THE LANCET

Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

Supplement to: 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.

Health system strengthening and deployment of midwives during the past 25 years: country case studies

This is an appendix to *Country experience with strengthening of health systems and deployment of midwives in countries with high maternal mortality,* The Lancet, June 2014. It contains the individual case study narratives, a note on the selection of the case studies and selected indicators on low- and middle income countries mentioned in the paper. References are to the reference list in the main paper.

1. Individual case studies

1.1. Health system strengthening and deployment of midwives in Morocco since the late 1980s

The position of women in Moroccan society has evolved considerably over the last 20 years, particularly in urban areas. Women have fewer children and marry later; modern family planning prevalence has doubled to 67%[21] Literacy has increased among women, as has labour market participation: 89% of women now approve of their daughter having a remunerated job[24]. A new family code in 2004 improved their legal status. The population has become far more vocal in expressing its expectations and discontent regarding maternal health care, and this fids ready echo in the Moroccan press[22].

This increased attention comes after two decades of progress which saw 1990 MMR levels drop from 310 in 1990 to 120 in 2013 and neonatal mortality from 35 to below 20.

During this period antenatal care coverage has tripled. Around 1990 33.5% of pregnant women received antenatal care, two thirds by medical doctors, one third by a nurse or midwife[23]. In 2010 coverage was 77%, about half in private clinics and half in public sector health centres (mainly nurses and midwives). The rural-urban gap has narrowed considerably, and 70% of women who consult for a health problem during pregnancy are seen by a medical doctor, against 23% by a midwife[21].

In the late 1980s 25% of mothers received professional care from a nurse or midwife at childbirth and 6% from a medical doctor. 28% of births took place in a health facility[23]. By 2010 73% did so, most in public facilities. Roughly half were assisted by a medical doctor, the others by a nurse or midwife[21]. Access to professional care at birth has become more equally distributed. The three upper quintiles are now all above 85%; the others still lag behind, but have multiplied coverage by a factor of 5 to 7. Each of the four lowest quintiles has increased the proportion of births attended by midwives with some 20% points, while the richest quintile has shown a shift from midwife-assisted to doctor-assisted birthing (Figure 3B in the main text).

In 2011 398,602 births were recorded in public health facilities alone and approximately 49,000 in private clinics. The public health facilities registered 262 maternal deaths, out of the estimated 782 in the country[24], a MMR of 65 within public facilities. Assuming that mortality in private facilities was lower or equal to that in public facilities, i.e. in a range between 0 and 65, MMR among the 165,000 mothers who did not give birth in a health facility was between 272 and 317. This is lower than what one would expect for non-facility births without professional attendant, suggesting that women with complications are increasingly able to seek professional help in an institutional context if they experience a major problem.

Figure 4A in the main text gives an overview of the health systems strengthening efforts undertaken, as they were identified through interviews with key informants and document analysis.

Efforts to improve access to services and quality of care

Much of Morocco's efforts have been targeted at improving access and coverage, with less attention for quality of care, which programme managers assumed to be taken care of by pre-service midwifery education and the expansion of the technical arsenal, particularly during the 2000s. For example, the antenatal care package broadened, with some 80% of women getting an ultrasound check. In 1990 the caesarean-section rate was only 2% and vacuum extraction a rare procedure[23]. In 2011 16% of births were by caesarean section, 7% by vacuum extraction or forceps[21]. Yet, only in 2010 was care at birth standardised across the country, and even now what midwives are allowed and not allowed to do remains unclear; for example, midwives are not formally authorized to use life-saving drugs[25]. The last 10 years have seen progress in the design, but less in the implementation, of quality assurance procedures, the timely referral of women, and managing complications[35].

Problems with substandard care thus persist. In 2009 a national confidential enquiry of maternal deaths provided a detailed analysis of 303 cases of maternal death. The audit estimated that 54.3% of these maternal deaths could have been avoided by correcting substandard care in hospitals[34]. This is reflected in a persisting perception by the population of poor quality and disrespectful care, staff absenteeism and prevalence of informal payments[22]. Tellingly, before 2010 no concrete measures were taken to make care more respectful; this became an explicit planning objective only in 2010[26].

Efforts to improve access and coverage have concentrated on extending the infrastructure network, expanding the health workforce and eliminating barriers to access. A massive expansion of the health care network was started in 1980s – with 394 public health units in 1960 increasing to more than 2600 currently. There is now 1 health facility per 12,000 inhabitants, against 1 per 17,000 in 1980, including 144 public and 373 private hospitals, totalling more than 32,000 beds. In 1987 only 26% of the population had a health facility at less than 3km. In 2003 this had doubled to 41%. Although in 2010 20% of the population still live at more than 10 km from a facility, significant improvements have been seen, despite substantial problems with staffing and supply of pharmaceuticals. Equipment is slowly improving: in the mid-2000s basic Emergency Obstetric and Newborn Care (EmONC) was available in 28% of the health centres and comprehensive EmONC in 69% of the hospitals. Five years later this was the case for 34%° of health centres and 85% of hospitals[26].

This expansion of health facilities stimulated demand for health workers. The increase in medical density has been slow, from some 4.3 medical doctors per 10,000 inhabitants in 1976 to 6.2 in 2011. Although this has not been considered commensurate with the country's ambitions, it has made it possible to step up referral services, particularly surgery. Nevertheless, availability of medical doctors for maternal health care in public facilities remains constrained by extensive moonlighting and by the attraction of the private sector [36]. In the meantime midwife density has been increasing rapidly over the last 5 years[24]. In 1990 there were no purposely trained midwives: female nurses with a minimal training would assist births. Around 2010 there were five midwives per 1,000 births. A key decision, formalised in 1994, was to reopen and re-energise midwifery schools which, although in place since independence in 1955, had for quite some time been producing few and ill-trained staff. In 2002 a competency-based midwifery training course began and the training capacity was raised to nine midwifery schools, with an intake of 332 midwives in 2005. Education of midwives currently consists of a direct entry three-year training system.

At the same time, budgetary room was made available to deploy these freshly trained midwives with a view of posting a minimum of two midwives per health centre with a maternity ward: 245 midwives were posted in 2008, 253 in 2009 and 191 in 2010[33]**.** Existing plans include the recruitment

of 273 additional midwives, 47 obstetrician-gynaecologists and 28 paediatricians, aiming for better 24/7 deployment, also in the rural areas. These midwives are government employees; there are no performance-related financial incentives to complement their modest salaries. Some midwives may complement their salaries through under-the-counter payments, but the extent of this phenomenon is not well documented.

Midwives are now working at all levels: at primary-care level, in the health centres with maternity wards under the supervision of general practitioners, and in both public and private secondary- and tertiary- level hospitals. However, their roles and responsibilities remain poorly defined, and midwives have no autonomy in responding to obstetric complications[25]. Certification mechanisms are being considered, as well as the legal cadre for recognition of the role of the midwife and regulation of the profession[30], but regulations in place tend to be old and obsolete (for example, the medicines they can use are defined in a 1916 regulatory text). The creation of an "Ordre des sages-femmes" to regulate the profession was agreed in 1955 but never implemented.

Since 2008 maternal and newborn care (vaginal delivery, caesarean section, medicines, laboratory, transfusion, hospital stay, as well as transport from a peripheral maternity centre to the hospital and in rural areas transport from home to the hospital) is provided free of charge by public facilities. Cost is now only a minor deterrent for institutional care: it is mentioned as a reason for home birth by only 6.5%, compared to 33% who indicate personal preference and 25% who refer to distance and transport problems[21]. Total household expenditure for a caesarean section in a public hospital has now dropped from US$283 to US$169. The autonomous University hospitals (US$291) and the private sector (easily more than US$1000 for the surgery alone) remain far more expensive[39]. Demand for and uptake of the expanded supply of maternity care continue to increase, in contrast with the underutilisation of other hospital and ambulatory care services.

Steering and governance support

Senior Ministry of Health officials in Morocco have long considered maternal and newborn health as a priority. Pressure has built up slowly but steadily during the 1980s and 1990s, accelerating in the second half of the 2000s. The 1980s build-up can be traced to a study on Unmet Obstetric Needs, which highlighted the massive deprivation of life-saving maternal health services for much of Morocco's population – urban and rural[40]. The extent of the unmet need took even programme managers by surprise. Ministry of Health advocates for maternal health care then benefited from the political momentum generated by the first international Safe Motherhood Conference in Nairobi[41]. They were acutely aware of the huge backlog in infrastructure, equipment and workforce, and consequently quite hesitant in tackling the issue head-on[40]. However, during the 1990s the government started an across-the-board (as opposed to a maternal health-specific) investment in its overall health infrastructure, including hospitals. The maternal and child health advocates within the Ministry exploited this opportunity, with the support of external agencies who played a key role in keeping maternal health on the Ministries' agenda, and helping to build an evidence- and information base around the health and population surveys. A systematic analysis of near-miss events, originally started as a research programme, played a further important role in understanding where midwifery and related services needed strengthening[42].

Better intelligence and persistent advocacy thus built synergies between the maternal and newborn health agenda and the overall expansion of the health care system. This made it possible to overcome the hesitancies of the 1980s, when the sheer size of the investment needed had seemed so disheartening. By the late 2000s any hesitancies were a thing of the past. A situation review in 2007-08 became the basis for a comprehensive 5-year action plan. Maternal health gained the visibility it has today, with the consequent budgetary allocations for creating large numbers of posts

for midwives. Maternal health is now a fashionable priority for politicians and the press as well as for health sector managers.

These system strengthening efforts have been a protracted process of building-up institutional capacities and extending the health service network. Specific efforts to expand the supply of maternal and newborn services have piggybacked on the expansion of the overall health care infrastructure network. In a context of rapid transformation of Moroccan society, improved supply has almost instantly been matched by rapidly growing uptake of services. The population now expects care to be generally available, and politicians respond to that expectation even to the point of setting up helicopter emergency evacuation schemes for remote populations. Maternal deaths no longer go unnoticed but give rise to public protest. These heightened expectations feed increased demand to step up the availability of midwives and referral back-up together with pressure to improve quality of care. The result is a virtuous cycle of increased supply and increased demand – albeit one that remains constrained by staffing and quality of care limitations.

1.2. Health system strengthening and deployment of midwives Burkina Faso since the 1990s

Burkina Faso is one of the world's poorest countries, with a life expectancy of barely 55 years[60]. The population is predominantly rural, living in a dispersed habitat. Illiteracy rates are among the highest in the world. Equal legal status notwithstanding, women remain subordinate to men. Signs of improvement seem related to rapid urbanisation[60] and modernisation (mobile phone use now stands at 45%[60]). Contraception, legal since 1986[60], now has a prevalence of 16%. There may be some limited progress in women having the last word in matters concerning their own health (from 19.3% in 2003 to 23.7 in 2010)[61,62]. Female genital mutilation appears to be diminishing, from 89% in older generations to 58% of 15-19-year-old girls[62]. Women are well aware of the risks associated with pregnancy: data from 2004 show that 46.1% had a plan for transportation, and 83.3% had a plan to save money for health care costs associated with childbirth[63].

Burkina Faso has halved maternal mortality and reduced neonatal mortality by one third since 1990. The key factor has been a dramatic improvement in access and uptake of maternal health care. First-visit antenatal care coverage is now well above 90% in all income quintiles[64]. Albeit often still delivered in a ritualistic way[65], its technical platform has become more sophisticated over the last decade[61,62]. In the mid-1990s only between 20 and 30% of women in the four lower quintiles gave birth in a health facility, against 3 out of 4 of those in the richest quintile. This situation has improved considerably (Figure 3A in the main text). The conditions for facility birthing remain poor, but births attended by health professionals (doctors, midwives, auxiliary midwives, nurses) increased in all quintiles (Figure 3B in the main text). Midwives and auxiliary midwives now assist 50% of women in the lowest and almost 90% of those in the richest quintile. During the early 1990s 0.7% of rural and 4.5% of urban women gave birth by caesarean section[66]. More recently rates of caesarean section have reached 1.1% in rural and 6.7% in urban areas[67].

Figure 4B in the main text provides an overview of the health systems strengthening efforts undertaken, as they were identified through interviews with key informants and document analysis.

Efforts to improve access to services and quality of care

Access to professional care for pregnancy and childbirth expanded in a context of persistent high fertility and low contraceptive prevalence, with a doubling of the yearly number of births between 1990 and 2010 (see section 3 of this appendix).

The 1991 the official policy on population did have an objective of reduction of maternal and infant mortality. However, this policy focused on family planning and strengthening the position of women, rather than on reinforcing maternal care services. Health care services were largely dysfunctional. For example, one third of 142 health centres built between 1985 and 1990 with World Bank support had to close down for lack of equipment and personnel. In reaction, the MOH embarked on a programme of decentralisation and reinvestment in health care services according to a district health care model[68]. The number of health facilities in the country increased from 797 to 1240 between 1990 and 2000. Referral facilities were upgraded, 165 public primary care centres and 8 maternity facilities created and 168 private facilities established. The workforce hardly increased during this period.

Despite the establishment and expansion of the district system, the ratio of births to health care infrastructure and health personnel stagnated because of the steep increase in the number of births due to high fertility in Burkina Faso (Table 1). During that period, however, the need to specifically address the maternal health priorities was gradually recognized. In 1998 the MOH set a target of 30%

reduction or maternal mortality. The Unmet Obstetrical Need survey of 1999 documented appallingly low levels of surgical care for obstetric emergencies: 0.3 % caesarean section rates in rural areas, 1.8% among urban populations[69]. An intra-hospital maternal mortality of 1.8% coexisted with a case-load of midwives ranging of only 2 to 8 births per month outside the capital[69]. This information would change the way health authorities positioned maternal health as a priority in terms of both infrastructure and workforce.

Table 1. The expansion of health facilities and workforce in Burkina Faso since 1990, related to the evolution of the expected caseload.

	1990	2000	2012
Referral facilities and Hospitals	81 (but less than 40 functional)	83	108
Primary care facilities **(of which maternities)**	716 (16)	989 (46)	1683 (24)
Private facilities	?	197	398
Medical Doctors	314	325	787
Nurses and medical officers	2039	3011	8048
Midwives	325	376	1321
Auxiliary midwives	500-1000?	1098	3130
Number of expected births	419,000	662,000	823,000
Ratio expected births/facility	525	521	376
Ratio expected births/Dr+nurse+medical officer	178	219	102
Ratio expected births/(auxiliary)midwife	316-507	449	184

Source of data: references 71,72

The next decade centred around the 2000 Poverty Reduction Strategy Framework and the implementation of the 2001-2010 National Health Development Plan (NHDP)[70]. The NHDP highlighted the priority to be given to maternal health care. At the same time several projects focused on increasing the use of skilled providers during pregnancy and childbirth[63].

The NHPD accelerated the expansion of the overall health service infrastructure, creating over 900 new facilities created by 2012 (Table 1). In 2012 a health facility covered an area within an average radius of 6.7km, down from 8.7 in 2003 and well over 10km in the 1990s[71,72]. The stagnation of the ratio births/facilities was reversed. Crucially the NHPD also arranged for increasing the stock of health workers, redeployment, financial incentives, punishing misconduct, and the development of training programmes and the creation of an ethics committee.

The NHPD was the turning point for the professionalisation of childbirth. It explicitly opted for professional midwifery, targeting one midwife per 130 women of reproductive age[73] with training of auxiliary midwives as an interim strategy. The professionalisation and upgrading of midwifery implied that traditional birth attendants would “refocus” their role on preparing women for childbirth, identifying the nearest health centre as place of birth and organising reliable transport.

Between 2000 and 2010 the number of midwives and auxiliary midwives increased threefold, albeit with deficiencies in practical training: financially autonomous midwifery schools accept paying students without sufficient places in maternity wards or tutors to provide quality training. In order to improve the deployment of midwives the profession was opened to men (by 2009 they represented 14% of the profession). Career paths allowing midwives to move towards a management or teaching career through an additional three-year public health training made the profession more attractive. The professional association for midwives, a union and a regulatory body (created in respectively

1973, 1997 and 2008) collaborate on the accreditation of midwives and control of professional practice. The auxiliary midwives – originally intended as a temporary solution - are being oriented towards a formal midwifery training curriculum with a longer education programme.

The combined result of infrastructure and workforce expansion was a significant improvement of births/facility and births/workforce ratios after 2000 (Table 1). In the mid-2000s, awareness of financial obstacles to access increased. Early attempts to overcome these were inspired by community-managed cost-sharing schemes in Mali that had sought solutions to overcoming barriers to referral at childbirth. The Parliament then voted in a national subsidy for childbirth and emergency obstetric and newborn care services, including caesarean sections[74]. Pilot implementation schemes showed an immediate effect on referrals: in one district, for example, it led to an increase in the number of emergency referrals by health centres from 84 in 2004 to 683 in 2005. Major obstetric interventions per 100 expected births increased from 1.95% in 2003 to 3.56% in 2005, those for immediately life-threatening conditions from 0.75% to 1.42%[75]. Overall facility-birthing took off from 2005 onwards.

Quality of care remained an issue despite various initiatives. MOH guidelines76[72] were issued in 2001, resulting from a consensus of all the regulatory bodies and professional associations. Several updates and new versions followed, but with little impact on the ground. Comparison of maternal and newborn case-fatality rate by different categories of personnel has shown that differences and deficiencies in training impact considerably on maternal and newborn case-fatality after caesarean section[77]. The childbirth subsidy regulation made it possible to standardise emergency obstetric care procedures, particularly caesarean section. Later in the decade “near miss” or maternal death reviews[78,79] highlighted how delays in obtaining care, poor referral linkages, premature discharge of women and inadequate follow-up of unresolved health problems contribute not only to immediate death or longer-term disability or illness, but also to an increased risk of death as long as 4 years after a complication[65].

Steering and governance support

Maternal and newborn health policies have been informed by the sequential DHS surveys, the UONN work, and numerous scientific and development projects sponsored by external agencies. Maternal – newborn health care has been championed by MOH staff and partner agencies since the end of the 1990s. Initiatives in this area enjoy considerable popular support. This has been echoed at policy level since the preparation of the National Health Development Plan, around 2000. At the political level explicit support was given by the First Lady since around 2002. Towards mid-2000s, the discussions about lifting financial constraints to access to maternal and newborn health care were an opportunity for mobilising parliamentarians. Professionals and parliamentarians interacted in various fora, including in the development of the 2006-2015 MNH acceleration roadmap, heightening the visibility of the maternal and newborn health agenda.

1.3. Health system strengthening and deployment of midwives in Indonesia since the late 1980s

The situation of Indonesian women has improved since 1990, with gender parity in education at the primary, secondary and tertiary levels[43], better women's rights[44] and more women's participation in government[45]. Surveys show progress in women's participation in household decisions, with the important exception of those related to their own health care[46,47].

Reducing maternal mortality has been a national priority since the 1987 Safe Motherhood Initiative was launched[41]. There was a drop of 56% between 1990 and 2013, although there are suggestions of a slowing down in recent years[47,48]. In 1990 there were an estimated 27,720 maternal deaths in Indonesia; twenty year later there were 9,812. Mothers who die are typically young, rural, less educated and poor. The poorest mothers still have a MMR that is more than three times that of the richer[49]. Neonatal mortality dropped by almost a half during the two decades, from 32 down to 19, with less of a drop in the lower than in the richer quintiles.

Facility birthing has tripled, from 21% in 1991 to 63% in 2012[47,48]. The poorest quintile has made the smallest gains (Figure 3A in the main text), and in 2012 stands at 30% facility birthing against 88% in the richest quintile [47]. This "progress in facility birthing needs" to be qualified. Out of the 46% of women who were using "health facilities" in the mid-2000s, only one out of four gave birth in a hospital[46]. 70% of "facility births" were in private midwifery clinics and village birthing posts or village midwife homes (90% of these private "facilities" lacked a steriliser or resuscitation equipment and 80% lacked magnesium sulphate)[51]. A further 7% gave birth in health centres, 85% of which had no staff trained for providing BEmONC[52]. It would therefore appear that in the mid-2000s a substantial proportion of 'facility births' actually occurs in unequipped or inappropriate facilities.

Nevertheless, the progress in access to facility birthing has boosted caesarean section rate trends, from 0.8% (1986-89) to 12.3% (2007-2011). Although women with severe obstetric complications typically rely on public hospitals, most caesarean sections are provided in private facilities, with a large gap between the poor and rich: 3.7% of those in the poorest quintile gave birth by caesarean section, against 23% of the richest[47].

In 2012 85% of births were attended by health professionals (doctors, midwives and nurses)[47], up from 32% in 1991[48]. The richest quintile is switching from assistance by midwives to assistance by doctors (Figure 7). The disparity between provinces[47] between the rich and the poor (97% against 58%)[47] and between mothers with a secondary education (97%) and those without education (32%) persists.

Figure 5A in the main text provides an overview of the health systems strengthening efforts undertaken, as they were identified through interviews with key informants and document analysis.

Efforts to improve access to services and quality of care

The salient feature of Indonesia's programmes since the late 1980s has been the massive scale-up of access to midwives. Between 1991 and 2012 midwife-assisted births increased from 29% to 62%[47,48]. In the three lowest quintiles midwife-assistance increased by 31 percentage points, in the fourth by 10 percentage points. In the richest quintile there was a 12 percentage points decrease as women switched to doctor-assisted childbirth: in the mid-2000s 20% of births were assisted by an obstetrician.

The centrepiece of these scale up efforts was the *Bidan di desa* or village midwife programme. The midwives or *Bidan* were to provide a range of primary care services including antenatal, labour, birth

and postnatal care, family planning promotion and services, and other basic primary health care services for newborns and children. The programme initially required that a trained midwife should receive only one year of midwifery training after nine years of schooling and three years of nursing training. This was extended to a three-year diploma course through midwifery academies in the mid-1990s. The government began to hire midwives on three-year contracts; midwives could apply for vacant civil service posts or could be hired by local governments.

The programme was attractive for women who saw in midwifery employment an opportunity for dual practice. This promised a career and good income, work compatible with a family life and socially fulfilling [53]. Midwifery academies proliferated and by 2008, there were nearly 600 schools. The speed and scale of expansion was such that clinical training sites and qualified clinical teachers could not match need and midwives reportedly were graduated without actively assisting at childbirth[54].

By 1997 over 54,000 midwives had been deployed and about 20,000 village maternity clinics established: 12 per 1000 expected births in the country. By 2012, the number of midwives had risen to over 135,000: 31 per 1000 expected births)[55]. Half function as village midwives while others work in health centres or clinics.

The increased supply of midwives led to increased use of maternity services[56], but the programme also presented a number of weak points. Confidential inquiries in western Java found village midwives' emergency diagnostic skills to be accurate, but clinical management of complications wanting[56]. Little or no information is available on progress in providing compassionate and respectful care, but persistent poor technical quality of care is well documented[49,50,53,54,55].

Reasons behind poor performance of midwives are partly related to the deficiencies in the basic training consequent to the pace of scaling up, and partly to the deployment strategy. Many midwives were put to work as a sole provider when practising at village level, in remote postings, or in private practice—all of which necessitated the adoption of multiple additional health care tasks beyond midwifery. Employment status has varied—from civil servants to short-term contract staff (local or national) to private practitioners--and hence supervision has often been inadequate. A lack of training and experience with obstetric emergencies or referral possibilities was compounded by the low volume of work for many midwives: village midwives average 30 births per year[51]. Performance problems have been exacerbated by poor communications between midwives and their back up care and resulting referral glitches.

Quality of care thus suffered from structural problems in the organisation of the programme and barriers to access as well as from inadequate individual behaviour and capacities. Poor quality of care at both midwifery and hospital levels has influenced the way families recognise problems and access care.[52] As time went by and problems were recognised, attempts were made to solve them.

The issue of individual capacities and preparation of the midwives was recognised at an early stage and led to a thorough review of the basic training in the mid-1990s, when the standard one year curriculum was transformed into a three-year programme. Certification of graduates has not been standardised although there are recent initiatives by the National Midwifery Association and an independent national accreditation body is in development. Quality improvement circles/maternal and perinatal audits have also been introduced recently. As a response to the quality challenges the MOH has mandated a 10 day in-service training program for strengthening competencies in assisting normal births in collaboration with the National Clinical Training Network, but sub-optimal support and lack of incentives for referrals and for 24/7 accessibility continue to hinder quality improvement.

Other problems however, were not addressed. The deployment of midwives was poorly coordinated with the parallel expansion of the hospital network (a 22% increase in the number of hospitals between 1998 and 2008, with most of the increase in larger size hospitals[57]) and the continuation of the expansion of the health centre started during the 1980s. The network of facilities itself continued to face major coordination problems further complicated by the way decentralisation was rolled out. Equipment and supplies systems for maternal health care also lagged behind. In 2011, a national facility survey showed that of the nearly 9000 health centers only 19% could provide basic EmONC, 20% had no transportation available for referral, and less than 50% could provide 24 hour services[58]. While 83% of public hospitals had at least one obstetrician, only 21% met the nine comprehensive EmONC criteria, including a 24 hour operating room, blood, laboratory and radiology services, and 24/7 availability. More than half lacked qualified human resources, equipment and blood. The Government has only recently launched measures to upgrade hospital and health centre services. These include rationalisation of recruitment and distribution of staff, accreditation of hospitals and health centres, introduction of quality improvement cycles and maternal and perinatal audits, and increased financial support from central as well as local government to address the gaps in infrastructure, equipment and supplies.

Families face very substantial transport and inpatient costs: typically US$111 for a normal birth and US$423 for a caesarean section[59]. Financial barriers to access became a prominent issue with the economic collapse of 1997 that resulted in almost a quarter of the population living in poverty. A financial safety net for health was designed and implemented as of 2005. It has since morphed into national and district-level insurance programmes for the poor and near poor[49] with the ambitious goal of universal health coverage by 2019. In 2011 the national insurance program was expanded to include maternity insurance for the 44% of pregnant women without coverage. These insurance programs have reduced the equity gap in accessing services---but not yet eliminated it. They also cover transport costs, but only partially and not to the first level of care, costs of which are borne by families[49].

Steering and governance support

Given the size and complexity of the country and the heavy reliance on the private sector, effective governance and integration of the health care delivery system has been a persistent challenge. In 1999, Indonesia decentralised health policy and program management to district level with the intention of improving access and quality. Given the variable capacity to design policies and manage programs across districts and municipalities the results have been uneven. Within the districts and municipalities the persistent lack of coordination of the different levels of government institutions has resulted in uneven progress and achievement, a multiplication of approaches and organisational set-ups, and little capitalisation on lessons learned. Prior to 2011, midwifery care at primary health facilities, and hospital care for emergencies, were managed and funded separately, with resulting communication and accountability problems. The absence of integration and continuity in the system has severely constrained the effectiveness of the midwife programme and may explain the trend towards stagnation in outcomes.

In 2011, the MOH put health centres and hospitals under the supervision of one Directorate General, thus attempting, with little success, to bridge the gap between primary and referral facilities[57]. The absence of a reliable information system, among others, to enable efficient and effective management of the health insurance programs, is well recognised, but effective solutions have remained at the planning stage. National regulations set minimum standards for districts for 18 health indicators in 2008, eleven of these health indicators relate to maternal, newborn and child health[58]. The results of these efforts to improve maternal health programs within and across districts remain to be seen.

The Government appears committed to addressing ongoing challenges as they arise (for example, it included private sector providers in its National Insurance Program). Much hope has been put in the flexibility that would come with decentralisation. The cautionary lessons learned, however, is that decentralisation is not always an easy recipe for improved maternity services, and the issue of equity requires attention. Decentralisation and devolution of authority to districts gives the mayor of each district the authority to select programmatic direction for the district. The political commitment shown at national Ministry level has not necessarily been taken up at district level.

1.4. Health system strengthening and deployment of midwives in Cambodia since the 1990s

After the Khmer Rouge regime and the subsequent Vietnamese-backed administration, Cambodia has been through a period of rapid economic growth and modernisation. Between 1993 and 1998 gross national income (GNI) per capita increased at a 5% yearly rate, accelerating to an average of more than 8% per year from 1999 onwards. Transport and communication improved markedly: in 2012 there were 132 mobile-phone subscriptions per 100 inhabitants in Cambodia, up from 1.1 in 2000. Female primary education completion rates tripled between 1995 and 2011, to 89.7%[80]. Life expectancy gained 15 years between 1993 and 2011 and is now more than 71[80].

Neonatal mortality halved from the 36-37 levels of the 1990s to 18.4 in 2012. MMR fell from 830 to 510 in 2000, and to 170 by 2013. The direct, unadjusted estimates of MMR of the three consecutive Demographic and Health Surveys (DHS) in 2000, 2005 and 2010 (437, 472 and 206) suggest that most of the progress took place in recent years[81-83]. This is consistent with the pace of economic growth and improved uptake of professional care after 2005. Antenatal care uptake has increased dramatically, from 38% in 2000 to 90% in 2010[83]. At 35%, contraceptive prevalence is behind national targets, but abortion is legal at the woman's request up to 12 weeks of gestation. Facility birthing has increased dramatically in all wealth quintiles (Figure 3A in the main text): in 2012 66% of births took place in health facilities, against 9.8% in 2000[81,83]. In 2000, professional assistance by very poorly skilled staff stood at 30.9%; in 2010 staff were much better prepared and coverage had reached 63.1%. Most assistance is provided by midwives, although in the upper quintile a shift towards doctor assistance is taking place (Figure 3B in the main text).

Figure 5B in the main text provides an overview of the health systems strengthening efforts undertaken, as they were identified through interviews with key informants and document analysis.

Efforts to improve access to professional care

At the end of the Khmer Rouge regime only 50 doctors were left in the country. The health care system improved little during the Vietnamese-backed administration. Reconstruction started only after the 1993 UN-sponsored national elections. With a GNI of only US$ 826[80], 16% coming from aid, and only a skeleton staff of health workers, the health sector was largely piloted through external technical assistance.

It was planned as a district system in 1995: a network of 10-20 primary care centres backed up by a district hospital would cover a population of 100,000 to 200,000, replacing dysfunctional commune clinics[84]. This "coverage plan" marked the transition from an administrative-based to a population-based approach[84]. The "package of activities" included maternal health care, with at least two midwives per health centre.

Implementation was coordinated through a Sector Wide Approach mechanism and rapidly picked up speed. By 1999 59% of facilities had started implementing the package[85]. Development was uneven. 50% of the referral hospitals still lacked equipment for comprehensive EmONC. Only three hospitals had mini-laparotomy kits for tubal ligation[86]. In Siem Reap province only 14 to 19% of women with life-threatening obstetrical complications reached the hospital for a major obstetrical intervention – often late: 1 out of 7 with a ruptured uterus[87].

Despite all these constraints, things improved. Antenatal care uptake picked up rapidly, and 57% of urban and 28% of rural women now had some professional assistance at birth[81]. Access to emergency care for complications improved: the caesarean section rate doubled from 1.0% in 1997-

2000, to 2.2% in 2002-2005. In the lowest quintile it multiplied from 0.2 to 1.0%, suggesting that access for major maternal complications started trickling down the income ladder[81,82].

As of 2003, 294 of the 935 planned health centres were functional and implementing a full package, as well as 44 out of 66 district hospitals and 16 other referral hospitals[88,89]. The package included family planning and birth spacing; safe abortions; maternal and child nutrition, antenatal care, PMTCT, skilled birth attendance, EmONC and integrated postnatal care for mothers and newborns[90].

By 2007 there 956 health centres and 74 hospitals were functional. The caesarean section rate continued to move up to 3.5% between 2007 and 2010 (1.3% in the lowest and 10.5% in the highest quintile). The expansion of the health care network continues today; on current plans there will be 1,694 health centres and 85 hospitals in 2015: an average 83 new health centres per year, each requiring 10 staff[90].

Financial barriers

As early as 1996, financial accessibility and poor staff performance were identified as major concerns. A Health Financing Charter introduced user fees, with exemptions for the poor. The income was used for local staff incentives (60%) and recurrent costs (39%), transferring only 1% to the Government's Treasury[85,91]. The explicit aim was to generate revenue to replace the ubiquitous under-the-table payments which made care expensive and unpredictable[86,92].

As of 1998 the country experimented with contracting the management of districts to (international) NGOs[93,94]. In combination with the user fees this enhanced performance whilst minimising under-the-table payments[95]. The contracts specified performance-based incentives linked to maternal and child health service improvement targets[94,96]. Access became more affordable and service uptake increased[97]. This worked well at health centre level, albeit less in hospitals[91]. There, cost remained the single most important deterrent to obtaining care, even for more than one out of every two women in the richest quintile[92].

This led to experimentation with "Health Equity Funds" to improve access for the poor[95]. These first covered hospital fees, but soon extended to part or full support for transport and other costs during hospitalisation[91]. Between 2003 and 2006 29 such schemes were launched[95]. They were not specific to maternal and newborn health but had a dramatic effect on uptake of care for obstetric complications.

Workforce

It would take nearly 10 years after the launch of the 1995 coverage plan before the midwifery workforce problems in Cambodia were confronted.

During the early 1990s midwifery was limited to occasionally assisting a birth in one of the underequipped hospitals; midwifery was non-existent at clinic level. In most places there were no maternal health services; in others they were difficult to reach and unpredictably expensive. The grossly underpaid staff was unresponsive, low skilled and under-equipped; quality of care was recognizably low[86]. In 1998 only 17% of the midwives in place actually reported assisting at births and 3% reported doing antenatal or postnatal care[98]. In a 1999 survey of 165 midwives, 45% had not attended a single birth in the preceding month and 24% only 1 to 2. Only 2% had attended 10 or more births[81,99]. Many of the more than 3000 midwives lacked elementary obstetrical and life-saving skills[86,100]: 34% were unable to define how to handle postpartum haemorrhage; 25% could not identify harmful practices or define third stage of labour; 15% were unable to use oxytocin or identify signs of shock[97]. Use of antibiotics by midwives was becoming almost universal. Inadequate training and ridiculously low salaries were compounded by a lack of self- confidence, job prestige,

professional image and career opportunities[102], and, in urban areas, by the direct competition from doctors for a share of the delivery market[86].
The training programmes for primary and secondary midwives had been terminated in 1988 and 1996. Years of discussion on possible curricula followed. As a result, the quality problem was compounded by insufficient numbers: in 2005 32% of health centres had only poorly trained primary midwives, and 18% no midwife at all[102].

Reopening of direct-entry midwife training schools produced its first graduates in 2005. Rapidly increasing facility-birthing provided students with increased training opportunities. By then the various performance incentive schemes compensated for the low public sector salaries. They were complemented by a nation-wide "live birth incentive" and vouchers for maternal care in parts of the country. Today, all the 1,007 health centres have at least one midwife; half have both primary and secondary midwives. The increase in number of expected births notwithstanding, the potential workload per health facility diminished from 963 births per facility per year in 2003 to 352 in 2011[102].

Efforts to improve quality of care

With the education and deployment of a new generation of midwives the MOH and partner organisations created opportunities for improving quality of care. Significant resources were directed towards continuous education and supervision of midwives and doctors. The Midwifery and Medical Councils are gearing up to start introducing formal continuous education systems. Critically, regular meetings between health centre midwives and hospital staff have now been institutionalised. Maternal death audits have been carried out since 2004. Maternal death reporting is improving, piloting web-based civil registration by district authorities. Clinical protocols for maternal-newborn care at health centres and at hospitals have recently been updated.

Essential interventions are being addressed to improve the quality of care. An evidence-based regimen of MgSO4 use is gaining momentum and the drug is generally available in hospitals. In 2009, a survey of major hospitals showed that only in 18% of births the third stage of labour was managed correctly[103]. In 2011-12 this improved to 80%, rising to 95% in 2013[104]. Key informants confirm an impression of steady improvement, albeit with signs of over-medicalization of pregnancy, such as generalized use of antibiotics by midwives. The shift from midwife to doctor among the richest quintile is associated with fast-rising caesarean section rates.

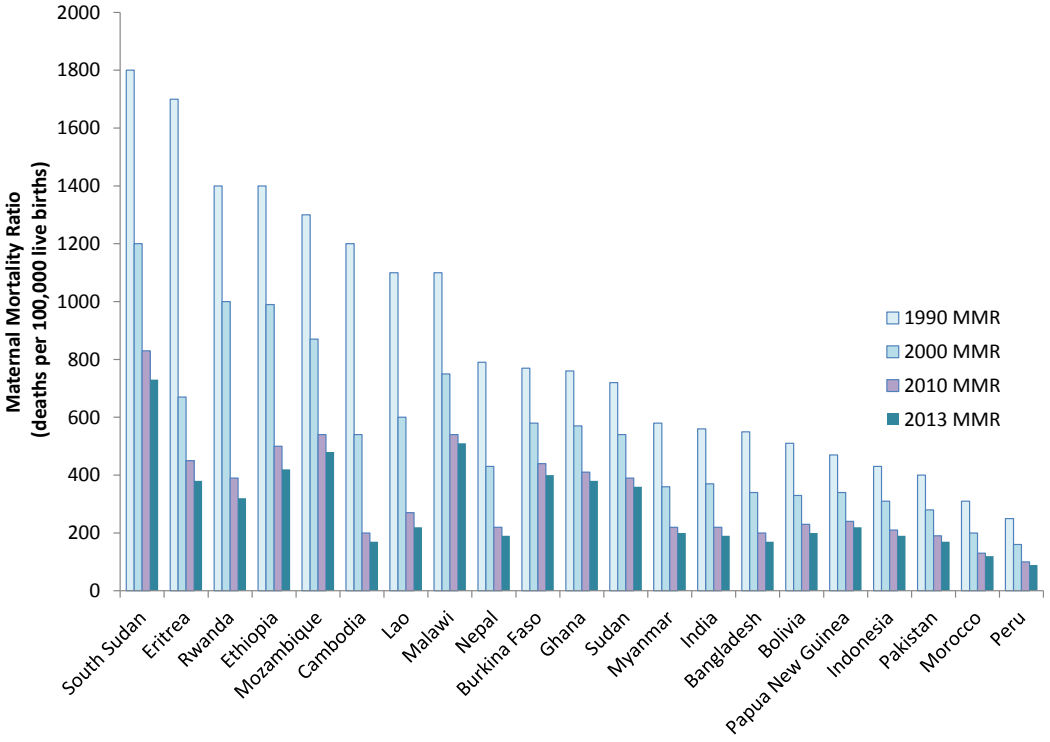
Steering and governance support

Maternal and newborn health has been recognised as a priority component of the roll-out of district health care network from the early planning stages. It has been a prominent part of the package of services and of the performance indicators. Whereas performance, access, coverage, quality of care and of education in Cambodia were rated very weak by key informants compared to other countries, policy support and system intelligence were rated above average[105]. Nonetheless, it took about 10 years before the extensive documentation of access and quality of care issues was translated into the deployment of specifically trained professionals. Once that was the case, uptake of services and outcomes started to improve rapidly. The maternal and newborn health agenda then also gained traction at the political level: in 2008 the Minister of Health wished to be remembered as the "midwifery minister", while the First Lady has been a national champion for safe motherhood since 2011.

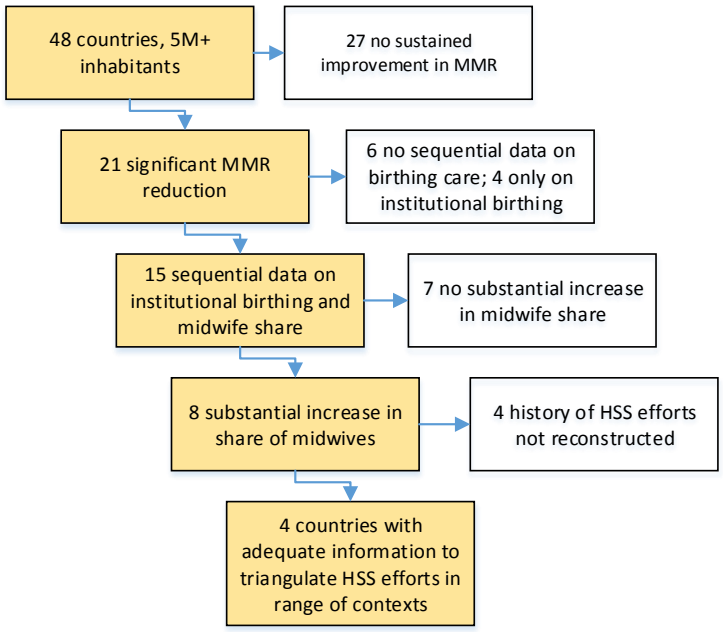
2. Country case selection

Countries were selected among 21 countries with two consecutive decades of rapid maternal mortality reduction after 1990 (Appendix Figure 1). Appendix Figure 2 shows how data availability has constrained the selection of country cases.

Appendix Figure 1. Twenty-one countries with two consecutive decades of rapid maternal mortality reduction from 1990. Source of data to determine MMR reduction: reference 29



Appendix Figure 2. Steps in the selection of case study countries



3. Selected health data on countries mentioned in the paper

Country	Population 2014 (000)	Number of births 1990	Number of births 2000	Number of births 2010	1990 MMR	2000 MMR	2010 MMR	2013 MMR	Average annual rate reduction MMR 1990-2000	Average annual rate reduction MMR 2000-2010	estimated approx years to halve MMR from 1990
Bangladesh	158513	3,767,807	3,575,505	3,174,400	550	340	200	170	4.81	5.31	15
Bolivia	10848	249,738	267,435	269,537	510	330	230	200	4.35	3.61	18
Burkina Faso	17420	418,659	538,355	661,853	770	580	440	400	2.83	2.76	23
Cambodia	15408	385,634	336,331	378,621	1200	540	200	170	7.99	9.93	9
Eritrea	6536	142,856	159,208	221,732	1700	670	450	380	9.31	3.98	8
Ethiopia	96506	2,291,910	2,886,305	3,028,722	1400	990	500	420	3.47	6.83	16
Ghana	26442	571,637	654,670	780,430	760	570	410	380	2.88	3.29	23
India	1267402	26,664,786	26,726,045	25,681,769	560	370	220	190	4.14	5.20	16
Indonesia	252812	4,623,693	4,504,569	4,820,608	430	310	210	190	3.27	3.89	20
Lao PDR	6894	182,616	165,787	180,275	1100	600	270	220	6.06	7.99	12
Malawi	16829	454,684	512,018	613,853	1100	750	540	510	3.83	3.29	20
Morocco	33493	740,395	630,940	696,053	310	200	130	120	4.38	4.31	16
Mozambique	26473	606,703	813,907	975,115	1300	870	540	480	4.02	4.77	17
Myanmar	53719	1,129,411	1,008,964	931,319	580	360	220	200	4.77	4.92	15
Nepal	28121	688,313	759,672	621,273	790	430	220	190	6.08	6.70	12
Pakistan	185133	4,469,317	4,461,464	4,610,564	400	280	190	170	3.57	3.88	19
Papua New Guinea	7476	146,179	188,161	207,376	470	340	240	220	3.24	3.48	20
Peru	30769	651,240	626,152	602,940	250	160	100	89	4.46	4.70	16
Rwanda	12100	314,002	323,197	400,642	1400	1000	390	320	3.36	9.42	15
South Sudan	11739	266,415	280,791	373,553	1800	1200	830	730	4.05	3.69	18
Sudan	38764	849,615	1,109,769	1,240,951	720	540	390	360	2.88	3.25	23

Country	Neonatal mortality rate 1990	Neonatal mortality rate 2000	Neonatal mortality rate 2012	Average annual rate of NMR reduction 1990-2000	Average annual rate of NMR reduction 1990-2012	% of births within health facilities (baseline)	% of births within health facilities (most recent)	Midwife or other skilled attendant as a % of all births (baseline)	Births with midwives* as a % of all attended births (baseline)	Midwife or other skilled attendant as a % of all births (most recent)	Births with midwives* as a % of all attended births (most recent)
Bangladesh	54.1	40.7	24.4	2.8	4.2	3.5	26.9	5.3	55.8	9.5	30
Bolivia	38.2	29.1	18.9	2.7	3.5	42.2	69.3	4.5	9.6	5.1	7
Burkina Faso	39.7	38.2	27.5	0.4	2.7	42.6	71.6	39.4	96.3	71.3	98.5
Cambodia	37.0	35.9	18.4	0.3	5.4	9.8	61.8	30.9	93.4	63.1	83.1
Eritrea	35.0	26.0	18.2	2.9	2.9	17.3	28.3	12.7	61.7	22.1	73.2
Ethiopia	54.2	45.5	29.0	1.7	3.7	4.9	11	-	-	8.2	69.5
Ghana	40.2	35.5	28.4	1.2	1.8	42.1	58	37.3	85.2	46.1	80.7
India	50.8	42.2	30.9	1.8	2.6	26	40.4	13	37.1	11.9	24.3
Indonesia	29.9	22.0	15.0	3.0	3.1	21	66.6	30.9	86.3	84	98.8
Lao PDR	43.9	37.2	27.2	1.6	2.6	-	37.5	-	-	3.5	18.5
Malawi	50.0	40.4	24.2	2.1	4.2	53.3	75.3	48.4	91.7	63.9	85.1
Morocco	34.5	25.4	17.8	3.0	2.9	30	73	26.6	82.1	48.8*	75.1
Mozambique	54.1	44.1	30.2	2.0	3.1	21	55	42.1	95.2	51.8	95.4
Myanmar	41.4	34.5	26.3	1.8	2.2	-	36.2	-	-	36.3	-
Nepal	52.7	38.3	24.2	3.1	3.8	7.6	40.6	3.8	39.6	30.8	62.2
Pakistan	55.7	49.4	42.2	1.2	1.3	14	52.7	6.4	34.0	10.2	19.6
Papua New Guinea	30.3	28.0	24.3	0.8	1.2	-	-	-	-	-	-
Peru	27.6	17.2	9.3	4.6	5.0	47.7	86.1	46.1	57.8	33.9	37.8
Rwanda	38.2	42.3	20.9	-1.0	5.7	61.7	78.5	22.8	88.7	59.2	85.8
South Sudan	56.7	48.3	35.7	1.6	2.5	-	-	-	-	-	-
Sudan	40.1	36.0	28.6	1.1	1.9	-	-	59.9	-	-	-

Country	% births by Caesarian Section (baseline)	% births by Caesarian Section (most recent)	Data source for place of birth, attendance at birth and % caesarian section (baseline)	Data source for place of birth, attendance at birth and % caesarian section (most recent)
Bangladesh	2.8	17.1	HS 1993/1994	DHS 2011
Bolivia	10.6	19.5	DHS 1994	DHS 2008
Burkina Faso	1.2	2.1	DHS 1993	DHS 2010
Cambodia	1	3.5	DHS 2000	DHS 2010
Eritrea	1.6	3.3	DHS 1995	DHS 2002
Ethiopia	0.6	1.6	DHS 2000	DHS 2011
Ghana	4.5	6.9	DHS 1993	DHS 2008
India	2.6	9	S 1992 / 1993	DHS 2004-2005
Indonesia	1.2	12.9	DHS 1991	DHS 2011
Lao PDR	-	-	-	MICS 2006
Malawi	3.4	4.7	DHS 1992	DHS 2010
Morocco	2.2	16	DHS 1992	ENPSF 2011
Mozambique	2.7	4	DHS 1997	DHS 2011
Myanmar	-	-	-	MICS 2009-2010
Nepal	1	5.3	DHS 1996	DHS 2011
Pakistan	2.9	15.9	DHS 1990	DHS 2012
Papua New Guinea	-	-	-	-
Peru	10.1	20.1	HS 1991/1992	DHS 2012
Rwanda	1.9	8.4	DHS 1992	DHS 2010
South Sudan	-	-	-	-
Sudan	-	-	DHS 1989- 90	-

Sources:

Population and births data from UN Population Prospects 2012 Revision

WHO, UNICEF, UNFPA, The World Bank.(2014) Trends in Maternal Mortality: 1990 to 2013. Geneva, World Health Organization[29]

DHS data availalbe at www.measuredhs.com

MICS data available at www.childinfo.org

Neonatal mortality data available at www.healthynewbornnetwork.org/resource/neonatal-mortality-rate-country-data-excel-spreadsheet

* *Most recent survey conducted in Morocco is the 2011 Enquete Nationale sur la Population et la Sante Familiale (ENPSF 2011)[26].
This survey does not have data on the % of midwives/other midwifery staff attending births. This data is therefore taken from the DHS 2003/2004 estimated year to halve based on linear interpolation