Social Science & Medicine 83 (2013) 34–41

Contents lists available at SciVerse ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

An impact evaluation of the Safe Motherhood Promotion Project in Bangladesh: Evidence from Japanese aid-funded technical cooperation

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ARTICLE INFO

Article history:
Available online 10 February 2013

Keywords:
Maternal health
Safe motherhood
Bangladesh
Community mobilization
Impact evaluation
Japan International Cooperation Agency
Development project

ABSTRACT

This paper reports the findings from a quasi-experimental impact evaluation of the Safe Motherhood Promotion Project (SMPP) conducted in the Narsingdi district of Bangladesh. SMPP is a Japanese aid-funded technical cooperation project aimed at developing local capacities to tackle maternal and newborn health problems in rural areas. We assessed whether the project interventions, in particular, community-based activities under the Model Union approach, had a favorable impact on women's access to and knowledge of maternal health care during pregnancy and childbirth. The project comprises a package of interlinked interventions to facilitate safe motherhood practices at primary and secondary care levels. The primary-level activities focused on community mobilization through participatory approaches. The secondary-level activities aimed at strengthening organizational and personnel capacities for delivering emergency obstetric care (EmOC) at district and sub-district level hospitals. The project impact was estimated by difference-in-differences logistic regressions using two rounds of cross-sectional household survey data. The results showed that the project successfully increased the utilization of antenatal visits and postpartum EmOC services and also enhanced women's knowledge of danger signs during pregnancy and delivery. The project also reduced income inequalities in access to antenatal care. In contrast, we found no significant increase in the use of skilled birth attendants (SBA) in the project site. Nonetheless, community mobilization activities and the government's voucher scheme played a complementary role in promoting the use of SBA.

Introduction

The reduction of maternal mortality has now become one of the leading global health agendas as emphasized in Millennium Development Goal 5. Approximately 300,000 women died worldwide due to pregnancy or childbirth-related complications in 2008 (Lozano et al., 2011), with 99% of these deaths occurring in low-income countries, particularly in Sub-Saharan Africa and South Asia. Most of the maternal deaths are due to direct obstetric causes such as hemorrhage, eclampsia, sepsis, unsafe abortion and obstructed labor. Many of these maternal deaths can be averted if the woman has access to skilled care during pregnancy and childbirth. During pregnancy, early and frequent antenatal care (ANC) can help identify high-risk pregnancies that require multiple interventions for maternal and newborn health (Abou-Zahr & Wardlaw, 2003). During delivery, skilled birth attendants (SBA) in well-equipped facilities play a crucial role in averting deaths from delivery-related complications (Campbell & Graham, 2006). Nevertheless, many women in the developing world face difficulties in accessing timely and adequate ANC, delivery care, and postpartum care.

During the last two decades, Bangladesh has made substantial progress in maternal and newborn health (Ahmed & Hill, 2011). Maternal mortality declined from 322 to 194 per 100,000 live births during 2001–2010, a 40% reduction in nine years (Government of Bangladesh, 2010). However, the maternal mortality ratio is still unacceptably high. Because one in seven pregnancies develops unpredictable life-threatening complications in Bangladesh (NIPORT, Mitra and Associates, & Macro International, 2007), availability and accessibility of emergency obstetric care (EmOC) services are key to reducing maternal mortality. In addition, life-saving care needs to be integrated into local health systems to realize a continuum of care from community to referral facilities (Kerber et al., 2007; Tinker, ten Hoope-Bender, Azfar, Bustreo, & Bell, 2005).

International aid agencies have implemented numerous maternal health projects in Bangladesh (Anwar & Islam, 2011;

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http://dx.doi.org/10.1016/j.socscimed.2013.01.035

Nasreen, Ahmed, Begum, & Afsana, 2010). The purposes of these projects are more or less the same, namely, to improve maternal health by conducting supply-side and demand-side interventions. The common interventions include upgrading EmOC services, supporting local-level planning, strengthening referral systems for pregnancy emergencies, developing human resources through training and local recruitment, and improving sick newborn care (Anwar & Islam, 2011).

One example is the Government of Bangladesh-UN Maternal and Neonatal Health Initiative. This project is jointly implemented by UNICEF, UNFPA, WHO, and the Ministry of Health and Family Welfare of Bangladesh (MoHFW) with a primary aim of enhancing quality and quantity of maternal and newborn health services in four districts from 2007 to 2012. The project mainly targets the poor and marginalized in rural areas. The community- and facility-based maternal and perinatal death review is one of the unique activities of this project (Anwar & Islam, 2011). Another example is the MaMoni Integrated Safe Motherhood, Newborn Care and Family Planning Project funded by USAID. This project concentrates on improving access to and quality of maternal health services through capacity building, improved planning, and good coordination between communities and health providers (USAID, 2009).

One of the biggest challenges for these internationally funded projects is whether the government can sustain and scale up the project's efforts with their limited capacities and budget after the project is terminated. Thus, developing capacities of public institutions and community leaders is crucial. Capacity development is defined by the Japan International Cooperation Agency (JICA) as "the process in which individuals, organizations, institutions, and societies develop abilities either individually or collectively to perform functions, solve problems, and set and achieve objectives" (JICA, 2004). Although capacity development is now acknowledged among major international partners as critical to achieving development objectives (HLF4, 2011), there is scarce evidence, in practice, of showing the effectiveness of capacity development.

In light of the above situation, the MoHFW requested technical and financial support from the Government of Japan for improving maternal health. Consequently, a project titled the Safe Motherhood Promotion Project (SMPP or simply the Project) was implemented jointly by the MoHFW and JICA from July 2006 to June 2011. The project was undertaken in Narsingdi district on a pilot basis to establish effective approaches for improving maternal and neonatal health by targeting both communities and public health facilities; the project became known as the Narsingdi Model.

Although a number of projects have been implemented to improve safe motherhood and newborn survival, few have been evaluated using a rigorous design (Bryce et al., 2010; Clemens & Demombynes, 2011; Oxman et al., 2010). The aim of our study was, therefore, to determine whether the Japan-funded safe motherhood project had positive effects on maternal and newborn health in rural Bangladesh.

Methods

Setting

The Narsingdi district of Bangladesh is a densely populated district approximately 54 km north-east of Dhaka with a population of approximately 2.26 million in an area of 1021 square km. The district is being industrially developed, but agriculture remains the primary source of income. The district consists of six sub-districts (Upazilas) and 71 sub sub-districts (unions). There are eight public hospitals that provide EmOC services in the district, including District Hospital, Sadar Hospital, the Maternal and Child Welfare Centre at the district-level, and five sub-district Health Complexes, namely, Shibpur, Monohardi, Palash, Belabo, and Raipura. Three district-level hospitals as well as Monohardi Health Complex were providing comprehensive EmOC at the time of project start-up, while the other sub-district Health Complexes offered basic EmOC. During the project period, Palash and Raipura Health Complexes were upgraded to provide comprehensive EmOC with support from the Project. At the sub-sub-district level, smaller centers provided ANC, postnatal care (PNC), family planning, and treatment of common diseases, especially for women and children. These services were provided by Family Welfare Visitors (FWV), Medical Assistants, or Community Medical Officers.

Safe Motherhood Promotion Project

The Project was a technical cooperation project providing expert support, training of local officials, and the supply of equipment. The local implementing partner was CARE Bangladesh. Participatory approaches included local people in planning, operational management and evaluation activities. The overall aim was to develop the community's capacity to improve safe motherhood practices at the local level and strengthen EmOC services at the secondary levels, namely at sub-district Health Complexes.

Regarding the community-level activities, nine unions in Narsingdi were selected to provide promotional activities in March 2008. First, a situation analysis on maternal and newborn health issues, including union-level health facility assessment, was conducted jointly by local government health staff and project team members. Based on findings from the analysis, an action plan was developed through a participatory planning workshop involving local stakeholders, including a union chairman, the local government (Union Parishad) members, Health and Family Planning staff, local elites, and community leaders in each union. The action plan in each of the nine unions contained in common a core package of interventions with some additional activities to reflect local needs. The main interventions included the formation of a Safe Delivery Team led by FWV and the other service providers, training on ANC, PNC and delivery care for FWV and community SBA, guidance for informal service providers, such as traditional birth attendants and village doctors to prevent harmful practices for pregnant women, the upgrade of union-level health facilities by supplying essential equipment, and the promotion of community mobilization.

The community mobilization activities were directed to increase people's awareness and demand for maternal health services mainly through the development of a community support system. The concept of community support was developed by CARE Bangladesh in 1998 under the Dinajpur Safe Mother Initiative (Hossain & Ross, 2006). Community support self-help groups were formed to support pregnant women from low SES households. Their activities included the mapping of households to register and monitor pregnant women, provision of home-based educational sessions for pregnant women and their family members, dissemination of information on local health services, promotion of ANC/PNC and SBA, creation of a community fund to financially support low SES pregnant women, introduction of referral slips for local transport to strengthen referral systems, and advocacy for maternal and newborn health issues at the local government level. Community groups were formed in the two sites with upgraded facilities, namely, Monohardi and Raipura. Each group consisted of 11–15 members and covered approximately 250–300 rural households. The EmOC interventions aimed at strengthening EmOC services at secondary hospitals. The project targeted the eight district and sub-district level hospitals to improve the availability and quality of EmOC services. To facilitate the effective operation of activities, the Plan–Do–Check–Act (PDCA) cycle was introduced into the hospitals. The cycle starts with conducting a facility assessment and

developing an action plan for each hospital. Based on the action plan, the project supported the implementation of training that targeted primarily medical officers and nurses to enhance their skills on the active management of the third stage of labor, safe delivery, immediate newborn care, neonatal resuscitation, and infection prevention practices. The project also supported minor renovations of hospitals, such as repair of roofs, toilets, hand washing facilities, doors, and the windows of operating theaters or delivery rooms. Progress on the action plan was checked at the EmOC team meetings and the plan was revised to reflect the latest situation and needs of each facility. For instance, as an additional renovation, partitions were attached to the corner of the female ward to secure the privacy of female postoperative patients after the hospital had experienced an increase in the number of caesarean section cases. A formal organizational mechanism to guide and monitor the project was established at the central level. Meetings were held every six months and served as a forum to share information related to the project activities and also to coordinate different stakeholders of the project.

Data

To measure the impact of the project, we use two rounds of repeated cross-sectional household surveys, including baseline and follow-up data, which were implemented during the project period. The surveys contained questions about the socio-demographic background of the women who experienced a child-birth and their use of pregnancy and delivery care. The baseline and follow-up surveys were conducted in March 2008 and in November 2009, respectively, in the project sites under the nine unions in Narsingdi and in the comparison site. As a comparison site, four sub-districts in Brahman Baria, a neighboring district of Narsingdi, were selected. No major community-based interventions for maternal and newborn health existed in Brahman Baria during the project period, and Brahman Baria was similar to Narsingdi in terms of health and socio-demographic indicators. During the project period, the comparison site received the usual health care services from the government, NGOs, and private sectors, as is the norm in other parts of the country.

For baseline data, a two-stage cluster sampling was applied. The clusters were villages in the nine unions located in six sub-districts of Narsingdi, namely Sadar, Belabo, Shibpur, Palash, Monohardi, and Raipura, and eight randomly selected unions in four sub-districts of Brahman Baria, the comparison site, namely, Sadar, Kashba, Sharail, and Akhura. To select the clusters, information on the names and the number of villages in each of the unions was collected from the 2001 census report. Then, in the first stage, 16 villages (eight each from the project and comparison sites) were selected through a method of probability proportionate to size. The second stage involved selection of households with targeted women from the selected villages. A sampling frame was developed to identify all of the married women who had had a live birth within one year prior to the survey. The follow-up survey followed a similar procedure.

Note, however, that because the baseline and follow-up surveys were originally designed for different purposes, there is a gap in sample size between the two surveys. The purpose of the baseline survey was to collect baseline information on key outcome indicators such as the coverage of ANC and SBA from both the project and comparison sites. The sample size calculated for the baseline survey was 840 women in total from the project and comparison sites. In contrast, the primary objective of the follow-up survey was to compare outcome indicators between the project and comparison sites to assess whether there was any change due to the intervention. The sample size for the follow-up survey was calculated as 1932 in total. The actual sample size achieved was $n = 831$ and $n = 2088$ in total for the baseline and follow-up, respectively.

Econometric model

Our primary interest was to measure the net impact of the project, for which intervention areas were not allocated randomly. Because we had access to two rounds of cross-sectional data in both the project and comparison sites, we employed as an empirical framework a difference-in-differences (DID) method, which is basically a combination of before–after and with–without comparison. In principle, the DID isolates a causal effect by calculating the difference between changes that occurred in the project site and those in the comparison site. Importantly, the DID is only applicable under the assumption that, in the absence of the project, the outcome indicators of interest in the project site would move in parallel with those in the comparison site, after controlling for all of the observable covariates. This assumption implies that the unobserved characteristics such as individual's intelligence, motivation, and skills which potentially affect outcomes both in the project site and comparison site are assumed to be constant on average over time.

As explained later, outcome variables in our analysis are binary variables. We thus applied a logistic model to obtain a DID estimate. We let y_{it} be a latent variable denoting the probability that a woman i at the survey time t will use health care services or acquire appropriate knowledge of danger signs for pregnancy, delivery, or the postpartum period ($t = 0$ for baseline, $t = 1$ for follow-up). PJ_{it} is a dummy variable representing whether a woman i lives in the project site ($\mathrm{PJ}_{it} = 1$ for project site, $\mathrm{PJ}_{it} = 0$ for comparison site). X_{it} denotes a vector of control variables and ε_{it} is an error term. The model is therefore expressed as follows.

$$\begin{aligned} y_{it}^{*} &= \alpha + \beta_1 \mathrm{PJ}_{it} t + \beta_2 \mathrm{PJ}_{it} + \beta_3 t + \gamma X_{it} + \varepsilon_{it} \\ y_{it} &= 1 \text{ if } y_{it}^{*} > 0, \text{ or } 0 \text{ otherwise} \end{aligned} \quad (1)$$

Table 1
Descriptive statistics at baseline.

Variables	Project site			Comparison site			*p*-Value
	n	Mean	SD	*n*	Mean	SD	
Outcome variables							
Received any ANC	421	0.549	0.50	410	0.541	0.50	0.835
Received ≥3 ANC	421	0.283	0.45	410	0.295	0.46	0.692
Delivery by SBA	419	0.191	0.39	407	0.160	0.37	0.239
EmOC: pregnancy	85	0.576	0.50	110	0.627	0.49	0.474
EmOC: delivery	84	0.440	0.50	82	0.390	0.49	0.514
EmOC: postpartum	67	0.239	0.43	68	0.500	0.50	0.002
Know Danger signs: pregnancy	421	0.107	0.31	410	0.129	0.34	0.318
Know Danger signs: delivery	421	0.171	0.38	410	0.161	0.37	0.698
Know Danger signs: postpartum	421	0.100	0.30	410	0.049	0.22	0.005
Control variables							
Woman's age	421	24.829	5.30	410	25.617	5.28	0.032
Woman's education: none	421	0.278	0.45	410	0.359	0.48	0.013
Woman's education: 1–5 years	421	0.285	0.45	410	0.280	0.45	0.885
Woman's education: ≥6 years	421	0.437	0.50	410	0.361	0.48	0.025
Woman's job	421	0.076	0.26	410	0.049	0.22	0.105
Husband's education: none	421	0.316	0.46	410	0.393	0.49	0.021
Husband's education: 1–5 years	421	0.257	0.44	410	0.263	0.44	0.821
Husband's education: ≥6 years	421	0.428	0.50	410	0.344	0.48	0.013
Husband's job	421	0.962	0.19	410	0.983	0.13	0.066
Number of living children	421	2.542	1.56	410	2.854	1.81	0.008
Family income: highest	417	0.237	0.43	390	0.213	0.41	0.404
Family income: upper middle	417	0.156	0.36	390	0.162	0.37	0.826
Family income: lower middle	417	0.295	0.46	390	0.338	0.47	0.185
Family income: lowest	417	0.312	0.46	390	0.287	0.45	0.447
Community support contact	421	0.000	0.00	410	0.000	0.00	

Table 2
Descriptive statistics at follow-up.

Variables	Project site			Comparison site			*p*-Value
	Obs	Mean	SD	Obs	Mean	SD	
Outcome variables							
Received any ANC	1043	0.733	0.443	1045	0.546	0.498	<0.001
Received ≥3 ANC	1043	0.347	0.476	1045	0.252	0.434	<0.001
Delivery by SBA	1043	0.254	0.436	1045	0.231	0.421	0.211
EmOC: pregnancy	155	0.645	0.480	226	0.650	0.478	0.916
EmOC: delivery	159	0.748	0.435	139	0.540	0.500	<0.001
EmOC: postpartum	72	0.556	0.500	101	0.446	0.500	0.155
Know Danger signs: pregnancy	1043	0.337	0.473	1045	0.232	0.422	<0.001
Know Danger signs: delivery	1043	0.460	0.499	1045	0.329	0.470	<0.001
Know Danger signs: postpartum	1043	0.129	0.336	1045	0.144	0.352	0.317
Control variables							
Woman's age	1043	24.446	5.694	1045	24.965	5.894	0.041
Woman's education: none	1043	0.180	0.385	1045	0.228	0.420	0.007
Woman's education: 1–5 years	1043	0.296	0.457	1045	0.311	0.463	0.464
Woman's education: ≥6 years	1043	0.523	0.500	1045	0.461	0.499	0.004
Woman's job	1043	0.018	0.134	1045	0.022	0.147	0.537
Husband's education: none	1043	0.261	0.439	1045	0.327	0.469	0.001
Husband's education: 1–5 years	1043	0.307	0.461	1045	0.267	0.443	0.044
Husband's education: ≥6 years	1043	0.432	0.496	1045	0.406	0.491	0.217
Husband's job	1043	0.981	0.137	1045	0.983	0.130	0.739
Number of living children	1043	2.130	1.283	1045	2.625	1.660	<0.001
Family income: highest	1043	0.187	0.390	1045	0.239	0.427	0.004
Family income: upper middle	1043	0.234	0.424	1045	0.162	0.368	<0.001
Family income: lower middle	1043	0.285	0.452	1045	0.241	0.428	0.024
Family income: lowest	1043	0.294	0.456	1045	0.358	0.480	0.002
Community support contact	1043	0.177	0.382	1045	0.000	0.000	<0.001

where y_{it} is a binary variable in which $y_{it} = 1$ if the woman uses health care services or acquires knowledge, and $y_{it} = 0$ otherwise. The parameter of interest is β_1, representing a DID estimate of the project impact.

When assessing the impact of the project on income inequalities in access to health care or knowledge, Equation (1) can be expressed as Equation (2).

$$\begin{aligned} y_{it}^{*} &= \alpha + \beta_1 \mathrm{Income}_{it}\mathrm{PJ}_{it}t + \beta_2 \mathrm{Income}_{it}\mathrm{PJ}_{it} + \beta_3 \mathrm{Income}_{it}t \\ &\quad + \beta_4 \mathrm{PJ}_{it}t + \beta_5 \mathrm{PJ}_{it} + \beta_6 t + \gamma X_{it} + \varepsilon_{it} y_{it} \\ &= 1 \text{ if } y_{it}^{*} > 0, \text{ or } 0 \text{ otherwise} \end{aligned} \quad (2)$$

where Income_{it} is a categorical variable that indicates income quartiles (highest, upper middle, lower middle, or lowest) to which a woman's household belongs. The parameter β_1 in the Equation (2) now represents differential impacts of the project according to income level.

In the estimation, we need to take into account the effects caused by other programs to elicit the net impact of the project. In 2007, the government launched a voucher program, known as Demand Side Financing (vouchers), to encourage the use of pregnancy and delivery care services. One of the sub-districts of Narsingdi (Raipura) had been covered by this scheme since 2008. This program gives pregnant women vouchers for free access to three ANC visits, skilled assistance for normal birth-delivery, emergency care for obstetric complications, including caesarean section, and post-natal care. The scheme not only covers the costs associated with using these services but also provides some money as an incentive for pregnant women to utilize services offered either at government health facilities or designated private clinics. Favorable effects of the scheme in enhancing uptake of maternal health services were confirmed in the past (Ahmed & Khan, 2011a, 2011b; Nguyen et al., 2012). Because our follow-up survey includes a question asking if the respondent is a beneficiary of the government voucher program, we used this information to examine the influence by vouchers on the use of maternal health care.

Outcome variables

We analyzed the following outcome variables to assess the impact of the project.

1. ANC: whether the woman received at least one ANC service during her pregnancy and whether the woman received three or more ANC services during the pregnancy. 2. Delivery assisted by SBA: whether the woman had a delivery assisted by SBA for her last delivery. 3. EmOC services: whether the woman received either basic or comprehensive EmOC services in the case of complication during pregnancy, delivery, or the postpartum period. 4. Women's knowledge of danger signs: whether the woman had appropriate knowledge of danger signs during pregnancy, delivery, and the postpartum period. In assessing knowledge, the survey question asked women if they could name at least three danger signs for each period.

Note that we use the receipt of at least three ANC as a target indicator following the government's Maternal Health Strategy (Government of Bangladesh, 2001) although UNICEF and WHO recommend that the minimum number of antenatal visits be four.

Control variables

We used the following socio-demographic factors as control variables: women's age (years), women's education: none, 1–5 years, ≥6 years; women's job: if the woman has a job (=1) or not (=0);

Table 3
Percentage of pregnant women fulfilling outcomes: results from the bivariate difference-in-differences analysis.

Variables	Project site			Comparison site			DID (A − B)	*p*-Value
	Baseline	Follow-up	Change (A)	Baseline	Follow-up	Change (B)		
Received any ANC	54.9%	73.3%	18.4%	54.1%	54.6%	0.5%	17.9%	<0.001
Received ≥3 ANC	28.3%	34.7%	6.4%	29.5%	25.2%	−4.3%	10.8%	0.004
Delivery by SBA	19.1%	25.4%	6.3%	16.0%	23.1%	7.1%	−0.8%	0.820
EmOC: pregnancy	57.6%	64.5%	6.9%	62.7%	65.0%	2.3%	4.6%	0.597
EmOC: delivery	44.0%	74.8%	30.8%	39.0%	54.0%	14.9%	15.9%	0.087
EmOC: postpartum	23.9%	55.6%	31.7%	50.0%	44.6%	−5.4%	37.1%	0.001
Know Danger signs: pregnancy	10.7%	33.7%	23.1%	12.9%	23.2%	10.2%	12.8%	<0.001
Know Danger signs: delivery	17.1%	46.0%	28.9%	16.1%	32.9%	16.8%	12.1%	0.001
Know Danger signs: postpartum	10.0%	12.9%	3.0%	4.9%	14.4%	9.6%	−6.6%	0.013

Table 4
Estimated results from the multivariate difference-in-differences logistic regressions.

Variable	Received any ANC	Received ≥3 ANC	Delivery by SBA	EmOC: pregnancy	EmOC: delivery	EmOC: post-partum	Know Danger signs: pregnancy	Know Danger signs: delivery	Know Danger signs: post-partum
Project × Time	0.850*** (0.189)	0.524*** (0.200)	−0.142 (0.230)	0.437 (0.405)	0.575 (0.438)	1.537*** (0.561)	0.858*** (0.245)	0.632*** (0.216)	−0.940*** (0.316)
Average marginal effect	0.165	0.095	−0.022	0.090	0.118	0.311	0.143	0.124	−0.097
Project	−0.184 (0.156)	−0.295* (0.167)	0.057 (0.198)	−0.398 (0.321)	0.089 (0.343)	−1.264*** (0.416)	−0.348 (0.220)	−0.025 (0.191)	0.709** (0.284)
Time	−0.189 (0.132)	−0.443*** (0.142)	0.378** (0.167)	−0.114 (0.266)	0.489 (0.305)	−0.130 (0.362)	0.619*** (0.169)	0.866*** (0.154)	1.121*** (0.248)
Woman's age	0.045*** (0.011)	0.031*** (0.012)	0.065*** (0.013)	0.002 (0.023)	0.039 (0.028)	0.039 (0.036)	0.038*** (0.012)	0.038*** (0.011)	0.023 (0.015)
Woman's education: no education†									
Woman's education: 1–5 years	0.553*** (0.115)	0.381*** (0.148)	0.072 (0.167)	0.521** (0.247)	0.346 (0.304)	0.415 (0.375)	0.253* (0.149)	0.217 (0.132)	0.182 (0.193)
Woman's education: ≥6 years	1.106*** (0.130)	0.856*** (0.152)	0.334** (0.169)	0.959*** (0.286)	0.716** (0.338)	0.690* (0.407)	0.769*** (0.157)	0.703*** (0.141)	0.737*** (0.201)
Woman's job	0.151 (0.247)	0.385 (0.241)	0.055 (0.270)	0.845* (0.513)	0.124 (0.520)	−0.076 (0.708)	0.648*** (0.249)	0.131 (0.249)	0.029 (0.337)
Husband's education: no education†									
Husband's education: 1–5 years	0.172 (0.109)	0.139 (0.132)	0.361** (0.155)	0.381 (0.249)	0.453 (0.297)	0.016 (0.346)	−0.063 (0.134)	0.044 (0.120)	−0.071 (0.168)
Husband's education: ≥6 years	0.704*** (0.118)	0.631*** (0.130)	0.955*** (0.152)	0.430* (0.259)	0.505* (0.303)	0.763** (0.359)	0.158 (0.136)	0.306** (0.124)	−0.177 (0.174)
Husband's job	−0.129 (0.310)	−0.230 (0.294)	−0.654** (0.301)	−0.173 (0.604)	0.292 (0.515)	0.138 (0.884)	0.108 (0.332)	0.102 (0.307)	−0.325 (0.375)
No. of living children	−0.203*** (0.041)	−0.211*** (0.049)	−0.394*** (0.058)	0.011 (0.086)	−0.226** (0.108)	−0.218* (0.128)	−0.083* (0.049)	−0.026 (0.043)	−0.003 (0.060)
Family income: highest†									
Family income: upper middle	−0.516*** (0.145)	−0.555*** (0.130)	−0.527*** (0.137)	−0.655** (0.318)	0.511 (0.339)	0.143 (0.454)	0.102 (0.135)	0.037 (0.128)	0.017 (0.169)
Family income: lower middle	−0.653*** (0.133)	−0.607*** (0.123)	−0.596*** (0.131)	−0.773** (0.304)	−0.159 (0.304)	−0.538 (0.402)	−0.189 (0.133)	−0.245** (0.122)	−0.128 (0.165)
Family income: lowest	−0.727*** (0.133)	−0.797*** (0.129)	−0.985*** (0.143)	−0.994*** (0.298)	−0.108 (0.302)	−0.626 (0.412)	−0.340** (0.138)	−0.598*** (0.128)	−0.526*** (0.180)
Community support contact	0.777*** (0.224)	0.944*** (0.176)	0.387** (0.188)	−0.366 (0.485)	0.519 (0.554)	0.462 (0.688)	−0.216 (0.180)	−0.490*** (0.173)	0.279 (0.230)
Constant	−0.554 (0.423)	−1.111*** (0.430)	−1.846*** (0.463)	0.584 (0.886)	−1.827** (0.895)	−0.954 (1.346)	−3.070*** (0.472)	−2.868*** (0.433)	−3.287*** (0.576)
Observations	2895	2895	2891	571	457	304	2895	2895	2895

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$, †reference group.
Estimates are coefficients derived from logistic regression. Standard errors are in parenthesis.

husband's education: None, 1–5 years, ≥6 years; husband's job: if the husband has a job (=1) or not (=0); number of living children; household income quartile: highest; upper middle; lower middle; lowest; Community support contact: if the woman was registered by the community support group during her last pregnancy.

Results

Descriptive statistics

Tables 1 and 2 show descriptive statistics at baseline and follow-up, respectively. At baseline the proportion of women who accessed EmOC during postpartum complications in the project site was significantly lower relative to the comparison site (23.9% vs. 50.0%, $p = 0.002$). In contrast, women in the project site on average had more knowledge of postpartum danger signs than those in the comparison site (10.0% vs. 4.9%, $p = 0.005$). With regard to control variables, both the women and the husbands in the project site were on average more educated than those in the comparison site during the project period.

Results from bivariate analysis

Table 3 presents the results from bivariate DID analysis on the effects of the Safe Motherhood project. The average DID estimator is calculated as the difference between the change in the outcome variable during baseline and follow-up surveys in the project site and that in the comparison site. There was a dramatic increase in the use of at least one ANC in the project site from 54.9% to 73.3% (+18.4%), whereas the increase in the comparison site was modest, i.e., from 54.1% to 54.6% (+0.5%). Therefore, the DID is calculated as 17.9% (18.4% − 0.5%, $p < 0.001$). Similarly, the DID estimate for at least three ANC is computed as 10.8% (6.4% − (−4.3%), $p = 0.004$).

With respect to delivery care, the proportion of women who used a SBA for their last delivery rose from 19.1% to 25.4% (+6.3%) in the project site. However, as there was a greater increase in the comparison site, from 16.0% to 23.1% (+7.1%), DID becomes −0.8% (6.3% − 7.1%) albeit with no statistical significance ($p = 0.820$).

Regarding the EmOC, there was a larger increase in the use of EmOC services in the project site than in the comparison site: +6.9% vs. +2.3% for pregnancy EmOC; +30.8% vs. +14.9% for delivery EmOC; and 31.7% vs. −5.4% for postpartum EmOC. The DID for the EmOC was thus 4.6%, 15.9%, and 37.1% for pregnancy, delivery, and postpartum periods, respectively. Finally, women's knowledge of danger signs in the project site increased significantly more than in the comparison site, at 12.8% for danger signs during pregnancy and at 12.1% for the delivery. However, a negative DID of −6.6% was observed for knowledge of postpartum danger signs.

Results from multivariate analysis

Table 4 reports the estimated results from multivariate DID logistic regressions. The coefficients of the interaction of Project × Time showed the DID estimate for the project impact. We calculated average marginal effects for each DID estimate on outcome variables. Regarding ANC, the project had a positive effect on the use of ANC, for both one and three ANC visits ($p < 0.01$). The marginal effects indicate that on average the project increased the probability that a woman received at least one and at least three ANC by 16.5% and 9.5%, respectively. In contrast, the project had no favorable impact on delivery by a SBA. Turning to EmOC, the project increased the use of postpartum EmOC with the average marginal effect of 31.1%, but no significant increase was observed for pregnancy or delivery EmOC. Finally, on average, the project enhanced a woman's chance of acquiring knowledge of danger signs for

Table 5
Estimated results from the multivariate difference-in-differences logistic regressions on income inequalities in maternal health.

Variable	Received any ANC	Received ≥3 ANC	Delivery by SBA	EmOC: pregnancy	EmOC: delivery	EmOC: post-partum	Know Danger signs: pregnancy	Know Danger signs: delivery	Know Danger signs: post-partum
Upper middle × Project × Time	1.027* (0.623)	0.524 (0.594)	−0.515 (0.688)	0.078 (1.421)	0.601 (1.410)	0.307 (2.017)	0.593 (0.711)	1.261* (0.653)	0.848 (0.930)
Lower middle × Project × Time	1.056* (0.548)	0.884* (0.522)	−0.523 (0.578)	0.468 (1.336)	−1.660 (1.240)	−0.950 (1.807)	−0.654 (0.661)	−0.656 (0.569)	−0.285 (0.805)
Lowest × Project × Time	1.688*** (0.548)	1.418*** (0.549)	0.479 (0.648)	0.831 (1.276)	−1.399 (1.177)	−2.402 (1.788)	0.412 (0.661)	−0.161 (0.599)	0.413 (0.973)
Observations	2895	2895	2891	571	457	304	2895	2895	2895

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$, highest income quartile is reference.
Standard errors are in parenthesis.

Table 6
Estimated results from the multivariate logistic regressions on the community support contact and income inequalities in maternal health using follow-up data.

Variable	Received any ANC	Received ≥3 ANC	Delivery by SBA	EmOC: pregnancy	EmOC: delivery	EmOC: post-partum	Know Danger signs: pregnancy	Know Danger signs: delivery	Know Danger signs: post-partum
Upper middle × Community support contact	0.786 (0.720)	0.906* (0.517)	1.973*** (0.532)	0.419 (1.701)	−13.48 (604.1)	−13.01 (1.241)	0.299 (0.502)	−0.191 (0.501)	−0.317 (0.618)
Lower middle × Community support contact	0.780 (0.669)	0.622 (0.497)	1.420*** (0.531)	(Omitted)	−14.69 (604.1)	−13.68 (1.241)	−1.155** (0.567)	0.026 (0.498)	−0.430 (0.647)
Lowest × Community support contact	0.311 (0.623)	0.650 (0.487)	1.065* (0.554)	2.413 (1.897)	−13.82 (604.1)	−11.91 (1.241)	−0.643 (0.519)	−0.051 (0.492)	−0.823 (0.672)
Observations	2088	2088	2088	378	298	171	2088	2088	2088

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$, highest income quartile is reference.
Standard errors are in parenthesis.

pregnancy and delivery by 14.3% and 12.4%, respectively ($p < 0.01$). In contrast, the coefficient on the knowledge of postpartum danger signs was negative ($p < 0.01$).

To scrutinize the insignificant increase in the use of SBA in the project site, we checked estimates for the dummy variable community support on the use of SBA. The estimated coefficient was positive at the less than 5% significance level, which indicates that women who were registered by community support groups were more likely to use SBA than those who were not. This result implies that even though there was no significant increase in the use of SBA in the project site relative to the comparison site, women in the project site would be more likely to use SBAs if they were registered and monitored by a village support group.

Effects on income inequalities in access to maternal health care

Table 5 reports the results of estimations using the Equation (2), which show whether the project reduced income inequalities in women's uptake of maternal health care and knowledge of danger signs. The coefficients of the interaction term, Income quartile × Project × Time, showed that, relative to the comparison site, there was a significant increase in ANC for women belonging to lower income quartiles compared to those in the highest quartile in the project site. An exception was the upper middle quartile for which there was no significant difference in the receipt of at least three ANC. However, the project had almost no positive effect on the reduction in income inequalities in uptake of SBA, EmOC, or the knowledge of danger signs.

Next, we investigate whether community support activities reduced inequalities in access to health care. As the information on community support registration is only available at the follow-up time, we conducted cross-sectional logistic regressions on the follow-up data. The coefficients of the interaction term, Income quartile × Community support contact, represent the effects of community support in reducing inequities in maternal health. The results are reported in Table 6, indicating that women from the lower income quartiles were more likely to use SBA than those in the highest if they were registered by community support groups. This result is consistent with the findings from the Community Support System Evaluation Report which was conducted in December, 2009. Among the women from the household with the lowest asset quintile, the SBA utilization rate was 21.7% in the community support areas, whereas it was only 7.8% in the non-community support areas (Khan, Rahman, & Nasrin, 2011).

Effects of Demand Side Financing

We examine the effects of Demand Side Financing (vouchers) on the use of ANC and SBA, using a study sample from the follow-up survey data. Among 2088 women from 17 unions at follow-up time, 150 women (7.2%) from two unions answered that they were eligible for the government's voucher scheme. Therefore, we first dropped those beneficiaries from our sample and conducted DID regressions using the same specifications with the Equation (1). The main results are not changed from Table 4 after this sample restriction. Next, we estimated the effects of the voucher scheme by including the interaction term Project × Demand Side Financing on the follow-up data. The results are shown in Table 7, which shows that the estimated coefficients for the interaction terms for ANC were significant and positive, indicating that, while the project had a favorable effect on the use of ANC, the effect was much greater for those who were eligible for vouchers. As to SBA, voucher beneficiaries were more likely to deliver a baby with a SBA. This implies that, although the project did not exert a significant effect on the increased use of SBA, vouchers had a complementary role in promoting their use.

Discussion

We evaluated the impact of the Japanese-supported Safe Motherhood Promotion Project in Bangladesh, with a special focus on its community-based activities. The results showed that the project exerted positive effects on the utilization of ANC and postpartum EmOC services, as well as on the improved knowledge of danger signs during pregnancy and delivery. For instance, the proportion of women who received at least three ANC services rose from 28.3% to 34.7% in the project site, while it dropped from 29.5% to 25.2% in the comparison site. The estimated average marginal effect indicates that the project increased the likelihood that a pregnant woman made at least three antenatal visits by 9.5%. With respect to delivery care, the proportion of women who used a skilled attendant for their last delivery increased from 19.1% to 25.4% (+6.3%) in the project site. However, there was a greater increase in the comparison site from 16.0% to 23.1% (+7.1%). We also confirmed that women from the poorer households increased both the likelihood and the number of ANC more proportionally than

Table 7
Estimated results from the multivariate logistic regressions on Demand Side Financing (government voucher scheme) using follow-up data.

Variable	Received any ANC	Received ≥3 ANC	Delivery by SBA
Project × Demand Side Financing	2.058*** (0.665)	1.346** (0.636)	−0.619 (0.611)
Project	0.654*** (0.108)	0.213* (0.113)	−0.069 (0.119)
Demand Side Financing	−0.493 (0.544)	0.120 (0.578)	1.212** (0.549)
Observations	2088	2088	2088

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.
Standard errors are in parenthesis.

those from the highest income quartile. However, this inequality-reduction effect was not confirmed for the uptake of SBA, EmOC or knowledge of danger signs.

There are possible reasons why the project's impact on the use of SBA and on lower-income women's uptake of SBA, EmOC, and knowledge of danger signs was not significant relative to the comparison site. We evaluated the relatively short-term impact of the project, assessing impact for one and a half years during the project implementation period. Improving access to and utilization of SBA and EmOC may require more time as these require functional referral systems, more equipment and infrastructure at health facilities, and trained professional health providers.

Nevertheless, demand-side interventions with the purpose of enhancing women's health-care seeking behaviors can improve the situation. We confirmed that registration and monitoring of pregnant women with community support groups led to more use of SBA as well as a reduction of inequalities in access to SBA. As the government's voucher incentive program was also effective in increasing the use of skilled attendants, demand-side interventions, of which community support registration and vouchers are two examples, will be key to increasing SBA coverage.

The main limitation of the study is lack of randomization in assignment to project and comparison sites, and thus selection bias might be a problem. Caveats are therefore needed in extrapolating the study results to other settings. Despite these caveats, the findings will provide important insights for designing and evaluating maternal health interventions in Bangladesh and for informing policy.

Acknowledgments

The authors extend their appreciation to the Ministry of Health and Family Welfare of Bangladesh, Japan International Cooperation Agency, and CARE Bangladesh to conduct this evaluation.

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