of the particular country, and must strengthen the country's technical capacity to generate and use credible estimates too.^{77,78} Measurement of broader maternal and newborn outcomes will provide more detailed evidence about quality of services, which can then be tied to the measurement of accountability and action for scaling up midwifery to improve maternal and newborn services, and to ensuring that services are designed to better meet the needs of women.^{65,79}

Outcomes in high-income countries, where quality of care and other health outcomes might have a different priority than additional deaths averted, need to be examined differently. Nonetheless, quality of care and the experiences of women are important in settings of high, middle, and low incomes, and are likely to influence health-seeking behaviours and outcomes. The panel explains the contribution that midwife-led care and units in high-income countries have on improving outcomes, including positive outcomes such as breastfeeding and women's views and experiences. In high-income countries, inappropriately used interventions—eg, unnecessary caesarean section or induction of labour, are also likely to contribute to morbidity and mortality.¹ Different approaches need to be developed to model the effect of too many interventions compared with too few, and the effect of midwife-led care in countries with different income levels.^{3,86–88}

Ensuring midwives can be the providers of care

We used this modelling to examine the contribution of midwifery interventions rather than midwives themselves as providers of health care. The midwife, as a health-care worker, can efficiently and effectively deliver the package of interventions as highlighted by Renfrew and colleagues.¹ Although the full spectrum of care up to and including specialist medical care averts the most deaths, the midwife addresses the continuum of care from the community through to complex clinical care,⁸⁹ whereas the medical specialist might not. Midwives can potentially bring the woman into the health-care system at the most effective and efficient time and level. Effective referral is often hampered by practical considerations, such as poor finance and transport services, and access to specialist medical care once in higher-level facilities. Again, this highlights the need for midwifery, specifically midwives, to be part of a team within a functional and enabling health system that has a skilled health workforce with the appropriate competencies and is based in the community and hospital or health facility. This is an important step towards ensuring that women can have access to a quality midwifery service that can provide the

maternal and newborn health interventions, and preventive health-care strategies.

Limitations

LiST provides a user-friendly method to quantify the effect that can be achieved by scaling up different maternal and newborn interventions.^{48,36,41} It has also been used to guide strategic planning at a country-specific level.⁵⁰ The method was originally developed for child health in what became the *Lancet's* Child Survival

Series³³ and has since been expanded to model the effect of scaling up in newborn infant,³⁴ fetal, and maternal health.³⁶ LiST, however, has limitations. It can only model mortality effects in low-income and some middle-income countries, and cannot examine broader, more sociological effects, such as empowerment or quality of life. Although it was initially designed to measure community-based effects on child survival, it has now been expanded to model maternal mortality and stillbirths, and some facility-based interventions. It was not designed to model the effect of intervention overuse, as might be seen in some high-income countries.⁹¹⁻⁹³ This method is also reliant on the data available for those countries, which is particularly important since the countries that can be modelled are those with the poorest quality and quantity of data, especially in terms of causes of maternal mortality. LiST is based on the estimation of mortality outcomes that includes only the interventions with known effect size differences. This characteristic means that interventions for which little research has been done to generate the data on effect size differences cannot be included, with the wide range of other non-mortality outcomes also unable to be included. Proxy indicators and interventions might have large variations and further research is needed to quantify these indicators.

Because of the emphasis of biomedical interventions, LiST does not take into account the effect of broader social determinants of health. Victora⁴⁸ has argued that most of the effect of broad social determinants on child mortality will be mediated by interventions included in LiST, such as improved water and sanitation, better antenatal, labour and birth care, improved nutrition, and greater access to high-quality case management of diseases, such as pneumonia, diarrhoea, and malaria. In the future, tools that are more sensitive to midwifery as a package of care need to be developed to enable the measurement of increase in the coverage of interventions, quality of care, and the broader aspects of care, including the interpersonal elements, which are part of midwifery.

Another limitation of LiST is that quality cannot be included as a separate and specific indicator. We based our analysis on the assumption that, as coverage of delivery care increases, so does quality. This statement might not be correct in all situations. The other elements that cannot presently be modelled include respect for and understanding of the individual needs of the mother, child, and family, and a commitment to active promotion of normal biopsychosocial cultural processes of pregnancy, childbirth, and the early weeks after birth.¹ In future, it will be important to go beyond the interventions that often focus on mortality and include these elements of broader quality of care in such analyses.

We used the HDI to categorise 78 countries into three groups. HDI is not the only measure that could have been

Panel: Improving quality and safety in maternity care: the contribution of midwife-led care and units in high-income countries

This Panel considers how the organisation of care providers, models of care, and birthplace setting contribute to high-quality and safe care for mothers and their newborn infants in high-income countries.

The philosophy behind midwife-led continuity models is “normality, continuity of care and being cared for by a known, trusted midwife during labour. The emphasis is on the natural ability of women to experience birth with minimum intervention”.³ Midwife-led continuity of care can be provided in small teams or as a caseload model, and occurs within a multidisciplinary network of consultation and referral with other care providers.

Midwife-led continuity of care is associated with substantial benefits for mothers and their newborn infants, and has no identified adverse effects compared with shared or medically-led care in high-income countries according to one systematic review.³ The authors of a second systematic review⁸⁰ concluded that midwife-led services might offer a cost-effective alternative to the prevailing maternity care model. More recently, an Australian randomised controlled trial⁸¹ reported that caseload midwifery is associated with cost savings in women of all risks, with similar clinical outcomes.

Midwife-led birth settings include midwife-led units sited alongside obstetric units and freestanding midwife units. Midwife-led units that are based in or next to hospitals compared with conventional hospital labour wards produce an increased likelihood of spontaneous vaginal birth and decreased likelihood of oxytocin augmentation, assisted vaginal birth, caesarean birth, and episiotomy, with no difference in infant outcomes.⁸²

With regard to freestanding midwife units, there is less evidence.⁸³ A prospective study of freestanding midwife unit care in Denmark⁸⁴ found important benefits, such as higher levels of satisfaction, decreased maternal morbidity, decreased use of birth interventions, including caesarean sections, and increased likelihood of spontaneous vaginal birth compared with labour ward care. There were no differences in perinatal morbidity in infants of low-risk mothers.⁸⁵

The Birthplace in England Study⁸⁶ assessed outcomes by intended place of birth for women at low risk. For low-risk women, the overall incidence of adverse perinatal outcomes was low in all birth settings. For multiparous low-risk women, no differences were noted in adverse perinatal outcomes between settings. However, the risk of an adverse perinatal outcome was higher for women having their first baby who planned to give birth at home compared with in an obstetric unit, although the overall level of risk was low. The intrapartum transfer rate for women having their first baby was high (36–45%), which might explain the adverse outcome rate. The costs were lower for births planned at home, in a freestanding unit, or alongside a midwife unit than for planned birth in obstetric units.⁸⁷

Overall, in high-income settings, both the model of care and place of birth are important influences on a range of health and clinical outcomes for mothers and newborn infants, and have economic implications for the health system. Systems need to be in place to allow safe and timely transfer to obstetric care and skills without financial, professional, and organisational barriers.

used. We did examine other indexes and did not find substantial differences in the classification of individual countries, hence we used the HDI.

We found it difficult to decide which interventions were deemed part of midwifery or specialist medical care. We recognise that some interventions, such as safe abortion services, could be considered part of midwifery as a package of care because of an increasing proportion of manual vacuum aspirations being safely done by mid-level providers, including midwives and nurses,⁹⁴ at a primary care facility level.⁹⁵ Another intervention that was classified as specialist care was antenatal corticosteroids. The classification of the interventions was a consensus decision and might not be universally acceptable. Nonetheless, the inclusion of antenatal corticosteroids as part of midwifery interventions would probably only enhance midwifery effectiveness.

For interventions such as ectopic pregnancy, we used a low-effectiveness estimate. We assumed that a CEmONC-level facility and caregiver would have the skills and means needed to deal with an ectopic pregnancy or post-abortion care. Additionally, LiST always assumes that women accessing CEmONC for emergencies would also have access to and use non-CEmONC for standard cases, which therefore means that both midwives and specialist providers are working within a functioning health system, something that is not the situation in many health systems worldwide.

Conclusions

We have described the range of potential benefits that full and comprehensive scale-up of midwifery can bring to communities and families worldwide, regardless of their present level of development. Although it is clear that these benefits can be very important, further critical assessment and research is required to establish how health systems and community services can be best improved and strengthened in order for midwifery to be available and accessible to all.

Contributors

CSEH devised the study and wrote the first and final drafts of the article, was responsible for overall leadership of the project, and led revision of all drafts. IKF and LAB led the statistical modelling and analysis, interpreted the results, and contributed to the writing and revisions. PtH-B and JS particularly contributed to the design of the study, as well as the introductory and discussion sections. AMS and MABD contributed to the design of the study and the writing. All authors helped to interpret the results and undertook reviews and revisions of the report.

Declaration of interests

We declare no competing interests.

Acknowledgments

This work was partly supported by a grant from the Bill & Melinda Gates Foundation (grant number OPP1042500), with additional support from the University of York, England, and the University of Dundee, Scotland. PtH-B's work was supported by the Instituto de Cooperación Social Integrare. These funding organisations had no role in the analysis or synthesis of the findings of this work. The findings and conclusions of this report are those of the authors and do not necessarily represent the official position of their employers or the Bill & Melinda Gates

Foundation. Thomson Prentice was the technical editor for the *Lancet* Series on Midwifery. Administrative support was provided by Jenny Brown and Tracy Sparey, and Natalie Muir provided project support. We thank the close readers and colleagues who made helpful contributions, namely Yves Bergevin, Dell Horey, Judith Fullerton, Sonia Lansky, Wendy Graham, Ann Starrs, Howard Friedman, Cathy Warwick, Frances Day-Stirk, Fabienne Richard, Jerker Liljestrand, Elizabeth Mason, Fran McConville, Blerita Maliqi, Matthews Mathai, Metin Gülmezoglu, Veronica Walford, Hermen Ormel, Kate Teela, France Donnay, and Mariam Claeson. All coauthors of the *Lancet* Series on Midwifery commented on drafts of this manuscript. Eugene Declercq and Vincent Fauveau, other members of the *Lancet* Series on Midwifery Helicopter Group, also made important contributions, along with Mary Renfrew, Luc de Bernis, Zoë Matthews, Helga Fogstad, and Alison McFadden, other members of the *Lancet* Series on Midwifery Executive Group, who made important contributions throughout the writing of this report.

References

- 1 Renfrew MJ, McFadden A, Bastos HM, et al. Midwifery and quality care: findings from a new evidence-informed framework for maternal and newborn care. *Lancet* 2014; published online June 23. [http://dx.doi.org/10.1016/S0140-6736\(14\)60789-3](http://dx.doi.org/10.1016/S0140-6736(14)60789-3).
- 2 Roberts D, Dalziel S. Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. *Cochrane Database Syst Rev* 2006; 3: CD004454.
- 3 Sandall J, Soltani H, Gates S, Shennan A, Devane D. Midwife-led continuity models versus other models of care for childbearing women. *Cochrane Database Syst Rev* 2013; 8: CD004667.
- 4 The Partnership for Maternal, Newborn & Child Health. Essential interventions, commodities and guidelines for reproductive, maternal, newborn and child health. A global review of the key interventions related to reproductive, maternal, newborn and child health (RMNCH). Geneva: The Partnership for Maternal, Newborn & Child Health, 2011.
- 5 Koblinsky M, Chowdhury ME, Moran A, Ronsmans C. Maternal morbidity and disability and their consequences: neglected agenda in maternal health. *J Health Popul Nutr* 2012; 30: 124–30.
- 6 Say L, Pattinson RC, Gülmezoglu AM. WHO systematic review of maternal morbidity and mortality: the prevalence of severe acute maternal morbidity (near miss). *Reprod Health* 2004; 1: 3.
- 7 Filippi V, Ganaba R, Baggaley RF, et al. Health of women after severe obstetric complications in Burkina Faso: a longitudinal study. *Lancet* 2007; 370: 1329–37.
- 8 Levy T, Orlans M. Attachment, trauma and healing. Washington DC: Child Welfare League of America Press, 1998.
- 9 Milgrom J, Erickson J, McCarthy R, Gemmill AW. Stressful impact of depression on early mother-infant relations. *Stress Health* 2006; 22: 229–38.
- 10 Murray L, Cooper P. Effects of postnatal depression on infant development. *Arch Dis Child* 1997; 77: 99–101.
- 11 Murray L, Cooper PJ. Postpartum depression and child development. *Psychol Med* 1997; 27: 253–60.
- 12 Buist A. Childhood abuse, postpartum depression and parenting difficulties: a literature review of associations. *Aust N Z J Psychiatry* 1998; 32: 370–78.
- 13 Milgrom J, Westley DT, Gemmill AW. The mediating role of maternal responsiveness in some longer term effects of postnatal depression on infant development. *Infant Behav Dev* 2004; 27: 443–54.
- 14 Murray L, Cooper P. The impact of postpartum depression on child development. In: Goodyer I, ed. *Aetiological Mechanisms in Developmental Psychopathology*. Oxford: Oxford University Press, 2003.
- 15 Wiegers TA, Keirse MJ, Berghs GA, van der Zee J. An approach to measuring quality of midwifery care. *J Clin Epidemiol* 1996; 49: 319–25.
- 16 Precht HF. The optimality concept. *Early Hum Dev* 1980; 4: 201–05.
- 17 Murphy PA, Fullerton JT. Measuring outcomes of midwifery care: development of an instrument to assess optimality. *J Midwifery Womens Health* 2001; 46: 274–84.
- 18 Low LK, Seng JS, Miller JM. Use of the Optimality Index-United States in perinatal clinical research: a validation study. *J Midwifery Womens Health* 2008; 53: 302–09.

- 19 Seng JS, Mugisha E, Miller JM. Reliability of a perinatal outcomes measure: the Optimality Index-US. *J Midwifery Womens Health* 2008; **53**: 110–14.
- 20 Sheridan M, Sandall J. Measuring the best outcome for the least intervention: can the Optimality Index-US be applied in the UK? *Midwifery* 2010; **26**: e9–15.
- 21 Bhutta ZA, Chopra M, Axelson H, et al. Countdown to 2015 decade report (2000–10): taking stock of maternal, newborn, and child survival. *Lancet* 2010; **375**: 2032–44.
- 22 Victora CG, Barros AJ, Axelson H, et al. How changes in coverage affect equity in maternal and child health interventions in 35 Countdown to 2015 countries: an analysis of national surveys. *Lancet* 2012; **380**: 1149–56.
- 23 WHO and UNICEF. Countdown to 2015: Maternal, newborn & child survival. Building a Future for women and children: the 2012 report. Geneva: World Health Organization and UN Children's Fund, 2012.
- 24 Barros AJ, Ronsmans C, Axelson H, et al. Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. *Lancet* 2012; **379**: 1225–33.
- 25 WHO. Working together for health. The World Health Report 2006. Geneva: World Health Organization, 2006.
- 26 WHO. The World Health Report 2005. Make every mother and child count. Geneva: World Health Organization, 2005.
- 27 Souza JP, Gülmezoglu AM, Vogel J, et al. Moving beyond essential interventions for reduction of maternal mortality (the WHO Multicountry Survey on Maternal and Newborn Health): a cross-sectional study. *Lancet* 2013; **381**: 1747–55.
- 28 International Confederation of Midwives. Essential competencies for basic midwifery practice. Geneva: International Confederation of Midwives, 2010.
- 29 Winfrey W, McKinnon R, Stover J. Methods used in the Lives Saved Tool (LiST). *BMC Public Health* 2011; **11** (suppl 3): S32.
- 30 Johns Hopkins University. LiST: the Lives Saved Tool: an evidence-based tool for estimating intervention impact. 2012. <http://www.jhsph.edu/departments/international-health/IHP/list/index.html> (accessed Sept 20, 2012).
- 31 USAid. Spectrum Policy Modeling System. 2011. <http://www.healthpolicyproject.com/index.cfm?id=software&get=Spectrum> (accessed Oct 6, 2012).
- 32 UN Population Fund. The State of the World's Midwifery Report. Delivering health, saving lives. NY: UN Population Fund, 2011.
- 33 Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS, and the Bellagio Child Survival Study Group. How many child deaths can we prevent this year? *Lancet* 2003; **362**: 65–71.
- 34 Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L, and the *Lancet* Neonatal Survival Steering Team. Evidence-based, cost-effective interventions: how many newborn babies can we save? *Lancet* 2005; **365**: 977–88.
- 35 Bhutta ZA, Ahmed T, Black RE et al, for the Maternal and Child Undernutrition Study Group. What works? Interventions for maternal and child undernutrition and survival. *Lancet* 2008; **371**: 417–40.
- 36 Pattinson R, Kerber K, Buchmann E, et al, and the *Lancet's* Stillbirths Series steering committee. Stillbirths: how can health systems deliver for mothers and babies? *Lancet* 2011; **377**: 1610–23.
- 37 Bhutta ZA, Das JK, Rizvi A et al, for the Maternal and Child Nutrition Study Group. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet* 2013 **382**: 452–77.
- 38 Blencowe H, Cousens S, Modell B, Lawn J. Folic acid to reduce neonatal mortality from neural tube disorders. *Int J Epidemiol* 2010; **39** (suppl 1): i110–21.
- 39 Blencowe H, Lawn J, Vandelaer J, Roper M, Cousens S. Tetanus toxoid immunization to reduce mortality from neonatal tetanus. *Int J Epidemiol* 2010; **39** (suppl 1): i102–09.
- 40 Boschi-Pinto C, Young M, Black RE. The Child Health Epidemiology Reference Group reviews of the effectiveness of interventions to reduce maternal, neonatal and child mortality. *Int J Epidemiol* 2010; **39** (suppl 1): i3–6.
- 41 Bryce J, Friberg IK, Kraushaar D, et al. LiST as a catalyst in program planning: experiences from Burkina Faso, Ghana and Malawi. *Int J Epidemiol* 2010; **39** (suppl 1): i40–47.
- 42 Cousens S, Blencowe H, Gravett M, Lawn JE. Antibiotics for pre-term pre-labour rupture of membranes: prevention of neonatal deaths due to complications of pre-term birth and infection. *Int J Epidemiol* 2010; **39** (suppl 1): i134–43.
- 43 Friberg IK, Bhutta ZA, Darmstadt GL, et al. Comparing modelled predictions of neonatal mortality impacts using LiST with observed results of community-based intervention trials in South Asia. *Int J Epidemiol* 2010; **39** (suppl 1): i11–20.
- 44 Hazel E, Gilroy K, Friberg I, Black RE, Bryce J, Jones G. Comparing modelled to measured mortality reductions: applying the Lives Saved Tool to evaluation data from the Accelerated Child Survival Programme in West Africa. *Int J Epidemiol* 2010; **39** (suppl 1): i32–39.
- 45 Lawn JE, Mwansa-Kambafwile J, Horta BL, Barros FC, Cousens S. 'Kangaroo mother care' to prevent neonatal deaths due to preterm birth complications. *Int J Epidemiol* 2010; **39** (suppl 1): i144–54.
- 46 Mwansa-Kambafwile J, Cousens S, Hansen T, Lawn JE. Antenatal steroids in preterm labour for the prevention of neonatal deaths due to complications of preterm birth. *Int J Epidemiol* 2010; **39** (suppl 1): i122–33.
- 47 Stover J, McKinnon R, Winfrey B. Spectrum: a model platform for linking maternal and child survival interventions with AIDS, family planning and demographic projections. *Int J Epidemiol* 2010; **39** (suppl 1): i7–10.
- 48 Victora CG. Commentary: LiST: using epidemiology to guide child survival policymaking and programming. *Int J Epidemiol* 2010; **39** (suppl 1): i1–2.
- 49 Walker N, Fischer-Walker C, Bryce J, Bahl R, Cousens S, and the CHERG Review Groups on Intervention Effects. Standards for CHERG reviews of intervention effects on child survival. *Int J Epidemiol* 2010; **39** (suppl 1): i21–31.
- 50 Fox MJ, Martorell R, van den Broek N, Walker N. Assumptions and methods in the Lives Saved Tool (LiST). Introduction. *BMC Public Health* 2011; **11** (suppl 3): 11.
- 51 Ronsmans C, Graham WJ, and *The Lancet* Maternal Survival Series steering group. Maternal mortality: who, when, where, and why. *Lancet* 2006; **368**: 1189–200.
- 52 Amouzou A, Richard SA, Friberg IK, et al. How well does LiST capture mortality by wealth quintile? A comparison of measured versus modelled mortality rates among children under-five in Bangladesh. *Int J Epidemiol* 2010; **39** (suppl 1): i186–92.
- 53 Larsen DA, Friberg IK, Eisele TP. Comparison of Lives Saved Tool model child mortality estimates against measured data from vector control studies in sub-Saharan Africa. *BMC Public Health* 2011; **11** (suppl 3): S34.
- 54 Bhutta ZA, Yakoob MY, Lawn JE, et al, and the *Lancet's* Stillbirths Series steering committee. Stillbirths: what difference can we make and at what cost? *Lancet* 2011; **377**: 1523–38.
- 55 Lawn JE, Blencowe H, Pattinson R, et al, and *The Lancet's* Stillbirths Series steering committee. Stillbirths: where? When? Why? How to make the data count? *Lancet* 2011; **377**: 1448–63.
- 56 Plosky WD, Stover J, Winfrey B. The Lives Saved Tool. A computer program for making child survival projections. Washington DC: United States Agency for International Development, 2011.
- 57 Pollard S, Mathai M, Walker N. Estimating the impact of interventions on cause-specific maternal mortality: a Delphi approach. *BMC Public Health* 2013; **13**: S12.
- 58 Noakes TD, Borresen J, Hew-Butler T, Lambert MI, Jordaan E. Semmelweis and the aetiology of puerperal sepsis 160 years on: an historical review. *Epidemiol Infect* 2008; **136**: 1–9.
- 59 Liu L, Johnson HL, Cousens S, et al, and the Child Health Epidemiology Reference Group of WHO and UNICEF. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *Lancet* 2012; **379**: 2151–61.
- 60 WHO, UNICEF, UN Population Fund and the World Bank. Trends in maternal mortality: 1990 to 2010. WHO, UNICEF, UNFPA and The World Bank estimates. Geneva: World Health Organization, 2012.
- 61 UNDP. Human Development Report 2011. Sustainability and equity: a better future for all. NY: Palgrave Macmillan, 2011.
- 62 The Organisation for Economic Co-operation and Development Development Centre. 2012 SIGI: social institutions and gender index: understanding the drivers of gender inequality. Paris: the Organisation for Economic Co-operation and Development Development Centre, 2012.

- 63 Human Development Report. Gender Inequity Index. 2012. <http://hdr.undp.org/en/statistics/gii> (accessed Dec 20, 2012).
- 64 United Nations. World population prospects: the 2010 revision. Volume I: comprehensive tables. New York: Department of Economic and Social Affairs, Population Division, 2011.
- 65 WHO. Every woman every child: accounting for results and progress in maternal, newborn and child health: global strategy for women's and children's health. Geneva: The Partnership for Maternal, Newborn and Child Health, 2010.
- 66 Koblinsky M, Matthews Z, Hussein J, et al, and the *Lancet* Maternal Survival Series steering group. Going to scale with professional skilled care. *Lancet* 2006; **368**: 1377–86.
- 67 Van Lerberghe W, Matthews Z, Achadi E, et al. Country experience with strengthening of health systems and deployment of midwives in countries with high maternal mortality. *Lancet* 2014; published online June 23. [http://dx.doi.org/10.1016/S0140-6736\(14\)60919-3](http://dx.doi.org/10.1016/S0140-6736(14)60919-3).
- 68 Pathmanathan I, Liljestrand J, Martins J, et al. Investing in maternal health: learning from Malaysia and Sri Lanka. Washington DC: The World Bank, 2003.
- 69 Costello A, Osrin D, Manandhar D. Reducing maternal and neonatal mortality in the poorest communities. *BMJ* 2004; **329**: 1166–68.
- 70 Ahmed S, Li Q, Liu L, Tsui AO. Maternal deaths averted by contraceptive use: an analysis of 172 countries. *Lancet* 2012; **380**: 111–25.
- 71 Cleland J, Conde-Agudelo A, Peterson H, Ross J, Tsui A. Contraception and health. *Lancet* 2012; **380**: 149–56.
- 72 Canning D, Schultz TP. The economic consequences of reproductive health and family planning. *Lancet* 2012; **380**: 165–71.
- 73 Osotimehin B. Family planning save lives, yet investments falter. *Lancet* 2012; **380**: 82–83.
- 74 Kennedy EC, Mackesy-Buckley S, Subramaniam S, et al. The case for investing in family planning in the Pacific: costs and benefits of reducing unmet need for contraception in Vanuatu and the Solomon Islands. *Reprod Health* 2013; **10**: 30.
- 75 Ross JA, Blanc AK. Why aren't there more maternal deaths? A decomposition analysis. *Matern Child Health J* 2012; **16**: 456–63.
- 76 Streatfield PK, El Arifeen S. Bangladesh Maternal Mortality and Health Care Survey 2010: summary of key findings and implications. Dhaka: International Centre for Diarrhoeal Disease Research, Bangladesh, 2010.
- 77 Graham WJ, Ahmed S, Stanton C, Abou-Zahr C, Campbell OM. Measuring maternal mortality: an overview of opportunities and options for developing countries. *BMC Med* 2008; **6**: 12.
- 78 Iguiñiz-Romero R, Palomino N. Data do count! Collection and use of maternal mortality data in Peru, 1990-2005, and improvements since 2005. *Reprod Health Matters* 2012; **20**: 174–84.
- 79 Labrique AB, Pereira S, Christian P, Murthy N, Bartlett L, Mehl G. Pregnancy registration systems can enhance health systems, increase accountability and reduce mortality. *Reprod Health Matters* 2012; **20**: 113–17.
- 80 Devane D, Brennan M, Begley C, et al. A systematic review, meta-analysis, meta-synthesis and economic analysis of midwife-led models of care. London: Royal College of Midwives; 2010.
- 81 Tracy S, Hartz D, Tracy M, et al. Caseload midwifery care versus standard maternity care for women of any risk: M@NGO, a randomised controlled trial. *Lancet* 2013; **382**: 1723–32.
- 82 Hodnett ED, Downe S, Walsh D. Alternative versus conventional institutional settings for birth. *Cochrane Database Syst Rev* 2012; **8**: CD000012.
- 83 Walsh D, Downe SM. Outcomes of free-standing, midwife-led birth centers: a structured review. *Birth* 2004; **31**: 222–29.
- 84 Overgaard C, Fenger-Grøn M, Sandall J. The impact of birthplace on women's birth experiences and perceptions of care. *Soc Sci Med* 2012; **74**: 973–81.
- 85 Overgaard C, Møller AM, Fenger-Grøn M, Knudsen LB, Sandall J. Freestanding midwifery unit versus obstetric unit: a matched cohort study of outcomes in low-risk women. *BMJ Open* 2011; **1**: e000262.
- 86 Brocklehurst P, Hardy P, Hollowell J, et al, and the Birthplace in England Collaborative Group. Perinatal and maternal outcomes by planned place of birth for healthy women with low risk pregnancies: the Birthplace in England national prospective cohort study. *BMJ* 2011; **343**: d7400.
- 87 Schroeder E, Petrou S, Patel N, et al, and the Birthplace in England Collaborative Group. Cost effectiveness of alternative planned places of birth in woman at low risk of complications: evidence from the Birthplace in England national prospective cohort study. *BMJ* 2012; **344**: e2292.
- 88 McLachlan HL, Forster DA, Davey MA, et al. Effects of continuity of care by a primary midwife (caseload midwifery) on caesarean section rates in women of low obstetric risk: the COSMOS randomised controlled trial. *BJOG* 2012; **119**: 1483–92.
- 89 International Confederation of Midwives. ICM: international definition of a midwife. The Hague: International Confederation of Midwives, 2011.
- 90 Korenromp EL. Lives saved from malaria prevention in Africa-evidence to sustain cost-effective gains. *Malar J* 2012; **11**: 94.
- 91 Gibbons L, Belizán JM, Lauer J, Betrán AP, Merialdi M, Althabe F. The global numbers and costs of additionally needed and unnecessary caesarean sections performed per year: overuse as a barrier to universal coverage. World Health Report (2010): Background Paper, 30. Geneva: World Health Organization, 2010.
- 92 Althabe F, Sosa C, Belizán JM, Gibbons L, Jacquerioz F, Bergel E. Caesarean section rates and maternal and neonatal mortality in low-, medium-, and high-income countries: an ecological study. *Birth* 2006; **33**: 270–77.
- 93 Dahlen HG, Tracy S, Tracy M, Bisits A, Brown C, Thornton C. Rates of obstetric intervention among low-risk women giving birth in private and public hospitals in NSW: a population-based descriptive study. *BMJ Open* 2012; **2**: e001723.
- 94 Warriner IK, Meirik O, Hoffman M, et al. Rates of complication in first-trimester manual vacuum aspiration abortion done by doctors and mid-level providers in South Africa and Vietnam: a randomised controlled equivalence trial. *Lancet* 2006; **368**: 1965–72.
- 95 WHO. Safe abortion: technical and policy guidance for health systems, 2nd edn. Geneva: World Health Organization, 2012.