Original Article

Effect of a comprehensive program on maternal and child healthcare service in Battambang, Cambodia: A multivariate difference-in-difference analysis

Hwa-Young Lee ,^{1,2} Jongho Heo ,³ Hyeonseok Koh ⁴

¹JW Lee Center for Global Medicine, Seoul National University College of Medicine, Seoul, Korea

²Takemi Program in International Health, Department of Global Health and Population, Harvard T.H. Chan School of Public Health, Boston, MA, USA

³National Assembly Futures Institute, Seoul, Korea

⁴Department of Medicine, Seoul National University College of Medicine, Seoul, Korea

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Correspondence to

Hwa-Young Lee

Takemi Program in International Health,
Department of Global Health and Population,
Harvard T.H. Chan School of Public Health,
665 Huntington Avenue, Bldg. 1, Room 1210,
Boston, MA 02115, USA.

E-mail: hwle@hsph.harvard.edu
diana0224@gmail.com

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ORCID iDs

Hwa-Young Lee

<https://orcid.org/0000-0003-2591-1436>

Jongho Heo

<https://orcid.org/0000-0002-6405-3860>

Hyeonseok Koh

<https://orcid.org/0000-0002-2759-6874>

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

ABSTRACT

Background: Interventions for raising use and quality of antenatal care and delivery service through building health information systems, training health professionals, and campaigning, etc., were performed in two operating districts of Battambang in Cambodia between 2013 and 2014 by Korean Foundation International Healthcare (KOFIH). We assessed the effect of KOFIH's comprehensive program on institutional delivery.

Methods: We used two waves of Demographic and Health Survey collected in 2010 and 2014. The outcome measures were a delivery at a public facility and any type of facility (public or private). A difference-in-difference approach compared changes of the intervention group (Battambang province) with the control group (other 24 provinces) in terms of institutional delivery before and after program implementation.

Results: Both intervention and control group showed an increase in both outcomes. Compared with a control group, the odds of giving birth to a baby at public facility or any type of health facility in the after- relative to the before-period were significantly higher in Battambang province (odds ratio [OR], 2.12; 95% confidence interval [CI], 1.26–3.57 for delivery at the public facility and OR, 2.08; 95% CI, 1.00–4.30 for delivery at any type of facility).

Conclusion: Comprehensive maternal and child health program performed by KOFIH in the Battambang area of Cambodia increased the use of institutional (public or any type) delivery. Recipient-driven, a need-based and comprehensive approach might have led to a positive effect.

Keywords: Maternal health; Institutional delivery; Cambodia; Program evaluation

INTRODUCTION

Most maternal and child deaths occur in low and middle-income countries (LMICs). Millennium Development Goal (MDG) 4 and 5 called for two-thirds reduction in under-5 mortality (U5M) and 75% reduction in the maternal mortality ratio (MMR) between 1990 and 2015. Since then, special efforts have been made to improve maternal and child health

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(MCH) in LMICs.^{1,2} This accomplished declines in MMR from 385 deaths per 100,000 live births in 1990 to 216 in 2015,³ and U5M from 90.6 deaths per 1,000 live births in 1990 to 42.5 in 2015.⁴ However, when we look at the picture country by country, only 9 of 95 countries that had showed high maternal mortality rate before the MDG period met the target 5 of 75% reduction,⁵ and 62(32%) of 195 countries achieved target 4.⁴ These efforts have been continuing through Sustainable Development Goals which target a U5M rate of no more than 25 per 1,000 livebirths⁶ and two-thirds less maternal mortality in every country of the world in 2030.⁷

Cambodia has achieved both MDG 4 and MDG 5. It reduced MMR from 1,020 in 1990 per 100,000 live births to 161 in 2016 with an annual continuous rate of reduction of 7.4% (80% uncertainty interval 5.6–8.7) and U5M from 116 per 1,000 live birth in 1990 to 31 in 2016.^{8,9} However, child mortality levels in Cambodia still remain high by regional standards.^{10,11} Moreover, such progress has not been shared among different demographic and socioeconomic groups, showing substantial inequalities between the wealthy and the poor for most of the indicators, especially, infant mortality and U5M (rates among the poorest quintile are at least 3 times higher than among the wealthiest).^{12,13}

To tackle these problems, the Korea Foundation for International Healthcare (KOFIH) implemented a 5-year comprehensive program for MCH in the Battambang province of Cambodia from early 2013.

The project started with a qualitative and quantitative situational analysis to identify underlying problems. Then, comprehensive approaches were performed to address problems identified through situational analyses. Key contents of the program are presented in **Table 1**.

Table 1. Components of the comprehensive MCH program conducted by KOFIH

1. Strengthening of service providers' capacity
• Training on health information
- Training on Annual Operational Plans to HC, RH
• Nutrition campaign and activities
- Interpersonal communications training on the complementary feeding campaign
• Training on nutrition & immunization
- Community Integrated Management of Child illness-11 to HCs staff Training of Trainer training to HC staff on management of acute malnutrition
- Minimum package of activities 10 to HCs in MR OD and SK OD (5 days)
- National vaccination training to new health care staff in MR and SK OD (3 days)
• Training on maternal and newborn care
- Upgrade the skills of new MWs
- Training on immediate newborn care to HC & RH staff in MR and SK OD (2 days)
- Coaching session to strengthening skills of MWs on ANC, PNC & delivery training on postpartum hemorrhage
- Training on partograph and MgSO ₄
- Workshop on newborn intensive care/anesthesia and resuscitation
• Equipment & supplies
- Print information, education & communication materials for the complementary feeding campaign
- Education materials for a coaching session for MWs
2. Demand creation
• Community-based health information system
- Training OD staff in Provincial Health Department
- Workshop with health center staff
- Community health forum
3. Referral system building
• Support for transportation
4. Strengthening of capacity for planning and management
• Capacity building of managers in each department

MCH = maternal and child health; KOFIH = Korean Foundation International Health; HC = health center; RH = referral hospital; MR = Maung Ruessei; OD = operational district; SK = Sangkae; MW = midwife; ANC = antenatal care; PNC = postnatal care.

The comprehensive MCH program was performed with goals of improving the quality, availability, and accessibility of maternal, neonatal, and child health care services in Cambodia. Two operational districts (ODs), i.e., Sangkae and Maung Ruessei, located within Battambang province were selected as initial target areas with a plan to expand if intervention was successful.

The whole strategy was mapped out based on the 4 objectives; Strengthening of service provider's capacity, creation of demand, referral system building, and strengthening the capacity of human resources at the management level. For the first objective, a comprehensive set of trainings on health information, nutrition, immunization, and maternal and newborn care was provided to the related staffs. Continuous promotion through community health forum, the community-based health information system (C-HMIS) was the main activities to increase the demand for utilization of health facility. For the establishment of the referral system, transportation such as tricycle, and an emergency ambulance to reach the health facility was offered. In addition, the transportation fee spent by a user was reimbursed ex post facto. Lastly, the program for enhancing capacity to manage the database and utilize it for the care in practice was provided through C-HMIS.

This study was performed with an aim to assess whether the comprehensive MCH program funded and led by KOFIH generated increases in positive birth outcomes in the Battambang province of Cambodia.

METHODS

Data source and study sample

To capture the change before and after the intervention which started in early 2013, data were retrieved from the Cambodian Demographic and Health Surveys (DHS) conducted in 2010 and 2014, which is the most recent wave. The DHS are nationally representative and provides detailed information about fertility, reproductive, MCH, immunization, mortality, human immunodeficiency virus infection and acquired immune deficiency syndrome, malaria, and nutrition among women of reproductive age between 15 and 49 and their children in Cambodia. The survey used a stratified sample selected in two stages. Stratification was achieved by separating 19 pre-defined domains into urban and rural area which resulted in total 38 sampling strata. Samples were selected in every stratum through a 2-stage process.

In the first stage of selection, 611 enumeration areas (EAs, 188 in an urban area and 423 in a rural area) were selected with probability proportional to size which was defined as the number of households residing in the EA. Some of the largest EAs (more than 200 households) were divided into segments among which only one segment was selected to be included in the survey. Thus, 611 DHS clusters were either an EA or a segment of an EA. After all the households were listed in each of 611 clusters, a fixed number of households (24 from every urban cluster and 28 from every rural cluster) were selected by equal probability systematic sampling in the second stage of selection.¹⁴

We limited the study sample to the last birth happened in the past 5 years preceding the survey. The initial sample for this study included 4,561 and 4,077 women in 2010 and 2014 respectively. After excluding observations with the missing or 'don't know' responses in the

outcome and explanatory variables, the final analytic sample was 4,374 and 4,018 women in 2010 and 2014, respectively.

Ethical approval

The National Ethical Committee for Health Research (NECHR) from the Ministry of Health, Phnom Penh, Cambodia, reviewed and approved the study protocol. In addition, ethical approval was obtained from the International Review Board of Informed Consent Form (ICF). The study was carried out following the rules of the Declaration of Helsinki (1975). All household and women were informed verbally and in writing about the aims and procedures of the study, and informed consent was obtained from all women and children, via their mother's or guardian's approval for these later, before enrollment.

Outcome measures

Two kinds of outcome variables related to institutional delivery were used for our analysis: a delivery-at-a public facility where the reference group was a delivery-at-home or a delivery-at-a private facility and delivery-at-any type of health facility, public or private where reference group was a delivery-at-home. Public facility includes government hospital, government health center, government health post, and other public sectors. Outcome variables were answered with 'yes' or 'no' and operationalized as a binary outcome.

Other explanatory variables

Selection of explanatory variables was guided by previous literature. As sociodemographic characteristics, mother's age (15–24, 25–34, and older than 35 years old), mother's and husband's education level (none, primary graduate, secondary graduate, and more than secondary graduate), economic status (wealth quintile), religion (Buddhist and others), and distance to the health facility (whether distance to the health facility is a big problem and not a big problem) were included.

Statistical analysis

First, descriptive statistics on sample characteristics were compared between the intervention area (Battambang) and control areas (other 24 provinces). Although KOFIH's program was performed in two ODs within Battambang province, we selected the entire Battambang province as an intervention area because the smallest administrative unit provided by DHS dataset is a province. A before-after difference in outcomes between intervention and control areas were presented by categories of demographic and socioeconomic status. Finally, we estimated a multivariate logistic regression specification of the difference-in-difference (D-in-D) model using the interaction term of province multiplied by year.¹⁵

We define $i = 1$ for the intervention group and $i = 0$ for the control group, and $t = 1$ as the year 2014 indicating post-intervention period and $t = 0$ as the year 2010 meaning pre-intervention period. Let μ_{it} be the mean of an outcome variable in group i at time t . The difference in the mean proportion of having an outcome event between intervention and control group in 2010 ($p_{11} - p_{01}$) is the unadjusted estimate of the intervention effect. Adjusting for the baseline difference, the adjusted estimate of intervention effect is $(p_{11} - p_{10}) - (p_{01} - p_{00})$, i.e., the D-in-D estimate of the intervention effect. The D-in-D estimator is actually the coefficient of the interaction term between intervention and time in a regression model with intervention, time, and their interaction as covariates. Model 1 included only two variables indicating year and intervention. Model 2 included all covariates.

To estimate a change in the rank of intervention province (Battambang province) for the prevalence of delivery at any type of health facilities between pre- and post-intervention, we created caterpillar plots, which plots residual of each province from the grand mean with 95% coverage band against the rank when both adjusted and not adjusted for other covariates. All statistical analyses were done with STATA14 (StataCorp, College Station, TX, USA). Caterpillar plots were produced using MLwin 3.02 (University of Bristol, Bristol, UK).

RESULTS

Table 2 shows the demographic and socioeconomic characteristics of the study sample by intervention and control area. Wealth level of the study sample is slightly higher in the intervention area than the control group. **Table 3** presented the comparison of the national prevalence of each outcome pre- and post-intervention by the categories of demographic and socioeconomic status. Overall, the greatest improvement was seen in the outcome of the utilization of prenatal care more than four times. All the categories of independent variables showed improvement in both outcomes related to the utilization of the delivery service except for the women whose husband's education level is more than a secondary graduate. As the mothers are older and education and income level are lower, the improvement was greater.

Table 4 summarized the unadjusted difference by treatment group and time period. Prevalence of delivery at the public facility and any type of facility were lower in the intervention area than the control area at pre-intervention. However, the results reversed after KOFIH's program was

Table 2. Sample characteristics by intervention area

Characteristics	Battambang (Intervention)		Other provinces (no intervention)	
	No.	PCT (%)	No.	PCT (%)
Total	337		8,055	
Age (yr)				
15–24	124	36.8	2,578	32.0
25–34	172	51.0	4,244	52.8
≥ 35	41	12.2	1,233	15.2
Mother's education				
None	43	12.8	1,362	16.9
Primary graduate	177	52.5	4,022	50.0
Secondary graduate	108	32.0	2,422	30.1
More than secondary	9	2.7	249	3.1
Husband's education				
None	27	8.0	918	11.4
Primary graduate	138	40.9	3,415	42.5
Secondary graduate	156	46.3	3,202	39.8
More than secondary	16	4.7	520	6.5
Wealth				
1st quintile (= poorest)	58	17.2	1,965	24.4
2nd quintile	55	16.3	1,529	19.0
3rd quintile	61	18.1	1,313	16.3
4th quintile	82	24.3	1,401	17.4
5th quintile (= richest)	81	24.0	1,878	23.3
Religion				
Others	5	1.5	524	6.5
Buddhism	332	98.5	7,531	93.6
Distance to facility				
Big problem	135	40.1	3,125	38.8
Not a big problem	202	59.9	4,903	61.0

Effect of MNCH program in Cambodia

Table 3. Prevalence of outcomes at pre- and post-intervention by baseline characteristics

Characteristics	Delivery at the public facility			Delivery at the public or private facility		
	Pre	Post	Diff	Pre	Post	Diff
Total	0.62	0.67	0.05	0.74	0.78	0.04
Age (yr)						
15–24	0.56	0.74	0.18	0.66	0.88	0.22
25–34	0.53	0.75	0.22	0.64	0.89	0.25
≥ 35	0.45	0.65	0.20	0.52	0.77	0.25
Mother's education						
None	0.36	0.65	0.29	0.38	0.69	0.31
Primary graduate	0.54	0.76	0.22	0.61	0.86	0.25
Secondary graduate	0.63	0.75	0.12	0.83	0.95	0.12
More than secondary	0.59	0.60	0.01	0.98	0.99	0.01
Husband's education						
None	0.38	0.65	0.27	0.40	0.70	0.30
Primary graduate	0.49	0.74	0.25	0.54	0.82	0.28
Secondary graduate	0.60	0.76	0.16	0.76	0.95	0.19
More than secondary	0.65	0.64	−0.01	0.94	0.97	0.03
Wealth						
1st quintile (= poorest)	0.40	0.68	0.28	0.41	0.70	0.29
2nd quintile	0.47	0.78	0.31	0.50	0.83	0.33
3rd quintile	0.55	0.81	0.26	0.61	0.91	0.30
4th quintile	0.63	0.79	0.16	0.76	0.95	0.19
5th quintile (= richest)	0.62	0.65	0.03	0.90	0.98	0.08
Religion						
Others	0.46	0.56	0.10	0.53	0.63	0.10
Buddhism	0.54	0.75	0.21	0.65	0.89	0.24
Distance to facility						
Big problem	0.46	0.70	0.24	0.52	0.80	0.28
Not a big problem	0.57	0.75	0.18	0.70	0.92	0.22

Diff = difference.

implemented, displaying higher prevalences in the intervention area, indicating that change in the prevalence during the study period was greater in Battambang.

The results remained similar in the multivariate analyses after controlling for other demographic and socioeconomic variables (Table 5). KOFIH's program showed a significant effect for increasing the prevalence of delivery at the public hospital, and delivery at any type of hospital in the intervention area. Specifically, change in probability that women deliver at the public or any type of health facility between pre-and post-intervention was greater in the intervention area than the control area holding the effect of other variable in the model constant (odds ratio [OR], 2.12; 95% confidence interval [CI], 1.26–3.57 for delivery at the public facility and OR, 2.08; 95% CI, 1.00–4.30 for delivery at any type of facility). Consequently, Battambang province jumped from 14th among 25 provinces at pre-intervention to 9th at post-intervention when not adjusted for sociodemographic factors (Fig. 1A and B). When adjusted, it moved 3 notches from 15th to 12th among 25 provinces (Fig. 2A and B).

Table 4. Unadjusted outcomes by intervention status and time period

Characteristics	Before	After	Diff	Diff in diff
Delivery at the public facility				
Battambang	0.50	0.84	0.34	
Other provinces	0.53	0.73	0.20	
Diff	−0.03	0.11		0.14
Delivery at any type of facility				
Battambang	0.61	0.94	0.32	
Other provinces	0.63	0.87	0.25	
Diff	−0.02	0.07		0.07

Diff = difference.

Table 5. Adjusted effect of MCH program on institutional delivery

Characteristics	Delivery at the public facility		Delivery at the public or private facility	
	Model 1	Model 2	Model 1	Model 2
Year (ref = 2010)				
2014	2.40 (2.19–2.63) ^a	2.34 (2.12–2.57) ^c	4.02 (3.60–4.50) ^c	4.27 (3.77–4.84) ^c
MCH intervention (ref = other provinces)				
Battambang	0.88 (0.65–1.19)	0.80 (0.58–1.09)	0.92 (0.67–1.25)	0.78 (0.55–1.11)
Year x MCH intervention	2.19 (1.31–3.66) ^b	2.12 (1.26–3.57) ^b	2.37 (1.18–4.73) ^a	2.08 (1.00–4.30) ^a
Age (ref = 15–24)				
25–34		0.98 (0.88–1.09)		0.91 (0.80–1.04)
≥ 35		0.70 (0.61–0.81) ^c		0.58 (0.49–0.69) ^c
Mother's education (ref = none)				
Primary graduate		1.45 (1.27–1.66) ^c		1.51 (1.30–1.75) ^c
Secondary graduate		1.49 (1.26–1.76) ^c		2.11 (1.72–2.58) ^c
More than secondary		0.98 (0.70–1.38)		8.40 (2.54–27.81) ^c
Husband's education (ref = none)				
Primary graduate		1.13 (0.96–1.32)		1.12 (0.95–1.33)
Secondary graduate		1.32 (1.11–1.58) ^b		1.64 (1.35–2.00) ^c
Primary graduate		1.15 (0.87–1.53)		1.67 (1.03–2.71) ^a
Wealth (ref = 1st quintile [= poorest])				
2nd quintile		1.30 (1.13–1.50) ^c		1.44 (1.24–1.68) ^c
3rd quintile		1.53 (1.31–1.78) ^c		1.99 (1.68–2.35) ^c
4th quintile		1.66 (1.42–1.95) ^c		3.24 (2.68–3.91) ^c
5th quintile (= richest)		1.08 (0.91–1.27)		6.71 (5.26–8.55) ^c
Religion (ref = others)				
Buddhism		2.45 (2.02–2.98) ^c		3.30 (2.66–4.09) ^c
Distance to facility (ref = big problem)				
Not a big problem		1.30 (1.18–1.43) ^c		1.43 (1.27–1.60) ^c

MCH = maternal and child health.

^a $P < 0.05$, ^b $P < 0.01$; ^c $P < 0.001$. **Fig. 1.** Rank of Battambang among 25 provinces for the delivery at any type of facilities (A) Before the intervention (unadjusted for socioeconomic factors) and (B) After the intervention (unadjusted for socioeconomic factors).

Fig. 2. Rank of Battambang among 25 provinces for the delivery at any type of facilities (A) Before the intervention (adjusted for socioeconomic factors) and (B) After the intervention (adjusted for socioeconomic factors).

With regard to other covariates, mother's and husband's education level, household income level, having a religion of Buddhism, and having no big problem to reach the health facility were all positively associated with the probability of giving birth at the public or any type of facility.

DISCUSSION

Our study was performed with an aim to assess the comprehensive MCH program implemented by KOFIH in two ODs of Battambang province in Cambodia. The results suggest that *ceteris paribus*, the program led to an increase in the delivery at the public health facility and any type of facilities among the mothers in the intervention area compared to the control area. Given that the survey collected birth information on babies born in the past 5 years preceding the survey year 2014 (i.e., babies born between 1999 and 2014) while KOFIH's program initiated in early 2013, more than 50% of births must have not been exposed to the program, meaning that the results might have been underestimated. Nevertheless, our results still showed a positive effect of the program with statistical significance.

We can infer that several distinguishing features of KOFIH's MCH program have contributed to the observed positive effect for delivery-related outcomes. First, the program was operated by the recipient-driven way i.e., inviting the recipient country into all kinds of discussion channels and having them become key players of the program to encourage self-sufficiency and ownership in the program.¹⁶ Working in a "donor-driven" way, e.g., intervening in every specific activity with an idea that the donor should guide all the details rather than giving recipient country a chance to stand on their own feet is the most common mistake committed by donor countries.

Second, the program was designed and performed based on the needs assessment and situational analyses performed at the initial step. The situation analyses from a demand perspective revealed that main factors preventing the mothers from accessing to MCH care

at the health center were transportation and financial barriers rather than the social culture or cognition or a wrong perception that the health center is not safe. The situation analyses from the service provider perspective showed that midwives are under-skilled, facility and equipment are insufficient in terms of quantity and quality. Lack of referral, communication, or collaboration among the various level of health facilities and lack of capacity of the healthcare manager for planning and managing were identified from the situational analyses from a management perspective. Program contents presented in **Table 1** were made on the basis of these results from the situational analyses. Thirdly, the program took comprehensive approaches from various perspectives to tackle the problems ranging from supports for hardware to human resource training. Last, the program was monitored and evaluated aggressively with high frequency.¹⁷ For example, supportive supervision on the maintenance of electronic material, and monitoring of OD and health centers on pre-and postnatal care and delivery were provided bi-monthly. A spot check on MCH health information system was performed twice a year and supervision on nutritional activity were given quarterly.

Institutional delivery is expected to improve maternal and neonatal outcome through timely intervention by skilled birth attendants supported by essential infrastructure and referral services if needed.¹⁸ However, uptake of institutional births is still low in LMICs. Varma et al.¹⁹ identified lack of transportation, poor quality of care at the facility as barriers to institutional delivery. Comprehensive training of health professionals at the managerial- and working-level in KOFIH's intervention program might have raised the trust and confidence of mothers in the quality of birth facilities. Also, support for transportation might have lowered the barriers to going to the facilities.

A few previous articles on the effect of the MCH program, contents of which overlapped with ours, also reported positive results. A systematic review found that training programs of healthcare workers for emergency obstetric care may improve quality of care.²⁰ Renfrew et al.²¹ put a special emphasis on the importance of midwifery, reporting that midwifery training makes an important contribution to the quality of care of women and infants. Support of transportation for patient referral in Sustainable Emergency Referral Care initiative in Ghana proved to be associated with increased volume of emergency referrals, increased caseloads of facilities capable of providing appropriate acute care, etc.²²

This study needs to be interpreted considering a few limitations. The first and most notable is that despite the expected positive effect of the program, there is no field-based data available for isolating the pure effect of the program. Therefore, we inevitably used DHS, open-access dataset published by ICF international where the smallest administrative unit of is a province while our intervention area is two ODs. However, there is a high chance of under-estimation rather than the over-estimation of the effect given that the intervention area, i.e., two ODs was smaller than Battambang province, which means that substantial portion of the intervention area defined in our study included areas which were not exposed to the program. Second, there is a chance of bias that might arise from not thoroughly being able to control the effect of other interventions. There were no other major MCH programs supported by other donors except a government funded nation-wide program. Although the national program is evenly supported across all provinces, compliance with the intervention and hence, effectiveness might differ by province.

Despite these limitations, this study, the first evaluation study of MCH program in Cambodia to our knowledge, has implications that the comprehensive, recipient-driven, and need-

based MCH program based on accurate problem identification can be effective. Further studies need to be performed to more fully evaluate the effectiveness of the program.

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REFERENCES

1. Hogan MC, Foreman KJ, Naghavi M, Ahn SY, Wang M, Makela SM, et al. Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5. *Lancet* 2010;375(9726):1609-23.
[PUBMED](#) | [CROSSREF](#)
2. Rajaratnam JK, Marcus JR, Flaxman AD, Wang H, Levin-Rector A, Dwyer L, et al. Neonatal, postneonatal, childhood, and under-5 mortality for 187 countries, 1970–2010: a systematic analysis of progress towards Millennium Development Goal 4. *Lancet* 2010;375(9730):1988-2008.
[PUBMED](#) | [CROSSREF](#)
3. Lozano R, Wang H, Foreman KJ, Rajaratnam JK, Naghavi M, Marcus JR, et al. Progress towards millennium development goals 4 and 5 on maternal and child mortality: an updated systematic analysis. *Lancet* 2011;378(9797):1139-65.
[PUBMED](#) | [CROSSREF](#)
4. You D, Hug L, Ejdemyr S, Idele P, Hogan D, Mathers C, et al. Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN inter-agency group for child mortality estimation. *Lancet* 2015;386(10010):2275-86.
[PUBMED](#) | [CROSSREF](#)
5. Alkema L, Chou D, Hogan D, Zhang S, Moller AB, Gemmill A, et al. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN maternal mortality estimation inter-agency group. *Lancet* 2016;387(10017):462-74.
[PUBMED](#) | [CROSSREF](#)
6. Liu L, Oza S, Hogan D, Chu Y, Perin J, Zhu J, et al. Global, regional, and national causes of under-5 mortality in 2000-15: an updated systematic analysis with implications for the sustainable development goals. *Lancet* 2016;388(10063):3027-35.
[PUBMED](#) | [CROSSREF](#)
7. Norheim OF, Jha P, Admasu K, Godal T, Hum RJ, Kruk ME, et al. Avoiding 40% of the premature deaths in each country, 2010-30: review of national mortality trends to help quantify the UN sustainable development goal for health. *Lancet* 2015;385(9964):239-52.
[PUBMED](#) | [CROSSREF](#)
8. Hug L, Sharrow D, You D. *Levels & Trends in Child Mortality: Report 2017. Estimates Developed by the UN Inter-Agency Group for Child Mortality Estimation*. New York, NY: UNICEF; 2017.
9. World Health Organization. *Trends in Maternal Mortality: 1990 to 2015*. Geneva: World Health Organization; 2015.
10. World Health Organization. *Success Factors for Women's and Children's Health: Cambodia*. Geneva: World Health Organization; 2015.
11. Hong R, Ahn PY, Wieringa F, Rathavy T, Gauthier L, Hong R, et al. The unfinished health agenda: Neonatal mortality in Cambodia. *PLoS One* 2017;12(3):e0173763.
[PUBMED](#) | [CROSSREF](#)
12. Wang W. *Assessing Trends in Inequalities in Maternal and Child Health and Health Care in Cambodia. Further Analysis of the Cambodia Demographic and Health Surveys*. Calverton, MD: ICF International; 2013.
13. Kamal SM, Hassan CH, Islam MN. Factors associated with the timing of antenatal care seeking in Bangladesh. *Asia Pac J Public Health* 2015;27(2):NP1467-80.
[PUBMED](#) | [CROSSREF](#)
14. National Institute of Statistics, Directorate General for Health, ICF International. *Cambodia Demographic and Health Survey 2014*. Rockville, MD: National Institute of Statistics, Directorate General for Health, ICF International; 2015.

15. Imbens GM, Wooldridge JM. Recent developments in the econometrics of program evaluation. *J Econ Lit* 2009;47(1):5-86.
[CROSSREF](#)
16. Booth D. Aid effectiveness: bringing country ownership (and politics) back in. *Confl Secur Dev* 2012;12(5):537-58.
[CROSSREF](#)
17. Evjen-Olsen B, Olsen OE, Kvåle G. Achieving progress in maternal and neonatal health through integrated and comprehensive healthcare services - experiences from a programme in northern Tanzania. *Int J Equity Health* 2009;8:27.
[PUBMED](#) | [CROSSREF](#)
18. Randive B, Diwan V, De Costa A. India's conditional cash transfer programme (the JSY) to promote institutional birth: is there an association between institutional birth proportion and maternal mortality? *PLoS One* 2013;8(6):e67452.
[PUBMED](#) | [CROSSREF](#)
19. Varma DS, Khan ME, Hazra A. Increasing institutional delivery and access to emergency obstetric care services in rural Uttar Pradesh. *J Fam Welf* 2010;56:23-30.
20. van Lonkhuijzen L, Dijkman A, van Roosmalen J, Zeeman G, Scherpbier A. A systematic review of the effectiveness of training in emergency obstetric care in low-resource environments. *BJOG* 2010;117(7):777-87.
[PUBMED](#) | [CROSSREF](#)
21. Renfrew MJ, McFadden A, Bastos MH, Campbell J, Channon AA, Cheung NF, et al. Midwifery and quality care: findings from a new evidence-informed framework for maternal and newborn care. *Lancet* 2014;384(9948):1129-45.
[PUBMED](#) | [CROSSREF](#)
22. Patel S, Koku Awoonor-Williams J, Asuru R, Boyer CB, Awopole Yepakeh Tiah J, Sheff MC, et al. Benefits and limitations of a community-engaged emergency referral system in a remote, impoverished setting of northern Ghana. *Glob Health Sci Pract* 2016;4(4):552-67.
[PUBMED](#) | [CROSSREF](#)