**Appendices**

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| Appendix 1: Indicators and benchmarks (thresholds) for global tracking of maternal healthcare provision |
| **INDICATOR** | **Global (UN) benchmarks (thresholds)** | **Examples of alternative benchmarks/ indicators used** |
| **Facility numbers**  |  |  |
| Numbers of EmOC facilities per births or population | * 5 EmOC facilities per 20,000 births (500,000 population) of which at least 1 CEmOC,1, 2 national and subnational
* 2-3+ EmOC facilities per 3,600 births (11+ per 20,000 births), of which at least 1 CEmOC3
* Neither UN benchmark is explicit about the number (or proportion) of deliveries, such facilities are expected to conduct.4, 5
 |  |
| **Facility size (volume and beds)** |
| Numbers of hospital beds per births | * 60-90 beds per 3000-3600 births (33-60 births per bed)3
 |  |
| Births per facility  | * 1,200 births per facility (ideal minimum to be safe &cost-effective)6
 | * 500 births per facility6
 |
| **Length-of-stay in facilities** |  |  |
| Length-of-stay after normal delivery | * All women stay at least 24 hours postpartum7
 | * All women stay at least 12 hours (MICS, UNICEF) 8
 |
| **Staffing/cadres** |  |  |
| Midwives and doctors per births | * 6 midwives per 1000 births (= 21.6 per 3600 births; 120 per 20,000 births; 175 births per midwife)9. It is unclear whether these are needed to manage only deliveries or if all other midwifery services (and if so the extent of these).
* 20 midwives and 3 (part-time) doctors per 3,600 births (5.6 midwives per 1000 births and 0.8 part-time doctors per 1000 births)3
 | * 1 full-time equivalent (FTE) midwife per 28 hospital births; 1 (FTE) midwife per 35 home births; 1 (FTE) midwife per 35 lower-dependency births in birth centres/midwifery led units.10
* 60 hours consultant presence per week in maternity units with 2,500-4,000 births per year; 98 hours in units with 4,000-5,000 births; 168 hours in units with > 5,000 births.11
 |
| Medical providers (physicians, nurses and midwives) per population needed to provide high coverage of essential health interventions (including maternal health care) | * 22.8 medical providers per 10,000 population12
 | * 34.5 skilled health professionals (physicians, nurses and midwives) per 10,000 population13
* 59.4 skilled health professionals (physicians, nurses and midwives) per 10,000 population14
* 16.5 medical providers per 10,000 population13
* 20-40 surgical providers (surgeons, anaesthesiologist, obstetricians) per 100,000 population15
 |
| **Travel time/distance** |  |  |
| **Travel time/distance to an EmOC facility** | * All women within 3 hour of an EmOC facility1, 2
 | * All women within 2 hours of an EmOC facility.16, 17
* Proportion of women living <15 km to EmOC facility (Zambia)4
* Proportion of women living <8km from childbirth services (Ghana)18
* All women within 30 minutes of obstetric & gynaecologic services (Germany)19
* Proportion of women <100 km of 1st & 2nd trimester abortion services (South Africa)20 or of abortion services (Canada)21
* Proportion of women within 15 km of PAC or TOP facility22
* Proportion of women within 6.4 km of family planning (Malawi) 23
* 1 ambulance per 20,000-100,000 population (LMICS) 24-26
 |

|  |
| --- |
| Appendix 2: Beyond childbirth care: the status of other health services |
| We focus on childbirth services because they target a high-risk period, but other health services are obviously important. Women who do not want to give birth need family planning and safe abortion, for example. Effective family planning enables women to meet their fertility intentions and avert maternal deaths from unsafe induced abortion and from any cause within unintended pregnancies. In 2015 globally, 64% of women used modern family planning and 12% had unmet need for contraception.27 Addressing unmet contraceptive need has the potential to reduce maternal deaths by an estimated 29%.28 An estimated 21.6 million women resort to unsafe services each year: 49% of all induced abortions.29 Abortion deaths contribute 7.9% of maternal deaths in developing countries,30 and a considerable associated morbidity burden poses high costs to health services. Access to safe abortion services avoids maternal death from unsafe abortion, and appears to have increased worldwide, as evidenced by decreasing abortion-related mortality.31-33 Improvements are attributed to increasing legal provision for abortion, safer technologies, particularly medical abortion with its transformative potential, and greater post-abortion care (PAC) provision.32, 34-38 However, provision and access remain sub-optimal, particularly in low-resource settings, and there is little comparative data on the scale of provision of safe abortion and PAC services, with some exceptions, for example, in India, Bangladesh, and Ethiopia.20, 39-44 An in-depth study in Ethiopia assessed safe abortion care (SAC) capability as a percentage of a SAC benchmark, noting it increased from 39% to 86% over time.39 A different approach used for regions in South Africa found women who had to travel more than 50 km to 1st trimester abortion services ranged from 0.3%-62.8%.20 All studies showed greater capability at hospital than lower-level facilities, and greater reported capability to provide PAC than termination of pregnancy.40-43 Studies of provider skills generally indicate that providers are less skilled in vacuum aspiration for PAC than other aspects of emergency care.45, 46 Standard ANC and postnatal care (PNC) complement intrapartum services and along with family planning and abortion services, fit along the continuum of care. Currently, a minimum of four ANC visits are recommended for women with uncomplicated pregnancies to deliver the optimal, cost-effective content of care, consisting of screening, diagnosis, treatment (if necessary), and counselling on pregnancy, childbirth and newborn care.47, 48 Unlike intrapartum care, ANC is generally an outpatient service, with many elements that can be provided by health professionals with fewer skills than SBAs, in facility environments with fewer resource requirements, and at times convenient to the woman and family. ANC is also an important entry path to other maternal and reproductive services, and even to general health services. Coverage of 1+ ANC visits is greater than coverage of SBA delivery,49 possibly reflecting shorter travel-times to lower-level facilities, and a longer window of opportunity to reach services compared to childbirth care.50 Coverage with 4+ ANC visits lags behind coverage with 1+ visits in many LMICs, with substantial proportions of women receiving some ANC but not being successfully retained to benefit from a complete care package.51, 52 Unlike for content of intrapartum care, women can be asked to report on which elements of ANC they received. Available data from 26 countries show only half the essential elements, such as blood or urine tests, are received among women attending ANC compared to recommended content.53 Similarly, development of a birth plan and counselling on pregnancy complications are essential ANC components that link women to routine and emergency childbirth care. We analysed 26 of the 29 LMICs with DHS data on ANC content. Coverage of 1+ ANC visits ranged from 43% (Ethiopia) to 99% (Ukraine), with a median of 93%. When we assessed whether the women using ANC recalled being informed about signs of pregnancy complications; countries ranged from 18% (Chad) to 80% (Cambodia), with a median of 50%. Combining coverage and content gaps showed that only about two in five women received this essential information (range 8% (Chad) to 78% (Malawi), with a median of 43%). Women who delivered at home were, on average, 22% less likely to receive such information compared to those who delivered in facilities, despite being precisely the women who might have benefitted most from timely recognition of complications and transfer to facilities.PNC receives much less attention than delivery care or ANC, particularly for mothers or bereaved women who experienced a stillbirth or newborn death. Current PNC guidelines recommend four postnatal checks, with the first within 24-hours of birth.7 Women are recommended to remain at least 24-hours after facility birth, but many do not.8 Recent analyses found substantial proportions of women in many LMICs discharged from facilities before 24 hours, and without a check, for example, in Ethiopia after a median length-of-stay of 6 hours,54 and in Egypt after a mean length-of-stay of half-a-day.8 Those with home births are recommended to receive a home-based postnatal contact as early as possible within the first 24-hours, but coverage is low.8 For home births, many LICs have tried to get community health workers to visit newborns and mothers but few are successful at getting them there in the first days. In Uganda for example, only 10.9% of all newborns received PNC, while only 5.6% of the subset of home births received it.55 Good quality, comparative data on PNC coverage are scant, largely stemming from a now-resolved lack of consensus on the desired timing and frequency of PNC visits.56 Content of PNC for mothers is poorly defined and based on expert opinion rather than empirical evidence.7In LMICs, little is known about ANC or PNC services for women needing general medical care for health concerns such as diabetes, obesity, or mental health problems. Maternal death reviews in HICs suggest women required to move across services (e.g. from ANC to mental health services) can fall through gaps when services are siloed, and that integration is important.57 The role of ANC and PNC for linking to services addressing problems associated with shifting epidemiology patterns, (including existing and emerging infections, such as malaria and Ebola, or non-communicable diseases, such as diabetes, obesity or mental ill-health), is increasingly recognised as important. |

# Appendix 3: Methods

## Where do births occur, and with whom: DHS data

**Data source**

We used the Demographic and Health Surveys (DHS), listed below. These are cross-sectional nationally-representative household surveys that use model questionnaires that are adapted to each country’s circumstances. Data are generally based on self-reports of women aged 15-49. The sampling design is based on a multi-stage cluster strategy. Women in each DHS survey have individual sample weights that were used to calculate country-level representative summary statistics.

|  |  |
| --- | --- |
| Bangladesh | 2011 |
| Cambodia | 2014 |
| Chad  | 2004 |
| DRC | 2013 |
| Egypt | 2014 |
| Ethiopia | 2011 |
| Ghana | 2014 |
| Haiti | 2012 |
| India | 2005-6 |
| Indonesia | 2012 |
| Jordan | 2012 |
| Kenya | 2008-9 |
| Madagascar | 2008-9 |
| Malawi | 2010 |
| Mali | 2012 |
| Morocco | 2003-4 |
| Mozambique | 2011 |
| Namibia | 2013 |
| Nepal | 2011 |
| Nigeria | 2013 |
| Peru | 2012 |
| Rwanda | 2010 |
| Senegal | 2014 |
| Sierra Leone | 2013 |
| Tanzania | 2010 |
| Turkey | 2003 |
| Uganda | 2011 |
| Ukraine | 2007 |
| Zambia | 2013 |

**Population**

For all women aged 15-49 with a live birth in the survey recall period (5-years), circumstances of all live deliveries were analysed. The final analysis sample included the >99.5% of births which had valid data on location of birth and person who attended the birth.

**Location of deliveries and Facility level**

Women reported the location of each birth, which was categorised into domestic locations (woman’s own home or another home environment – e.g., her parents’) or a health facility. We grouped health facility locations by level into higher-level (i.e., hospitals) and lower-level (e.g., health centres, health posts, clinics). In some countries’ surveys, higher- and lower-levels of private-sector childbirth facilities were conflated in a single response option (e.g., “private hospital/clinic”). Such response options were grouped into higher-level facilities, as were the few births recorded as having occurred “abroad”.

**Birth attendant**

Women were asked to list all types of people who assisted with each birth. If multiple cadres of birth attendants were listed, the person with the highest level of qualification was considered. Eleven standardised categories of person assisting with birth were constructed from individual surveys’ response options: doctor, nurse/midwife, auxiliary midwifery staff, auxiliary staff, traditional birth attendants (TBAs), community health workers (CHW), traditional practitioners, general facility staff, husband/friend/relative, others, and no-one.58 Professionals in the first three categories were considered to be skilled birth attendants (SBAs), corresponding with the World Health Organisation definition of skilled childbirth care as “accredited health professional – such as a midwife, doctor or nurse – who has been educated and trained to proficiency in the skills needed to manage uncomplicated pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns”.59 Not all eleven categories of birth attendants existed in all countries. In analyses of childbirth attendant by facility level, we considered doctors separately from other SBAs (nurse/midwives and auxiliary midwifery staff), and also showed non-SBA attendants.

**Ethical approval**

The DHS received institutional review centrally (ICF International) and approval by every participating country. This secondary analysis of anonymised data was approved by the Research Ethics Committee of the London School of Hygiene and Tropical Medicine, UK.

**DHS Statcompiler trend data**

Trends in facility delivery, for the countries with more than one DHS survey were obtained using Statcompiler, accessed 18 January 2016.

## Where do births occur, and with whom: Other data sources

Other data were obtained from country reports and indicator tabulations, as outlined in Supplementary Table 1, below. Some basic calculations were made using reported percentages. For Mongolia and Russia, data were only available on the percentage of deliveries in health facilities and percentage of deliveries with a skilled birth attendant (with no cross tabulation of these indicators). Since fewer than 2% of deliveries occurred at home, and there was a **higher** proportion of deliveries in health facilities than deliveries with SBAs, we assumed that all deliveries at home were without an SBA and a very small percentage in facilities occurred without an SBA

Supplementary Table 1: Sources of data on where births occur, and with whom, for countries that do not have DHS available

|  |  |  |
| --- | --- | --- |
| **Country** | **Year** | **Source**  |
| Argentina | 2013 | Ministerio de Salud. Estadisticas Vitales Informacion Basica – Ano 2013. Bueno Aires: 2014. Available at: <http://www.deis.msal.gov.ar/Publicaciones/Archivos/Serie5Nro57.pdf> |
| Brazil | 2006 | Brasil. Ministério da Saúde. Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher – PNDS 2006: dimensões do processo reprodutivo e da saúde da criança/ Ministério da Saúde, Centro Brasileiro de Análise e Planejamento. Brasília: Ministério da Saúde, 2009.  |
| Canada | 2006-2007 | Available at <http://www5.statcan.gc.ca/cansim/pick-choisir?lang=eng&p2=33&id=1024516> |
| China | 2008 | Feng XL, Xu L, Guo Y, Ronsmans C. Socioeconomic inequalities in hospital births in China between 1988 and 2008. *Bulletin of the World Health Organization* 2011; **89**(6): 432-41. |
| Cuba | 2014 | MICS survey report. Available at: <http://mics.unicef.org/surveys> |
| Ecuador | 2004 | Encuesta Demográfica y de Salud Materna e Infantil 2004. Available at: <http://microdata.worldbank.org/index.php/catalog/979>  |
| England  | 2015 | NHS Maternity Statistics – England Health and Social Care Information Centre Available at: http://www.hscic.gov.uk/catalogue/PUB16725 |
| France | 2010 | International comparison of selected service lines in seven health systems. (2014) Available at: <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/382855/Annex_13_Maternity_services_in_France.pdf>  |
| Germany | 2014 | Hospital births and total births. Available at: <https://www.destatis.de/EN/FactsFigures/SocietyState/Health/Hospitals/Tables/HospitalsDeliveriesYears.html> and <https://www.destatis.de/EN/FactsFigures/SocietyState/Population/Births/Tables/BirthDeaths.html> |
| Japan | 2005 | Matsuoka E, Fumikoa H, eds: Birth Models That Work, Chapter 8; Maternity Home in Japan. University of California Press; 2009:484. |
| Malaysia | 2011 | UNICEF statistics. Available at: <http://www.unicef.org/infobycountry/malaysia_statistics.html> |
| Mexico | 2011 | Gutiérrez JP, Rivera-Dommarco J, Shamah-Levy T, Villalpando-Hernández S, Franco A, Cuevas-Nasu L, Romero-Martínez M, Hernández-Ávila M. Encuesta Nacional de Salud y Nutrición 2012. Resultados Nacionales. Cuernavaca, México: Instituto Nacional de Salud Pública (MX), 2012 |
| Mongolia | 2010 | National Statistics Office The Mongolia Multiple Indicator Cluster Survey 2010. Available at <http://mics.unicef.org/surveys> |
| Netherlands | 2013 | Perinatale Zorg in Nederland HAA Brouwers, HW Bruinse, J . J. Dijs-Elsinga, AM van Huis, E de Miranda, P Tamminga Available at <http://www.perinatreg.nl/> and <http://www.sciencedirect.com/science/article/pii/S0266613813002106> |
| New Zealand | 2014 | Report on maternity, 2014, http://www.health.govt.nz/publication/report-maternity-2014  |
| Norway | 2010 | Euro-Peristat project with SCPE and Eurocat. European Perinatal Health Report. The health and care of pregnant women and babies in Europe in 2010. May 2013. |
| Russia | 2011 (2008) | Data on SBA from European Health for All Database available at <http://data.euro.who.int/hfadb/>Data on health facility delivery: <http://www.cdc.gov/reproductivehealth/global/publications/surveys/russia/russia-survey-2011-exec-sum.pdf>  |
| South Africa | 2008 | Health indicators resource. Available at: <http://www.hst.org.za/health-indicators-advanced-search>  |
| Sri Lanka | 2007 | Department of Census and Statistics (DCS) and Ministry of Healthcare and Nutrition (MOH). 2009. Sri Lanka Demographic and Health Survey 2006-07. Colombo, Sri Lanka: DCS and MOH.  |
| Sweden | 2010 | Euro-Peristat project with SCPE and Eurocat. European Perinatal Health Report. The health and care of pregnant women and babies in Europe in 2010. May 2013. |
| United States | 2013 | CDC vital statistics data. Available at: <http://www.cdc.gov/nchs/data_access/VitalStatsOnline.htm>  |

## Countries meeting or exceeding the threshold of 23 midwives, nurses or doctors per 10,000 population

**Data source**

World Health Organization Statistics.

**Data analysis**

We added doctors per 10,000 population and nurses/midwives per 10,000 population for the most recent year since 2000, for countries reporting both figures. We then looked at the proportions of countries above and below the threshold of 23 per 10,000.

## Volume & Capability of Facilities: Facility assessment Data

**Data source**

These analyses are based on data from the Service Provision Assessments (SPA), the Emergency Obstetric and Newborn Care (EmONC) assessments, and the China health facility survey which are nationally representative surveys of facilities within a given country. Data from assessment that included numbers of deliveries are available for the following countries and time points:

|  |  |
| --- | --- |
| **EmONC assessments -** | **SPAs -** |
| Ethiopia, 2008 | Tanzania, 2006 (only used in looking at facility volume, not facility capability) |
| Ghana, 2010  | Uganda, 2007  |
| Mozambique, 2012 | Rwanda, 2007  |
|  | Namibia, 2009  |
|  | Kenya, 2010  |

The health facility survey in China was conducted in 2011.

**Data preparation**

Data were available across the majority of the facility assessments listed above to produce signal functions to look at emergency obstetric and routine childbirth care, and to look at general facility readiness; however, there was some variation in how the signal functions were defined as a result of data availability. Supplementary Table 2 provides a description of the definition of each signal function by the data source.

Supplementary Table 2: Definition of signal functions to look at general facility readiness to provide childbirth services

|  |  |  |  |
| --- | --- | --- | --- |
|  | **SPA (2006-2010: Kenya, Uganda, Namibia and Rwanda)** | **AMDD (2008-2012: Ethiopia, Ghana and Mozambique)**  | **China, 2011** |
| **Emergency obstetric care (EmOC)** |  |
| **Parenteral antibiotics** | Ever provided + reported availability of drugs | Administered in last 3 months | Administered in last 3 months |
| **Parenteral oxytocin** | Ever provided + reported availability of drugs | Provided in the last 3 months | Provided in the last 3 months |
| **Parenteral anticonvulsants** | Ever provided + reported availability of drugs | Provided in the last 3 months | Provided in the last 3 months |
| **Manual removal of placenta** | Ever provided | Provided in the last 3 months | Provided in the last 3 months |
| **Removal of retained products** | Ability of facility + reported vacuum aspirator or D & C kit | Provided in the last 3 months | Provided in the last 3 months |
| **Assisted vaginal delivery1** | Ever provided + reported ventouse or large forceps | Provided in the last 3 months | Provided in the last 3 months |
| **Blood transfusion**  | Ever provided | Provided in the last 3 months | Provided in the last 3 months |
| **Caesarean section** | Ever provided | Provided in the last 3 months | Provided in the last 3 months |
| **Routine childbirth care** |  |
| **Monitoring and management of labour using a partogram2** | Reported availability of partogram + foetoscope | Used partogram for management of labor in last 3 months | Not asked |
| **Infection prevention measures** | Reported clean water source + hand soap + gloves | Soap + gloves (examination gloves, sterile or non-sterile) + water for infection prevention | Not asked |
| **Routine injection of oxytocin/AMTSL** | Routine or selective administration of uterotonic medicine for AMTSL + reported availability of uterotonic | Staff at facility routinely use of AMTSL | Not asked |
| **General facility readiness** |  |
| **Service availability 24/7** | Coverage of childbirth services 24/7  | Coverage of childbirth services 24/7 | Not asked |
| **Electricity**  | Any source of electricity which is always available  | Any source of electricity | Not asked |
| **Water supply** | Water pipe or tap available within 500m of the facility  | Water for infection prevention available at the facility | Not asked |

Abbreviations: D & C – dilation and curettage; AMSTL – active management of the third stage of labour

**1**Information on large forceps not available in Uganda or Rwanda. Information on ventouse not available in Malawi.

**2**No information on fetoscope in Uganda

Subsequently, within each domain (EmOC, routine care or general facility readiness) summary variables were created, by calculating the total number of functions that each facility was reported to be able to conduct. Facilities with missing data on at least one function, meaning the summary variable could not be calculated, were excluded.

**Data analysis**

Data were analysed using Stata/SE 14.0 and Stata/SE 13.0, and all analyses were restricted to facilities that reported that they conducted deliveries.

**Service provision assessments**

To examine the distribution of facilities by EmOC and routine care capability, percentages were calculated using two different methods. Firstly, we used traditional survey weights so that we could see the **percentages of facilities** falling into each capability category. We then weighted the data using both the traditional facility weights and information on the number of deliveries that occurred in the past 12 months (i.e. giving increased weight to facilities that conduct a high volume of deliveries). The latter method gives estimates of the **percentage of facility deliveries** falling into each capability category.

To examine the general facility readiness, we calculated the percentage of facilities that reported having each basic component as outlined in Table 1, stratified by the level of facility (hospital/health centre/dispensary). These percentages were calculated taking account of facility weighting.

**EmONC assessments**

All EmONC assessments included a census of facilities that provide childbirth services and therefore did not require survey weights. The Ghana EmONC assessment included a census of hospitals and a restricted census of lower level facilities (i.e. all lower-level facilities performing at least 5 deliveries per month in most regions, and 1 delivery per month in the three regions that make up the North Zone). Ethiopia and Mozambique EmONC assessments included a census of all health facilities that offered childbirth services. Analysis of these data followed the above methodology, though weighted only by number of deliveries to determine the percentage of facility deliveries falling into each capability category.

**China Health Facility Survey**

A nationally representative, cross-sectional facility-based survey of a sample of facilities offering EmOC in China was conducted in 2011. Analyses of these data were the same as those for the SPAs, using both facility and delivery weights.

## Telephone and motorized vehicle ownership

**Data source**

Kenya 2014 Demographic and Health Survey (DHS)

**Data analysis**

We calculated the proportions of households owning telephone (mobile or landline), and the proportions owning a motorized vehicle (car, motorcycle or truck) in each sampling cluster. Kenya DHS survey clusters are geo-located, so we were able to map each cluster. Proportion owning each item are shown in red. Sampling is proportional to population size, so dense and urban areas have more clusters sampled.

# Appendix 4: Trends in facility deliveries by country & year (1990-2014), nationally representative DHS data

Source: Statcompiler (data accessed May 2016)

# Appendix 5: Distribution of a) facilities that conduct deliveries by annual number of deliveries, showing many facilities do <100 deliveries per year and b) facility deliveries by annual number of deliveries showing small facilities do a small proportion of all deliveries



# Appendix 6: Pie charts showing percentage of households in each cluster in red owning telephone (left) and motorized vehicles (right), Kenya Demographic and Health Survey, 2014



# Appendix 8: Estimated percentage of seriously injured patients transported by ambulance, by country

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Source: WHO, “Post-crash response: Pre-hospital care by country” in Regional Health Observatory Data Repository (available at rho.emro.who.int/rhodata/node.main)

# Appendix 9: Existence of a universal access telephone number for pre-hospital care



Source: WHO, “Post-crash response: Pre-hospital care by country” in Regional Health Observatory Data Repository (available at rho.emro.who.int/rhodata/node.main)

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