MEASURING THE IMPACT OF MAMA KITS ON FACILITY DELIVERY RATES IN RURAL CHADIZA AND SERENJE DISTRICTS IN ZAMBIA

END OF PROJECT TECHNICAL REPORT

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LIST OF ACRONYMS

3DE	Demand Driven Evaluations for Decisions
ANC	Antenatal care
DHO	District Health Office
CHAI	Clinton Health Access Initiative
EDD	Estimated date of delivery
LMP	Last menstrual period
MDGs	Millennium Development Goals
MoH	Ministry of Health
MoCDMCH	Ministry of Community Development, Mother and Child Health
SMAG	Safe Motherhood Action Group

EXECUTIVE SUMMARY

Background

Improving facility delivery rates is a strategic priority of the Zambian government. Non-monetary "mama kit" gifts, provided to pregnant mothers conditional on delivering their baby in a health facility, have been used by several organizations to incentivize facility delivery. However, to date, no impact and cost effectiveness estimates existed in Zambia or globally, and little documentation previously existed about ideal mama kit contents and operations.

This study, commissioned by Zambia's Ministry of Health (MoH) and Ministry of Community Development, Mother and Child Health (MoCDMCH), measures the impact of mama kits on rural facility delivery rates and provides operational guidance on how to implement a mama kits programme at scale. Partners include Serenje and Chadiza District Medical Offices, UNICEF and the H4+ Consortium, and the DFID-funded Demand Driven Evaluations for Decisions (3DE) initiative involving Zambia's MoH, MoCDMCH, Clinton Health Access Initiative (CHAI) and IDinsight.

Intervention design

Cost-effectiveness modelling, stakeholder consultation, and semi-structured interviews with rural women to assess the desirability of potential mama kit items was used to establish that a mama kit valued at around 20 ZMW / $4 USD containing a chitenge (cloth), nappy and blanket was a potentially cost-effective mama kit package.

Evaluation method

A clustered randomized controlled trial was used to measure the impact of mama kits on facility delivery rates. Thirty rural health facilities in Serenje and Chadiza Districts were stratified by district and paired based on historical facility delivery rates. Within each pair, one facility was randomly allocated to receive mama kits with the other allocated into a comparison group (no intervention). Focus groups in treatment areas were also done to elucidate women's attitudes around challenges to delivering in a facility and the potential impact of the mama kit on encouraging this behavior.

Results

Logistic regression analysis estimates that **mama kits increased institutional deliveries by 44.1%** (statistically significant at the <1% level, 95% CI: [29.9%, 60.2%]) yielding a **cost-effectiveness of $3,490 per death averted,** which is comparable to many other commonly scaled public health interventions.[1]

[1] Examples include LLIN distribution, anti-retroviral therapy for HIV, and other maternal and child health interventions. Example benchmarks described in Appendix D.

BACKGROUND

Despite recent advances, Sub-Saharan Africa still suffers from high levels of maternal and infant mortality.[i] In many African countries, more than 50% of women give birth at home without skilled care,[ii] and 25% to 33% of all deaths of women of reproductive age come from complications during pregnancy or childbirth.[iii]

In Zambia, important strides have been made to advance maternal and child health but room for improvement remains. Under the leadership of Zambia's MoH and MoCDMCH, Zambia has piloted a number of interventions to attempt to improve its facility delivery rates. However, the relative impacts and cost-effectiveness of these interventions remain largely unknown, and Zambia's facility delivery rates still remain low at 43% nationally, with even lower rates in rural areas.[iv]

A growing body of literature has shown that incentives can be effective at encouraging the utilization of available health services. A randomized study in India showed that offering raw lentils worth about $1 USD as an incentive for immunization boosted immunization rates from 6% to 39%.[v] In Nicaragua, a non-randomized study observed an increase in immunizations from 77% to 94% when coupled with a food incentive.[vi] In Kenya, a non-randomized study showed that offering free bed nets at prenatal care triggered a 117% increase in usage of antenatal care services and 84% increase in usage of HIV testing services.[vii] Overall, small incentive-based nudges have enormous potential to encourage recommended patient behaviors of many kinds.

However, there is limited evidence on the effectiveness of small incentives to promote safer child birth. Non-randomized evaluations of schemes that provide cash incentives in India and Nepal have been shown to increase facility delivery rates.[viii, ix, x] Even fewer studies have looked at the impact of non-monetary incentives on improving maternal health. In Zambia, numerous organizations have piloted the use of various types of mama kits – small packages containing low cost items like baby blankets, nappies, baby clothes and chitenges (cloth garment) – as incentives to encourage facility delivery. However, no rigorous evaluation has measured the impact of using nonmonetary incentives, like mama kits, to encourage facility delivery in Zambia.

This study was commissioned by the Zambia's MoH and MoCDMCH to inform maternal and child health policy and practice throughout Zambia, and to contribute to the global knowledge base on the use of incentives to increase facility delivery and the use of public health services. Furthermore, this study will provide operational insight into how mama kits can be implemented at a national scale.

METHODS

Study Setting, Population and Sample

This study was conducted in rural Chadiza District in Zambia's Eastern Province and rural Serenje District in Zambia's Central Province.[2] The population of interest was all pregnant women residing in these areas, and the primary study sample was selected via the following steps:

1. All hospitals were excluded from the sample.

[2] These districts were two of the five H4+ supported districts where H4+ were planning to distribute mama kits. The two districts were chosen by MoH, MoCDMCH and H4+ as having the appropriate setting to carry out this evaluation.

2. All facilities where administrative records indicated that the ratio of facility deliveries to antenatal care attendees exceeded 66% were excluded in the study.[3]
3. In the remaining 30 facilities (10 in Chadiza and 20 in Serenje), the study population was comprised of pregnant women who visited a study facility at least once for antenatal care (ANC). Women in this population were selected into the primary study sample if her estimated date of delivery (EDD) fell within the three month intervention period of June 1 – August 31, 2013. The EDD was determined as follows:

    a. If the ANC record included the date of last menstrual period (LMP), the typical pregnancy duration of 40 weeks was added to the LMP. In cases where the LMP month and year only were recorded, the 15th of the month was used.
    b. If the ANC record did not include the LMP, but did include an EDD, this was used. Again, if only a month and year were recorded, the 15th of the month was used.
    c. If the ANC record included neither the LMP nor EDD, but did include an estimate of current gestational age (in weeks), this gestational age was subtracted from the ANC visit date and 40 weeks was added.

4. If a woman's LMP, EDD and gestation stage were not recorded in the ANC register, she was excluded from the primary study sample (even though she still may have benefited from the intervention)[4].

Intervention

Mama kits valued at $4 USD containing a chitenge (cloth), nappy and baby blanket were given to all women in the treatment facilities who: 1) delivered at that facility between June 1, 2013 – August 31, 2013, or 2) resided in the facility catchment area, but upon arrival at the facility, was referred to another facility due to medical reasons. Mothers who delivered stillbirths at the health facility were still provided with a mama kit. The process to determine the exact mama kit contents and value is included in Appendix A.

Study Methods

A clustered randomized controlled trial stratified by district was utilized to measure the impact of mama kits on facility delivery rates. In both districts, study facilities were match paired according to historical facility delivery rates based on estimates from H4+ administrative records. Within each pair, one facility was randomly assigned to the treatment group and one to the control group. This process yielded 10 treatment and 10 control facilities in Serenje, and 5 treatment and 5 control facilities in Chadiza. The power calculation is included in Appendix B.

Intervention Roll-out and Monitoring

The mama kits intervention was introduced to the treatment facilities on June 1, 2013. Six to seven weeks before the intervention start date, facility health staff and Safe Motherhood Action Group (SMAG) members – community health volunteers focused on maternal and child health issues – were informed about the intervention, and trained on proper mama kit distribution, storage, and documentation.

[3] The 66% cut-off rate was established to ensure that it was plausible for a facility to experience a 50% increase in institutional deliveries as a result of the intervention.

[4] LMP, EDD and gestation information was missing for 7% of women in control facilities and 8% of women in treatment facilities

Facility health staff were instructed to inform pregnant mothers of the mama kits programme during antenatal care visits at the facility, and SMAG members were instructed to notify all pregnant women in the facility catchment area. Health staff were instructed to record whenever a mama kit was given out in the facility's delivery register, on a mama kit attachment form that came with every mama kit, and on the newborn infant's government-issued under-5 card. One of the facility health workers was appointed to be the mama kit manager responsible for monitoring mama kit stocks at the facility and notifying the District Health Office (DHO) when an additional delivery of mama kits was required.

Before the intervention started, health staff at control facilities were also informed about the intervention and evaluation, and trained on proper data documentation. However, control facility staff were not asked to do anything differently than what was stipulated beforehand by MoH regulations.

Mama kits were provided to mothers delivering babies at treatment facilities from May 1 – August 31, 2013. Each facility was visited regularly by study field officers to ensure adherence to mama kit rules, monitor mama kit stock, verify accurate administrative data record keeping, and detect any issues arising. Over the course of the programme, the research team visited each treatment facility at least six times and each control facility at least three times.[5]

Data sources and quality checks

Facility ANC registers were used to determine the women in the primary study sample per the criteria described above, while facility delivery registers were the main data source for the primary outcome of whether a woman had delivered in the health facility during the intervention period.[6] Data on the provision of a mama kit to a woman was recorded in the facility's delivery register, on a mama kit attachment form that came with every mama kit, on the newborn infant's government-issued under-5 card, and in a newly introduced mama kit register kept by the research team. Basic information for each facility was provided by district medical staff at each District Health Office.

Home spot check surveys were used to independently confirm facility delivery data, collect data concerning decision factors affecting a mother's choice of delivery location, and confirm a mother's prior knowledge of the mama kit program. In all thirty study facilities, 20% of mothers recorded as giving birth in the facility in the delivery registers were randomly selected for a home spot check. Of these women selected for home spot checks, 89% were found and interviewed by the study team in their homes, and 100% of responses regarding delivery location matched the facility records.[7] Of the 11% not found, the primary reason for not finding them was because these women lived in inaccessible or distant (outside of the study area) villages.

Register Matching

To determine which women in the sample delivered in a facility, records were matched across the ANC and delivery registers. Several iterations of matching were done; initial iterations used different combinations of the safe motherhood number, maternal name, maternal village, maternal age,

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[5] Visits from outside NGOs was fairly common in these facilities, so such visits would not have been perceived as anything out of the ordinary.

[6] Delivery register data was matched to ANC register data using the Safe Motherhood Number or name / village matching. Stata was used to identify records that appeared like a match based on the information recorded in each register, and each potential match was confirmed manually.

[7] An additional 10% of the home spot check surveys were randomly selected for resurvey to detect any enumerator error. No discrepancies were detected via the home spot check resurveys. Unfound women is primarily attributed to the difficulty of tracking individual mothers in remote areas using only information recorded in the delivery register.

gravidity, and parity across registers. Each pair was checked to verify that it was a true match. A final iteration was done by manually searching for matches for each delivery that occurred between June 1, 2013 and August 31, 2013 that still did not have a corresponding ANC record.

Qualitative Methods

Focus group discussions for the mama kit evaluation were conducted between September 16 – September 30, 2013 in 15 randomly selected treatment villages. Across these villages, 109 women were interviewed in order to obtain a variety of perspectives. Of these 109 women, 71 had delivered in a facility, while 38 had delivered at home. Community health workers were asked to help identify women in their villages who had delivered within the past year. Focus groups were divided into women who had delivered at a facility and those who had delivered at home.

The focus group questions focused on use of health facility services, perceptions of health facility services and staff, thoughts on facility/home delivery, depending on where they had delivered, and mama kit items and desirability. Since the primary aim of the focus group discussions was to provide more context around the mama kit intervention, focus groups were only done in treatment villages.

Statistical Methods

Facility-level and individual-level summary statistics were examined between control and treatment groups. A multi-level logistic regression using a clustered sandwich estimator was also used to estimate the impact of mama kits on the likelihood of a woman attending ANC delivering in a health facility. This model adjusted for both individual-level and facility-level covariates, though we also examined regression models that adjusted only for individual-level covariates and only for facility-level covariates. These covariates are described in **Table 1**. Results from the logistic regression were also used to complete a margins analysis at the means to calculate the marginal difference in facility delivery percentage, and well as the percent difference between the treatment and control groups.

Table 1. List of variables for primary analysis

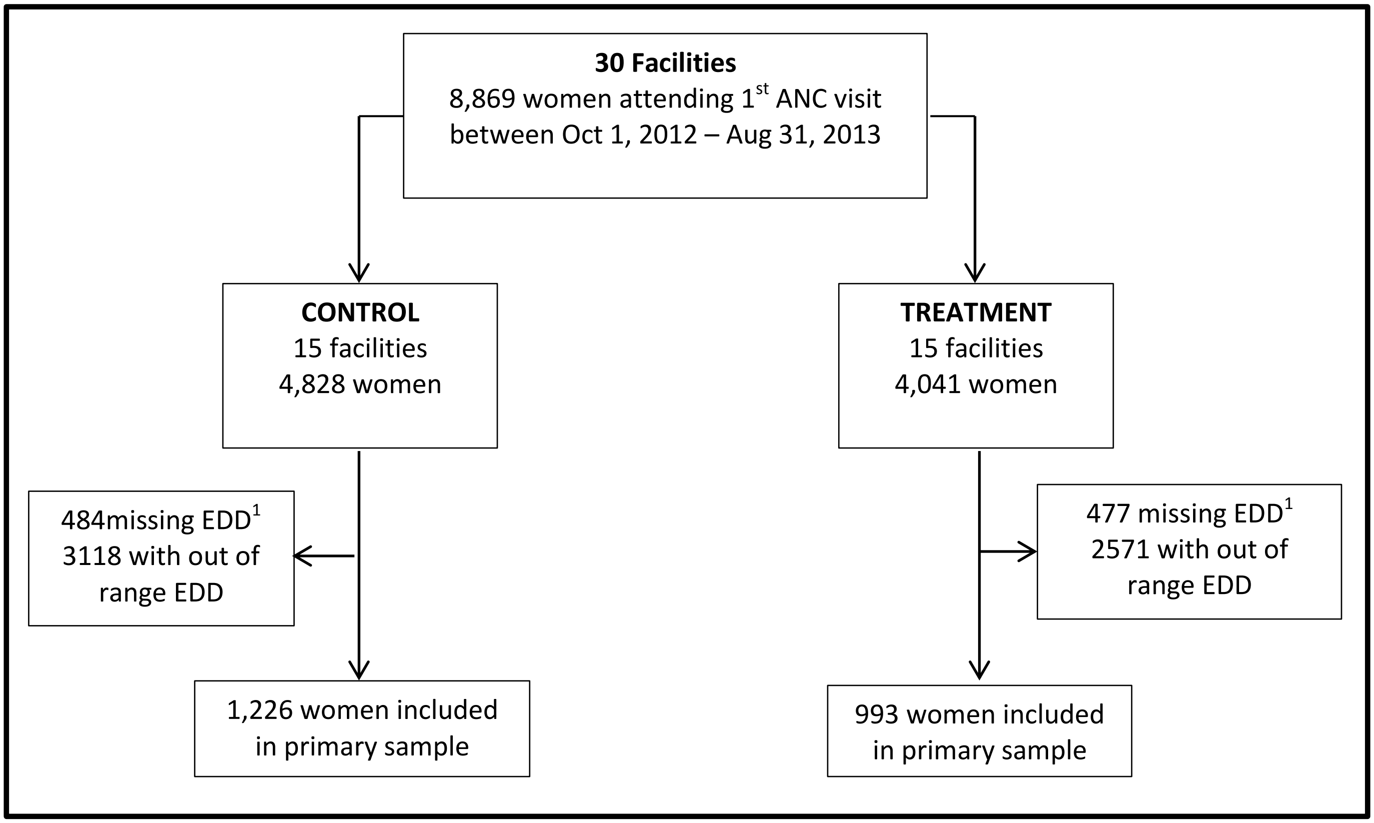
Variable	**Source**
Mama kit treatment	Study random assignment
Individual-level variables	
Variable	**Source**
# deliveries / # pregnancies	ANC register
Gravida	ANC register
# of past ANC visits	ANC register
# days calculated EDD is from July 15 (middle of intervention period)	ANC register
# days 1st ANC was from April 1 (peak 1st ANC)	ANC register
Age	ANC register

Facility-level variables	
Variable	**Source**
Ln (facility catchment population)	District administrative records
Travel time between facility and district health office	District staff report
# trained staff	Facility staff report
% of staff that are male	Facility staff report
Ln (# of trained staff / facility catchment population)	District administrative records, facility staff report
DHO rating of external NGO maternal & child health activity	District staff report
DHO rating of community engagement in promoting facility delivery	District staff report
Proportion of ANC visits that are outreach	Facility staff report

RESULTS

The final sample included 2,219 eligible women who attended ANC at 15 treatment facilities (n=993) and 15 control facilities (n=1226) (**Figure 1**). Facility-level characteristics were similar between control and treatment facilities (Table 2). Historical numbers of deliveries in 2012 by facility ranged from 11 (Masase Health Center) to 314 (Tafelansoni Health Center) in the control group, and from 21 (Yoram Mwanje Health Center) to 373 (Miti Health Center) in the treatment group. Chisomo Health Center was not included in this estimate, because of an absence of trained staff for a part of the year as well as missing delivery records. Individual-level characteristics were also similar between the treatment and control facilities (**Table 3**).

Figure 1. Diagram of Selection of Primary Study Sample



[1]Woman was missing an LMP date, an EDD date, and a gestational age on the ANC register

Table 2. Baseline Facility-Level Characteristics by Treatment Group

	Control N=15		Treatment N=15	
	Mean	(SD)	Mean	(SD)
Facility catchment population	7458.2	(4201.23)	7411.47	(2956.85)
Travel time from clinic to DHO (mins)	88.67	(65.15)	98	(62.44)
Number of trained staff	1.33	(0.62)	1.33	(0.82)
Percent of trained staff that are male	0.49	(0.46)	0.49	(0.50)
Population per trained staff	6031.39	(3570.08)	6140.19	(2631.75)
Proportion of ANC done as outreach	0.3	(0.14)	0.31	(0.11)
Average total number of deliveries in 2012^	123.33	(86.39)	138.14	(123.02)
	N	(%)	N	(%)
District				
Serenje	10	(66.67)	10	(66.67)
Chadiza	5	(33.33)	5	(33.33)
Level of MCH activity[%]				
Least active	3	(20.00)	6	(40.00)
Less active	1	(6.67)	0	
More active	9	(60.00)	3	(20.00)
Most active	2	(13.33)	6	(40.00)
Level of catchment area engagement[%]				
Least engaged	1	(6.67)	4	(26.67)
Less engaged	7	(46.67)	4	(26.67)
More engaged	7	(46.67)	5	(33.33)
Most engaged	0		2	(13.33)

^1 treatment facility (Chisomo) was excluded because of missing delivery records in 2012 as well as an absence of trained delivery staff for a significant portion of the year

[%]As rated by health facility staff

Table 3. Maternal Characteristics by Treatment Group

Characteristic	Control N=1,226		Treatment N=993	
	Mean	(SD)	Mean	(SD)
Pregnancy to delivery ratio	0.52	(0.32)	0.53	(0.32)
Number of previous pregnancies	3.87	(2.54)	3.94	(2.55)
Number of ANC visits	1.7	(1.04)	1.72	(1.11)
Number of days between EDD & Jul 15, 2013	182.81	(126.90)	183.33	(125.48)
Number of days between 1st ANC visit & April 1, 2013	189.54	(133.08)	189.96	(131.80)
Maternal age	25.13	(6.93)	25.42	(6.87)

Matching Across Registers

There were 1,369 women who delivered in one of the 30 evaluation health facilities between June 1, 2013 – August 31, 2013. Of these women, 1,012 (73.9%) had a corresponding ANC record. This did not differ significantly by treatment group, with 74.6% of control deliveries and 73.4% of treatment deliveries having a matching ANC record. Women were considered to be in a control group if the ANC visit occurred at a control facility, regardless of the location of delivery. There were 15 women who matched across registries from different facilities. Two of these women remained at a treatment facility, four remained at a control facility, three delivered at a control facility after going to a treatment facility for ANC, while six delivered at a treatment facility after going to a control facility for ANC.

Multi-Level Analysis: Impact on facility deliveries in treatment facilities

Higher facility delivery rates were observed for treatment facilities than for control. The odds ratio of delivering in a facility was 1.61 [95% CI: 1.03, 2.51], with 25.4% of women attending ANC delivering at a facility in the control group, compared to 34.9% in the treatment group (**Table 4**). After adjusting for individual and facility-level covariates, women in the treatment group had a 1.68 higher odds [95% CI: 1.27, 2.21] of delivering at a facility compared to those in the control group, which was statistically significant at the 0.1% level. The adjusted model also found an increase of 10.6% (95% CI: 4.8%, 16.4%) in the percentage of women delivering at a facility between the treatment and control group. This translates into a 44.1% (95% CI: 29.9%, 60.2%[8]) higher delivery rate (**Figure 2**).

[8] The 95% confidence interval for the percent change was calculated by using the following formula: 95% CI = (marginal effect at the means +/- 1 standard error of marginal effect at the means) / (facility delivery rate in the control group -/+ 1 standard error of facility delivery rate in the control group)

Table 4. Logistic Regression Models of Odds Ratios and Percent Increase of Delivering in a Facility

Variables	Unadjusted		Individual-level Covariates[1]		Facility-level Covariates[2]		All Covariates[3]	
	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Delivery Category								
Control	Ref		Ref		Ref		Ref	
Treatment	1.61*	[1.03,2.51]	1.64*	[1.11,2.43]	1.67**	[1.19,2.34]	1.68***	[1.27,2.21]
Pregnancy to delivery ratio			0.74	[0.44,1.24]			0.75	[0.43,1.30]
Number of prior pregnancies			1.04	[0.96,1.13]			1.05	[0.97,1.13]
Number of ANC visits			1.53***	[1.30,1.81]			1.58***	[1.32,1.91]
Number of days between EDD & Jul 15, 2013			0.99	[0.99,1.00]			0.99	[0.99,1.00]
Number of days between 1st ANC visit & April 1, 2013			0.99***	[0.98,0.99]			0.99***	[0.98,0.99]
Maternal age			0.97**	[0.95,0.99]			0.97*	[0.95,0.99]
Catchment population (ln)					1.65*	[1.06,2.58]	1.87***	[1.32,2.64]
Travel time from clinic to DHO (mins)					1.00	[1.00,1.00]	1.00	[1.00,1.00]
Number of trained staff					0.38**	[0.19,0.75]	0.34***	[0.21,0.55]
Percent of trained staff that are male					1.00	[0.64,1.56]	1.02	[0.70,1.50]
Catchment population (ln) per staff ratio					0.73**	[0.60,0.90]	0.72***	[0.63,0.82]
Level of MCH activity					1.06	[0.81,1.39]	1.04	[0.83,1.29]
Level of catchment area engagement					0.86	[0.67,1.11]	0.98	[0.81,1.18]
Proportion of ANC done as outreach					0.14	[0.02,1.04]	0.13**	[0.03,0.61]
	% Diff	[95% CI]	% Diff	[95% CI]	% Diff	[95% CI]	% Diff	[95% CI]
Percentage point increase in facility delivery rate between control and treatment	0.10*	[0.00, .19]	0.10*	[0.02, 0.18]	0.11**	[0.03, 0.18]	0.11***	[0.05, 0.16]
Percent change[4]	0.40	[0.18, 0.66]	0.42	[0.23, 0.66]	0.44	[0.27, 0.63]	0.44	[0.30, 0.60]

* p<0.05, ** p<0.01, *** p<0.001

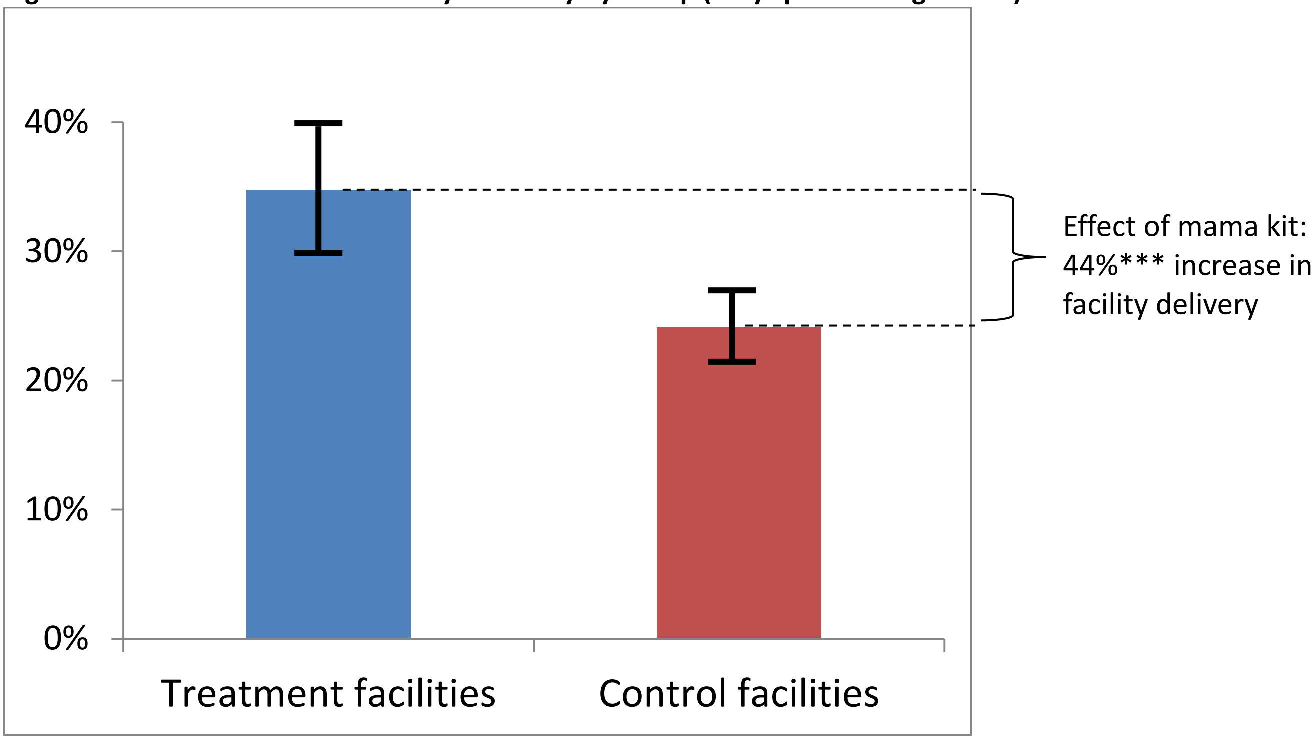
[1]Individual level characteristics include: % of completed pregnancies, gravida, # of ANC visits, # of days between estimated delivery date & July 15, 2013, # of days between first ANC visit and April 1, 2013, and mother's age

[2]Facility level characteristics include: natural log of catchment population, travel time from facility to District Health Office, # of trained staff, % of trained staff that are male, natural log population per trained staff, level of MCH activity, level of catchment area engagement, and proportion of ANC done as outreach

[3]Includes individual and facility level variables

[4]Calculated as marginal percentage point increase divided by percent delivering at a health facility in the control group

Figure 2. Women Confirmed Delivery in Facility by Group (fully specified regression)



**P-value <0.001

Cost-Benefit Analysis: Impact on facility deliveries in treatment facilities

Using a base cohort of 413,147, the estimated number of rural deliveries in a year in Zambia, the mama kits intervention would avert 31 annual maternal deaths and 426 annual neonatal deaths, resulting in 457 annual deaths averted (**Table 5**). The average cost per maternal death averted was $51,832 and average cost per neonatal death averted was $3,742, yielding a total average cost per death averted of $3,490 in rural areas (includes both maternal and neonatal deaths). This makes the mama kits intervention comparable to many other commonly scaled health interventions.[9] The cost-effectiveness model is described in Appendix C and cost-effectiveness benchmarks are described in Appendix D.

[9] Examples include LLIN distribution, anti-retroviral therapy for HIV, and other maternal and child health interventions.
Sources:

- Laxminarayan, R, J Chow, and SA Shahid-Salles, Chapter 2: Intervention Cost-Effectiveness: Overview of Main Messages. Disease Control Priorities in Developing Countries. 2nd Edition. Ed. Jamison DT, Breman JG, Measham AR, et al. 2006. Washington (DC): World Bank.
- Website: http://www.givewell.org/international/technical/programs/insecticide-treated-nets#HowcosteffectiveisLLINdistribution. Accessed 27 Feb 2014.
- Barnighausen T., et al., Economics of antiretroviral treatment vs. circumcision for HIV prevention. Proceedings of the National Academy of Sciences of the United States of America. Dec 26, 2012; 109(52): 21271-21276.

Table 5. Cost-Effectiveness Analysis Results

		Maternal	Neonatal	Total
Impact	Int Deaths	1,710	10,071	11,781
	Ctrl Deaths	1,741	10,497	12,238
	Deaths averted	31	426	457
Costs	Intervention Cost			$3,587,921
	Control Cost			$1,992,398
	Difference in Cost			$1,595,524
	Cost/death averted	**$51,831.74**	**$3,742.29**	**$3,490.29**

Qualitative Analysis: Focus Group Discussions

Focus group discussions helped shed light on some factors that influence a mother's choice around where to deliver. It appeared that mothers knew about the benefits of delivering in the health facility, and it was not due to lack of knowledge or ignorance that mothers did not go to the health facility. While some mothers did have negative perceptions of health facilities (inadequate space and privacy, long lines) or facility staff (too busy, negative attitude), none of these seemed to be the major deterrent to mothers delivering at the health facility.

The major challenges for mothers to deliver in a health facility appeared to be:

1. **Distance to the health facility:** The health facilities were very far and there was typically inadequate transport. Few communities had bicycles available for the mothers.
2. **Delivery came too soon:** Some mothers did not know how far along in their pregnancy they were, or had not adequately planned their transport to the health facility in time.
3. **Male staff at the health facility:** Male staff could make the mothers uncomfortable, and husbands might also refuse for their wives to go to the facility so that other men don't see their wives naked.
4. **Lack of baby supplies to bring to facility:** Some mothers were ashamed to go to the health facility without the adequate supplies, while others thought that the law stated they *must* come with supplies.

   - "Some people say that at the clinic, you need soap for washing and for bathing and two chitenges, as well, so some people are scared to go to clinic because of this." ~ Nshoshe woman who delivered at home

   - "There is a law at the clinic where the health staffs do not discharge mothers who do not have baby items until the father brings the baby clothes. Such laws prevent mothers who do not have baby clothes to deliver at the facility" ~Kampingu woman who delivered at a facility

Nearly all of the mothers knew about the mama kit programme and the items contained in the kits, having heard about the programme through SMAGs or ANC counseling. While many had positive things to say about the mama kit, many of the mothers had trouble vocalizing whether it would be an influential factor in their decision about where to deliver. Of those that suggested that it could influence their decision, many saw it as a way to mitigate some of the challenges around delivering at a facility.

Comments indicating mama kits had a positive influence include:

- "Because we have seen at the clinic they are giving you something for the baby, now us who gave birth in the village, we were given nothing" ~Nshoshe woman who delivered at home

- "The mama kit encourages mothers to deliver at a clinic because most mothers do not have these items." ~Champalagna woman who delivered at a facility

- "Even from the past, they used to tell us to deliver at the clinic, but we were scared of not having the things required for the baby; powder, soap, baby blanket, but now since we were being given a mama kit, we were free to come." ~Miswema Village woman who delivered at a facility

- "When I came home, I went to show my friends [the mama kit], and they were full of envy. I was very excited." ~Miswema woman who delivered at a health facility

Other women appreciated what was given, but still cited the importance of delivering in a facility.

- "For myself it is not the mama kit that made me deliver from the clinic. I have observed that those who give birth from the village really face complication, they die or even lose the baby." ~Miswema Village woman who delivered at a health facility

- "What will lead us to go to the clinic is so that they can assist you in case of complications" ~Nshoshe woman who delivered at home

DISCUSSION

Summary of results

This randomized evaluation revealed that a modestly priced non-monetary mama kit incentive was a cost-effective intervention to improve rural facility delivery rates in Africa. Our primary analysis estimated a $4 mama kit increased facility deliveries by 44% (statistically significant at the 1% level) in poor, remote areas of Zambia. Cost-effectiveness modeling estimates the mama kits cost effectiveness at $3,490 per death averted, a figure that is comparable to other public health interventions, such as insecticide-treated bed net distribution, anti-retroviral drugs for HIV, and other established maternal and child health interventions.[10]

[10] Sources:

Study limitations

While the evaluation was done using a randomized design to minimize bias, it was not without its limitations. One such limitation was the study sampling procedure, which required a woman to be included in an ANC register, as well as to have an estimated delivery date. This may, therefore, have eliminated the women least likely to deliver at a health facility, resulting in an over-estimate of the percentage of women who delivered at a facility among those who attended ANC. However, we do not feel that the women who were excluded for these reasons differed across treatment and control facilities, thus preserving internal validity. Another limitation is the evaluation's heavy reliance on administrative records for sampling and outcome data. Home spot checks, however, confirmed high delivery registry accuracy, and our name-matching procedure protected against over-reporting of facility deliveries. While the matching procedure between the ANC and delivery registers was unlikely to bias the impact estimate, it did not achieve sufficient matching rates to allow us to confidently estimate the rate of facility deliveries.

Additionally, it is not clear that similar impacts will be found if conducted in a different area with different baseline facility delivery rates. This evaluation tightly monitored the implementation of the mama kits program which may not be replicated in other contexts. Finally, we did not test mama kits of different contents or monetary values, making it impossible to draw strong conclusions about the most cost-effective mama kit package. Despite these limitations, we feel that the impact estimates that were found in this evaluation are generalizable to other rural African settings that are facing comparable barriers to delivering in a facility.

Policy recommendations

This evaluation confirms that low-cost mama kits are a promising intervention to cost-effectively increase facility delivery rates in rural, Sub-Saharan African settings. Although the evaluation did not test mama kits of different monetary values, ideally mama kits should be valued at less than ~$30 USD, since any kits that are more expensive than $30 would have to achieve mathematically impossible impacts to be equally cost-effective.[11] Low-cost mama kits are unlikely to provide a complete solution to safe delivery challenges, but can be embedded in larger maternal and child health programs. Finally, any large-scale implementation of a mama kits intervention should have proper stocking controls similar to other commonly scaled health commodities.

- Laxminarayan, R, J Chow, and SA Shahid-Salles, Chapter 2: Intervention Cost-Effectiveness: Overview of Main Messages. Disease Control Priorities in Developing Countries. 2nd Edition. Ed. Jamison DT, Breman JG, Measham AR, et al. 2006. Washington (DC): World Bank.
- Website: http://www.givewell.org/international/technical/programs/insecticide-treated-nets#HowcosteffectiveisLLINdistribution. Accessed 27 Feb 2014.
- Barnighausen T., et al., Economics of antiretroviral treatment vs. circumcision for HIV prevention. Proceedings of the National Academy of Sciences of the United States of America. Dec 26, 2012; 109(52): 21271-21276.

[11] This is demonstrated through a simple example. Suppose the baseline facility delivery rate is 30% in a given area. Our study estimates that a $4 USD mama kit will boost the facility delivery rate to 43%. For a mama kit double in value ($8 USD) to be equally cost-effective, it would have to boost the facility delivery rate to 56%. For a mama kit quadruple in value ($16 USD) to be equally cost-effective, it would have to boost the facility delivery rate to 82%. A $28 USD mama kit would have to achieve a facility delivery rate of 121%, which is mathematically impossible.

APPENDIX A – MAMA KIT DESIGN PROCESS

The contents of the mama kit were established via the following process. First, a model was built to calculate the facility delivery impact sizes required for mama kits of different values to be cost-effective. This model determined that a mama kit valued at 20 ZMW / 4 USD could be ideal since 1) that value exceeds the potential cost of transport to a facility for most women, 2) a plausible effect (e.g. 50% increase in facility delivery rates) could make a kit of that value as or more cost-effective than other MCH interventions, and 3) more expensive mama kits would have to be accompanied by larger effect sizes to be comparably cost-effective (e.g. a $8 mama kit would have to have an effect twice that of a $4 mama kit to be equally cost-effective).

Second, semi-structured interviews were conducted to assess potential mama kit contents according to desirability.[12] These interviews – coupled with a survey of local wholesale prices – were used to determine that a mama kit containing a chitenge (cloth), nappy and blanket would be highly desirable and fall within the 20 ZMW / 4 USD price range. These recommended contents were then presented before discussed with study stakeholders who confirmed that such a mama kit was context-appropriate and had good potential to be a cost-effective intervention.

[12] 26 women in Chongwe (peri-urban setting) were asked to rank-order potential mama kit items in terms of desirability for a mama kit, with three points assigned to a top choice, 2 points for a 2nd choice, and 1 point for a 3rd choice. The outcome of this exercise was as follows (desirability score in parentheses): Nappy (64), chitenge (39), blanket (31), baby vest (15), baby booties (4), Vaseline (2), baby hat (1), soap (0).

APPENDIX B – POWER CALCULATION

A revised power calculation conducted with Optimal Design Software Version 3.0 with the refined parameters is presented below:

- Unit of randomization: Rural health facility
- Level of outcome: Delivery/pregnancy
- Overall sample size: 30 facilities with an average of 200 pregnant women per facility per quarter
- Probability of success in control: 20%
- Probability of success in treatment: 30% (The required effect size was determined via cost-effectiveness comparison with other nationally scaled health interventions in Zambia such as ART provision and mass LLIN distribution)
- 95% plausibility interval: 10-40%
- Null hypothesis: 0% additional percent of mothers deliver in-facility
- Alpha: 5%
- Power: 83%

The above power calculation did not account for any gains in precision due to the inclusion of covariate controls in the regression. Thus, the estimated power represents a conservative estimate of the actual statistical power of the study design.

APPENDIX C - COST-EFFECTIVENESS ANALYSIS

The cost-effectiveness analysis used the model in **Figure 3**. The cohort of mothers and newborns was calculated by multiplying an estimated 645,542 Zambian births per year by the percent of the population that is rural (**Table 6**). The intervention time horizon was one year, while the analytic time horizon was 42 days for mothers and 28 days for newborns, since the outcomes were maternal and neonatal deaths averted by delivering at a facility. The analysis was done from the government perspective, since the Zambian Government would be the primary decision-maker and implementer at scale-up.

Outcomes

Baseline maternal and neonatal mortality estimates were based on 2007 Zambia DHS maternal mortality estimates. We used Graham et al.'s estimate of 16% of maternal deaths[13] and Save the Children's estimate of 35% of neonatal deaths[14] that could be averted with skilled birth attendance. While both of these estimates also include home deliveries that are attended by skilled personnel, we assumed that these were conservative estimates of the proportion of maternal and neonatal deaths that would be averted by delivering at a facility with trained health staff.

Costs

The two cost categories that were included in the cost-effectiveness model were intervention-related costs and the costs of a facility delivery. Intervention costs included the base cost of the mama kit of $4, as well as costs to deliver mama kits to health facilities. Transport for delivery of mama kits was estimated to be $1.00 per mama kit.[15] The cost of a rural facility delivery was assumed to be $20.[16]

ICER

The incremental cost-effectiveness ratio (ICER) was estimated by comparing the outcomes and costs between the intervention and control arms. Outcomes for each arm were calculated by adding the total number of maternal and neonatal deaths for our one year cohort. The costs for each arm were also calculated. Intervention arm costs included both intervention costs and facility delivery costs, while control arm costs only included facility delivery costs. The ICER was then calculated using the following formula:

$$ICER = (costs_{intervention} - cost_{control}) / (deaths_{control} - deaths_{treatment})$$

The ICER was reported in terms of cost per deaths averted. Separate ICERs were calculated for both maternal and neonatal deaths averted. The primary ICER combined both maternal and neonatal deaths. Because the costs would be the same regardless if we are considering maternal or neonatal deaths,

[13] Graham W., J. Bell, and C. Bullough. Can skilled attendance at delivery reduce maternal mortality in developing countries? *HSO&P.*2001;17:97-129.
[14] Save the Children. Missing Midwives. PDF report. March 2011.
[15] We assume that a driver can deliver 100 mama kits to 5 health facilities in 1 day, covering 100 kilometers per health facility. We assume costs of $0.80 / kilometer for vehicle and fuel, $30 / day for a driver, and 15% administrative costs.
[16] Figure from Erim et al. Assessing health and economic outcomes of interventions to reduce pregnancy-related mortality in Nigeria. *BMC Public Health* 2012, 12:786

combining both maternal and neonatal deaths results in a smaller ICER compared to those that consider only maternal or neonatal deaths.

Figure 3. Decision-Tree for Cost-Effectiveness Model (for mothers and neonates)

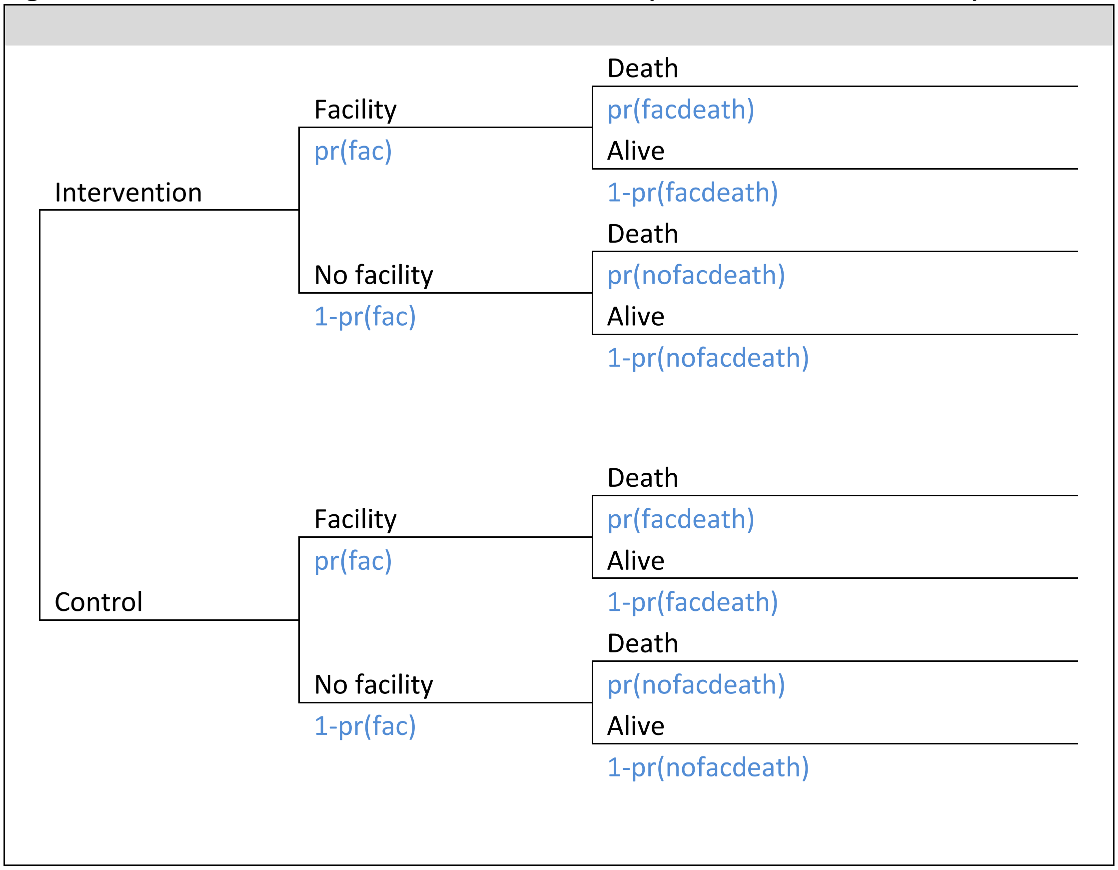


Table 6. Cost-Effectiveness Inputs

Model Inputs		
Assumptions		**Source**
Births per year	645,542	GAVI Alliance. Zambia Fact Sheet. 2013
% of population that is rural	64%	Zambia Demographic and Health Survey 2007 Zambia: Central Statistical Office, Ministry of Health, Tropical Diseases Research Centre, University of Zambia, 2009.
% births die in neonatal period in rural areas	3.70%	Zambia Demographic and Health Survey 2007 Zambia: Central Statistical Office, Ministry of Health, Tropical Diseases Research Centre, University of Zambia, 2009.
Maternal mortality rate (per 100,000)	0.44%	Zambia Demographic and Health Survey 2007 Zambia: Central Statistical Office, Ministry of Health, Tropical Diseases Research Centre, University of Zambia, 2009.
% all maternal deaths in rural areas	85%	Vork F., S. Kyanamina, and J.V. Roosmalen. Maternal mortality in rural Zambia. *Acta Obstetricia et Gynecologica Scandinavica*. 1997;76:646-650.
% all deaths that are unattended	75%	Lumbiganon P et al. Why are Thai official perinatal and infant mortality rates so low? *International Journal of Epidemiology.* 1990 Dec;19(4):997-1000.
% of unattended maternal deaths that would be saved if attended	16%	Graham W., J. Bell, and C. Bullough. Can skilled attendance at delivery reduce maternal mortality in developing countries? *HSO&P.*2001;17:97-129.
% of unattended neonatal deaths that would be saved if attended	35%	Save the Children. Missing Midwives. PDF report. March 2011.
Probabilities		**Calculations**
Intervention Pr(fac)	0.3474	Int Attendance %
Control Pr(fac)	0.2411	Baseline Attendance %
Pr(Mat death out of fac)	0.0044	(Births * MMR * % mat deaths in rural * % mat deaths unattended) / (Births * % pop rural)
Pr(Mat death in fac)	0.0037	Pr(Mat death out of fac) * (1 - % of deaths averted with attendance)
Pr(NN death out of fac)	0.0278	(Births * % of rural births*% births that die in NN pd in rural areas * % deaths unattended) / (Births * % pop rural)
Pr(NN death in fac)	0.0180	Pr(NN death out of fac) * (1 - % of NN deaths averted with attendance)
Costs		
Cost of kit	$4.00	
Multiply factor for transport	1.25	100 kits / clinic, 5 clinics / day, 100 km / clinic, $0.80 / KM, $30 /day for driver, 15% admin costs
Total cost of kit	$5.00	
Cost of facility delivery	$20	Erim et al., Assessing health and economic outcomes of interventions to reduce pregnancy-related mortality in Nigeria., *BMC Public Health* 2012, 12:786

APPENDIX D - COST-EFFECTIVENESS COMPARISON

The study estimates the mama kits cost effectiveness at $3,490 per death averted. This is comparable to estimates of cost effectiveness to other commonly scaled public health interventions. Some example health interventions with comparable cost effectiveness are presented in **Table 7** below.

Table 7. Cost-Effectiveness Benchmarks

Intervention	Cost per death averted	Source
Mama kits	$3,490	Study finding
LLIN distribution	$3,400	Website: http://www.givewell.org/international/technical/programs/insecticide-treated-nets#HowcosteffectiveisLLINdistribution. Accessed 28 April 2014.
Medical male circumcision	$5,198	Barnighausen T., et al., Economics of antiretroviral treatment vs. circumcision for HIV prevention. Proceedings of the National Academy of Sciences of the United States of America. Dec 26, 2012; 109(52): 21271-21276.
ART at CD4 <350/μL	$5,604	Ibid.
Improved coverage of basic MCH interventions	$3,337-6,129	Laxminarayan, R, J Chow, and SA Shahid-Salles, Chapter 2: Intervention Cost-Effectiveness: Overview of Main Messages. Disease Control Priorities in Developing Countries. 2nd Edition. Ed. Jamison DT, Breman JG, Measham AR, et al. 2006. Washington (DC): World Bank.

[i] World Health Organization. Maternal Mortality Fact Sheet. May 2012.
[ii] Abwao, S., P. Kalesha-Masuma, and N. Mugala. Scaling up Newborn Health: Zambia. Draft. October 2007.
iii Ibid.
[iv] Ibid.
[v] A. Banerjee et al. Improving immunisation coverage in rural India: clustered randomised controlled evaluation of immunisation campaigns with and without incentives. BMJ, 340:c2220, 2010.
[vi] Loevinsohn BP, Loevinsohn ME. Well child clinics and mass vaccination campaigns: an evaluation of strategies for improving the coverage of primary health care in a developing country. *Am J Public Health.* 1987;77:1407-11.
[vii] P. Dupas. The Impact of Conditional In-Kind Subsidies on Preventive Health Behaviors: Evidence from Western Kenya. Unpublished manuscript. July 2005
[viii] T. Powell-Jackson et. al. The impact of Nepal's national incentive programme to promote safe delivery in the district of Makwanpur. *Advances in Health and Economic Services Research*. 2009;21:221-49.
[ix] A. Dongre. Effect of Monetary Incentives on Institutional Deliveries: Evidence from India. Working Paper. August 2010.
[x] S. Lim et. al. India's Janani Suraksha Yojana, a conditional cash transfer programme to increase births in health facilities: an impact evaluation. Lancet. 2010; 2002-2023.