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Impact of the Integration of Water Treatment, Hygiene, Nutrition, and Clean Delivery Interventions on Maternal Health Service Use

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Abstract. Reducing barriers associated with maternal health service use, household water treatment, and improved hygiene is important for maternal and neonatal health outcomes. We surveyed a sample of 201 pregnant women who participated in a clinic-based intervention in Kenya to increase maternal health service use and improve household hygiene and nutrition through the distribution of water treatment products, soap, protein-fortified flour, and clean delivery kits. From multivariable logistic regression analyses, the adjusted odds of ≥ 4 antenatal care (ANC4+) visits (odds ratio [OR] = 3.0, 95% confidence interval [CI] = 1.9–4.5), health facility delivery (OR = 5.3, 95% CI = 3.4–8.3), and any postnatal care visit (OR = 2.8, 95% CI = 1.9–4.2) were higher at follow-up than at baseline, adjusting for demographic factors. Women who completed primary school had higher odds of ANC4+ visits (OR = 1.8, 95% CI = 1.1–2.9) and health facility delivery (OR = 4.2, 95% CI = 2.5–7.1) than women with less education. For women who lived ≤ 2.5 km from the health facility, the estimated odds of health facility delivery (OR = 2.4, 95% CI = 1.5–4.1) and postnatal care visit (OR = 1.6, 95% CI = 1.0–2.6) were higher than for those who lived > 2.5 km away. Compared with baseline, a higher percentage of survey participants at follow-up were able to demonstrate proper handwashing (*P* = 0.001); water treatment behavior did not change. This evaluation suggested that hygiene, nutritional, clean delivery incentives, higher education level, and geographical contiguity to health facility were associated with increased use of maternal health services by pregnant women.

BACKGROUND

In Kenya, maternal and neonatal mortality rates are high, at 362 per 100,000 live births, and 22 per 1,000 live births, respectively.[1] Among 15- to 49-year-old women, 14% of deaths are pregnancy associated. The benefit of increasing maternal health service use to pregnant women can be inferred from studies suggesting that a lack of antenatal care (ANC) services is associated with adverse health outcomes, such as maternal and perinatal mortality, low birth weight, and premature delivery.[2–4] The Kenyan Ministry of Health recommends that expectant mothers have at least four ANC visits and deliver in a health-care facility to ensure the health of the mother and child. The 2014 Demographic and Health Survey revealed that 58% of rural Kenyan women had four or more antenatal visits (ANC4+).[1] In western Kenya, 61% of women delivered in a health facility, and 47% of mothers received no postnatal checkup.[1] A perceived lack of quality of ANC, distance to health facility, and cost of ANC visits are considered important barriers to maternal health service utilization in Kenya.[5–7]

From March 2011 to March 2012, the Safe Water and AIDS Project (SWAP), a local nongovernmental organization (NGO) (http://www.swapkenya.org), collaborated with the Kenyan Ministry of Health to integrate several health interventions into reproductive health services as incentives to help lower barriers to care and increase service use in 25 health facilities in Suba and Mbita districts in western Kenya. During this period, the Centers for Disease Control and Prevention collaborated with SWAP in an evaluation of this program.

METHODS

Evaluation design. In March 2011, we conducted a baseline cross-sectional survey of pregnant women to determine their use of maternal health services, water, and hygiene practices. The intervention was implemented in 25 health facilities after the baseline survey, and in March 2012, we conducted a follow-up survey with participants enrolled at baseline. Because of logistical and financial constraints, the surveys were limited to 12 of 25 health facilities, all within a 3-hour drive of Mbita, the district seat of government. To assess the reliability of the survey data, we also abstracted data for all patients from the antenatal registers in health facilities for 12 months preintervention (March 2010–February 2011) and during the 12-month intervention period (March 2011–February 2012).

Evaluation location. In collaboration with the Kenyan Ministry of Health and SWAP, we selected Suba and Mbita districts in Nyanza Province for the project because of poor reproductive health service use in these districts. We targeted 25 health facilities that together served approximately 2,000 pregnant women per year for program implementation. We excluded four health facilities from the review of antenatal register data: two on remote islands that were difficult to reach because of distance, time, and unreliable transport, and two that had no registry data for more than 6 months of the preintervention period.

Sample size. Based on previous health intervention studies in western Kenya, we assumed that confirmed water treatment would increase from 5% to 15%, with a confidence level of 95%, a power of 80%, and a design effect of 2 (for clustering of women by health facility), resulting in a

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sample size of 328 pregnant women.[8–10] To account for a possible loss to follow-up of 20%, we increased the target sample size to 400 pregnant women. The median number of women projected to be enrolled per health facility was 13 (range 9–36).

Survey enrollment procedures. We attempted to enroll pregnant women $\geq$ 14 years of age presenting to antenatal clinic in the 12 selected health facilities, as pregnant women $\geq$ 14 years of age are classified as emancipated minors in Kenya. We aimed for the number of enrolled women per clinic to be proportional to the average monthly attendance per clinic relative to the entire sample of 12 clinics. Women who consented to participate were interviewed at the clinic, and then visited at home to observe their household water, sanitation, and hygiene practices at enrollment. They were also told that they would receive a home visit after approximately 12 months for a follow-up survey.

Baseline survey. Enumerators fluent in Dholuo and English used a standardized questionnaire at baseline to interview respondents during their first ANC visit about demographic and socioeconomic characteristics; current utilization of antenatal services; past utilization of antenatal, delivery, and postnatal services; water sources, storage, and treatment; and hygiene practices. We also made observations of water storage containers, water treatment products (if any), soap, and handwashing procedure (correct procedure was defined as using soap, lathering, and drying hands with a clean towel). We tested stored drinking water in all homes for residual chlorine using the N,N-diethyl-p-phenylenediamine colorimetric method (LaMotte Co., Baltimore, MD) as an objective measure of chlorination.

Program implementation. Program implementation included several components. First, to help improve the quality of care at project health facilities, a 1-week training course on managing obstetric emergencies, neonatal resuscitation, patient-centered care, rapid syphilis testing and treatment, water treatment, and handwashing with soap was provided to nurses and clinical officers after the baseline survey. Second, each clinic received a bulb syringe for neonatal suctioning, an ambu-bag for neonatal resuscitation, and handwashing and drinking water stations. Third, to serve as incentives for attendance at maternal health services, the Kenyan Ministry of Health and SWAP gave free hygiene kits (WaterGuard water treatment solution or P & G Purifier of Water [Procter and Gamble Co., Cincinnati, OH], and soap) to mothers at their first and third ANC visits, protein-fortified flour at their second and fourth ANC visits, and a clean delivery kit (surgical gloves, a sterile razor blade, a clean cord tie, swaddling cloth, water storage container with a tap, and a hygiene kit) at the time of delivery in health facilities.[11,12] Finally, all women were offered free screening with a rapid syphilis test kit and treatment of women testing positive during their initial ANC visit. By providing testing and treatment services that were not typically offered because of a lack of supplies, the syphilis program served as an incentive for women to attend ANC.[13]

The incentives described above were provided to pregnant women at antenatal visits, delivery in a health facility, and postnatal check-up. Women also received reproductive health education from local providers. Throughout the implementation phase of the program, we communicated with health facility personnel through weekly short message service (SMS) texting, telephone calls, and monthly clinic visits to monitor distribution of incentives and use of services.

Follow-up survey. In March 2012, we conducted a follow-up home visit to women enrolled at baseline to assess their maternal health service use and household water treatment and hygiene practices. The follow-up questionnaire included questions from the baseline survey and several additional queries about maternal health service use and incentives received.

Maternal registry data abstraction. To determine whether antenatal and delivery register data captured similar results to the survey, we abstracted data on the number of women with four or more antenatal visits (ANC4+), first recommended intermittent preventive treatment of malaria (IPT1), second IPT (IPT2), health facility deliveries, and postnatal check-ups from the antenatal registers in participating intervention health facilities for 1 year preintervention (March 2010–February 2011) and during the intervention period (March 2011–February 2012).

Statistical analysis. Data from baseline and follow-up surveys were collected electronically using Visual CE software (Syware, Inc., Cambridge, MA) on personal digital assistants, entered into a Microsoft Access 2007 database, and analyzed using SAS software version 9.4 (Cary, NC). The primary outcomes of interest included ANC4+ visits, delivery at a health facility, postnatal care visits, visits for IPT1 and IPT2, WaterGuard use, and knowledge of correct handwashing technique. We did not assess P & G Purifier of Water use because distribution was initiated too late in the study to be captured by the survey. Primagravidas were excluded from analysis because there were no previous pregnancies as a basis of comparison. For women lost to follow-up, a χ^2 test for independence was used to determine whether they were similar to those included at follow-up. Fisher's exact *P* values were reported when a cell count was less than five.

Baseline and follow-up survey data were summarized and compared using McNemar's test for paired participant data. Preintervention ANC registry data were compared with postintervention data with a *t* test. Because over 97% of women in western Kenya have at least one ANC visit (ANC1), ANC1 was used as a proxy for the denominator of all pregnant women.[1,14] Considering data from each health facility separately, we calculated the mean ratios of each outcome to ANC1 visits and compared the means for the preintervention and intervention periods.

Multivariable logistic regression using generalized estimating equations were used to assess the association of the intervention (pre versus post) with ANC4+ visits, health facility delivery, and postnatal care visit, adjusting for demographic factors. The demographic factors included age (in years), education (did or did not complete primary school), distance to clinic ($\leq$ 2.5 km and $>$ 2.5 km), and socioeconomic status. As a proxy measure of socioeconomic status, reported household assets were used to calculate wealth index tertiles through principal component analysis.[15] Distances from households to clinic were calculated using ArcGIS 10.3.1 (Environmental Systems Research Institute, Redlands, CA). Distance was calculated using the most direct route, and did not account for roads or terrain. A 2.5-km threshold was used to assess distance as a barrier to service use.[16,17]

Data on the distribution of hygiene kits, nutrition supplies, and clean delivery kits, and utilization of antenatal, labor and delivery, and postnatal services, were obtained through SMS texting, telephone calls, and clinic visits, and described.

Ethical considerations. The institutional review boards at the Kenya Medical Research Institute (protocol 1898) and the Centers for Disease Control and Prevention (protocol 5996) reviewed and approved the study protocol. Informed consent was obtained from all study participants. Personal identifiers were kept in encrypted files and destroyed at the end of the study.

RESULTS

Evaluation enrollment. At baseline, 399 women were enrolled from 12 health facilities. We excluded 97 (24.3%) women experiencing their first pregnancies from analysis, three (0.7%) with insufficient information, and five (1.3%) for whom we had duplicate identification numbers. Of 294 women with at least one previous pregnancy, 93 (31.6%) were excluded from the final analysis because 89 (88.1%) had moved and four (4.0%) had died. The 93 women lost to follow-up were less likely than study participants to own animals ($P < 0.001$), or to live in a dwelling with a thatched roof ($P = 0.03$), dung/earth flooring ($P < 0.001$), or dung walls ($P < 0.001$) (Table 1).

Baseline demographic and socioeconomic characteristics. The median age of participants was 23 years (range 14–42); 51.7% had completed primary school (Table 1). At the time of enrollment, participants had a median of three previous pregnancies (range 1–10); 19.1% were 1–3 months pregnant and 80.9% were 4–6 months pregnant. The homes of 201 participants included 29.8% with thatched roofs, 77.3% with dung/earth floors, 75.3% with dung walls, and 3.5% with electricity. Of 179 participants with reported Global Positioning System coordinates, 96 (53.6%) lived ≤ 2.5 km from the nearest health facility. Walking was the primary form of transportation to ANC among 87 (90.6%) of 96 women who lived ≤ 2.5 km, and 65 (78.3%) of 83 women who lived > 2.5 km, from the nearest health facility. Of the women who were transported by a vehicle, the mean cost of transport was about 80 Shillings, or US$0.80.

Program implementation. *Hygiene kits.* Of 201 respondents, 195 (97.5%) received ≥ 1 hygiene kit, 142 (71.0%) received two, and 64 (31.8%) received three kits. No mothers reported that hygiene kits motivated them to attend ANC.

Protein-fortified flour. At least one bag of protein-fortified flour was given to 145 (72.5%) participants, and 106 (53.0%) received two bags; all mothers reported that receiving flour motivated them to attend ANC.

Clean delivery kits. The clean delivery kit was given to 114 (57.0%) mothers; 111 (96.5%) said they were motivated by the kits to deliver in the health facility. Respondents reported receiving a median total of three WaterGuard bottles ($N = 201$).

Water source, storage, and treatment. At baseline, 35.8% of participants reported using an improved water source (Table 2). Over 85% of participants were observed storing their water at both baseline and follow-up. Compared with baseline, a higher percentage of respondents had water storage buckets observed at follow-up ($P < 0.001$), after clean delivery kit distribution. Over 99% of participants had heard of WaterGuard at baseline and follow-up. There were no differences between baseline and follow-up in the proportion of participants that reported using WaterGuard within the previous 24 hours or that could demonstrate proper WaterGuard use. Free chlorine residual was detected in stored water in 8.1% of households at baseline and 5.6% at follow-up.

Hand hygiene practices. Soap was observed in 87% of households at baseline and 83% at follow-up (Table 3). The percentage of participants that demonstrated correct handwashing techniques increased from baseline to follow-up ($P < 0.001$), as did the percentage that reported washing hands after changing a nappy (diaper) ($P < 0.001$).

Maternal health service use. On univariate analysis, compared with baseline, a significantly higher percentage of respondents at follow-up had ANC4+ visits (56.0% versus 78.0%, $P < 0.001$), delivered in a health facility (36.5% versus 69.3%, $P < 0.001$), and had a postnatal checkup (38.0% versus 62.5%, $P < 0.001$) (Table 4). From baseline to follow-up, there was also an increase in the proportion of women who reported receiving contraception advice ($P < 0.001$), iron supplementation ($P = 0.01$), and exclusively breastfeeding their most recent child ($P < 0.001$). There was no difference from baseline to follow-up in distance

TABLE 1

Demographic and household characteristics of pregnant women included and lost to follow-up in evaluation ($N = 302$), Suba and Mbita districts, rural western Kenya, 2010–2012

	Baseline ($N = 201$)	Lost to follow-up ($N = 93$)	P value
Age (years)*	23 (14–42)	22 (17–42)	0.22
Respondent completed primary school	104 (51.7%)	52 (55.9%)	0.51
Male head of household completed primary school	138 (71.1%)†	57 (64.0%)‡	0.23
Own animals	133 (66.2%)	34 (36.6%)	< 0.001
Household has electricity	7 (3.5%)	4 (4.3%)	0.75§
Thatch roof	59 (29.8%)‖	16 (17.6%)¶	0.03
Dung/earth floor	153 (77.3%)‖	47 (51.7%)¶	< 0.001
Dung walls	149 (75.3%)‖	46 (50.6%)¶	< 0.001

*Median.
†$N = 194$.
‡$N = 89$.
§Fisher's exact test.
‖$N = 198$.
¶$N = 91$.

TABLE 2

Comparison of knowledge and practices regarding water handling and WaterGuard treatment from baseline to follow-up among participants in maternal health incentive program, rural western Kenya, 2010–2012

	Baseline (*N* = 201)	Follow-up (*N* = 201)	*P* value
Improved water source*	72 (35.8%)	65 (32.3%)	0.31
Observed water storage container			
Bucket†	33 (16.8%)	68 (34.5%)	< 0.001
Clay pot†	96 (48.7%)	79 (40.1%)	0.05
Jerry can†	48 (24.4%)	32 (16.2%)	0.03
Barrel/drum†	18 (9.1%)	17 (8.6%)	1.00
Pours or uses tap to remove drinking water‡	43 (21.6%)	70 (35.2%)	0.001
Effective treatment method			
Chlorine§	144 (85.2%)	139 (82.3%)	0.49
Boil§	29 (17.2%)	36 (21.3%)	0.31
Free chlorine residual present‖	16 (8.1%)	11 (5.6%)	0.40
WaterGuard usage			
Used in prior 24 hours¶	17 (23.9%)	20 (28.2%)	0.69
Knowledge of proper usage†	116 (58.9%)	123 (62.4%)	0.40
Available in village**	98 (51.3%)	127 (66.5%)	0.001

*Improved water sources include water that is piped into the household or yard, public taps, covered wells (public or private), and boreholes.
†*N* = 197.
‡*N* = 199.
§*N* = 169.
‖*N* = 198.
¶*N* = 71.
***N* = 191.

between home and health facility and ANC4+ visits or postnatal care visits.

Multivariable logistic regression analyses revealed that there were higher odds of ANC4+ visits (odds ratio [OR] = 3.0, 95% confidence interval [CI] = 1.9, 4.5), health facility deliveries (OR = 5.3, 95% CI = 3.4–8.3), and postnatal care visits (OR = 2.8, 95% CI = 1.9–4.2) at follow-up than at baseline, adjusting for demographic factors (Table 5). For women who completed primary school, the odds of ANC4+ visits (OR = 1.8, 95% CI = 1.1–2.9) and health facility deliveries (OR = 4.2, 95% CI = 2.5–7.1), were estimated to be higher than for women who did not. For women who lived ≤ 2.5 km from the clinic, the odds of health facility delivery (OR = 2.4, 95% CI = 1.5–4.1) and postnatal care visit (OR = 1.6, 95% CI = 1.0–2.6) were estimated to be higher than for women who lived > 2.5 km away.

Antenatal registry data. From March 2010 to February 2011, ANC registries from the 21 health facilities recorded 4,693 women with ANC1 visits, 1,475 with ANC4+ visits, 1,866 with health facility deliveries, 2,507 with postnatal check-ups, 3,535 with IPT1, and 2,619 with IPT2 (Table 6). From March 2011 to February 2012, registries recorded 3,932 women with ANC1 visits, 1,987 with ANC4+ visits, 2,593 with health facility deliveries, 2,397 with postnatal check-ups, 3,486 with IPT1, and 2,738 with IPT2. Using total ANC1 visits (a proxy for the total number of pregnant women) as a denominator, from baseline to follow-up, there were significantly higher proportion of pregnant women with ANC4+ visits (0.34 versus 0.52, *P* = 0.04), health facility deliveries (0.32 versus 0.57, *P* = < 0.001), and IPT2 (0.60 versus 0.76, *P* = 0.02).

DISCUSSION

Findings of this evaluation suggest that integrating hygiene, nutrition, and clean delivery interventions into maternal health service use resulted in an increase in the percentage of participants that made four or more ANC visits, delivered in health facilities, and made postnatal visits compared with previous pregnancies. These findings were supported by their consistency with data abstracted from antenatal and delivery registries at 21 of the 25 intervention health facilities that showed increases in ANC4+ visits and hospital deliveries among the entire population of pregnant women from the 12 months preceding the intervention to the 12-month intervention period.

There are several possible explanations for the increase in care-seeking behavior of pregnant women observed in

TABLE 3

Hand hygiene practices reported and observed at baseline and follow-up among participants in maternal health incentive program, rural western Kenya, 2010–2012

	Baseline (*N* = 198)	Follow-up (*N* = 198)	*P* value
Wash hands before			
Eating	180 (90.9%)	171 (86.4%)	0.20
Cooking	63 (31.8%)	63 (31.8%)	1.00
Giving child food	1 (0.5%)	6 (3.0%)	0.13
Wash hands after			
Using toilet	146 (73.7%)	153 (77.3%)	0.41
Eating	76 (38.4%)	90 (45.4%)	0.18
Nappy change	8 (4.0%)	62 (31.3%)	< 0.001
Owns soap	172 (86.9%)	164 (82.8%)	0.27
Able to demonstrate proper handwashing technique	42 (21.2%)	83 (41.9%)	< 0.001

TABLE 4

Percentage of pregnant women with antenatal clinic attendance, hospital deliveries, and access to maternal interventions during previous and most recent pregnancies, maternal health incentive program, rural western Kenya, 2010–2012

	Baseline (*N* = 201)	Follow-up (*N* = 201)	*P* value
≥ 4 Antenatal care visits*	112 (56.0%)	156 (78.0%)	< 0.001
Last child delivered in hospital†	70 (36.5%)	133 (69.3%)	< 0.001
Had a postnatal check after last child was born‡	73 (38.0%)	120 (62.5%)	< 0.001
Exclusive breastfeeding§	45 (25.9%)	91 (52.3%)	< 0.001
Received advice about family planning during/after last pregnancy*	90 (45.0%)	140 (70.0%)	< 0.001
Received depo-provera injection/IUD after last pregnancy*	81 (40.5%)	86 (43.0%)	0.64
Received iron supplementation**	48 (53.3%)	66 (73.3%)	0.01

IUD = intrauterine device.
*N = 200.
†N = 192.
‡N = 193.
§N = 174.
‖N = 90.

this study. First, reports by mothers suggested that they were motivated by some of the interventions, particularly the protein-fortified flour and clean delivery kits, to visit health facilities to receive services. These results were consistent with qualitative research findings obtained during this project.[18] In western Kenya at the time of this evaluation, pregnant women in labor were required to purchase surgical gloves and give them to the health-care provider to be admitted to the health facility. The provision of surgical gloves, sterile razor blades, and cord ties therefore lowered barriers to care while helping ensure better quality of care, whereas swaddling cloth and water storage containers in the delivery kits provided valued commodities as incentives for mothers to deliver in a health facility. Quantitative and qualitative data collected in this evaluation were also consistent with findings in other studies where incentives such as hygiene kits, insecticide-treated bed nets, and cash payments increased the use of antenatal services.[18–23] Second, other organizations might have provided different incentives which may have influenced mothers to seek care. Multiple queries over the course of the intervention yielded no evidence of additional incentives being offered at these clinics, or of any decrease in the cost of care for ANC services that could have explained the increase in care-seeking behavior. The Kenyan Ministry of Health did initiate a program for free deliveries to mothers in 2013, but the program began a year after the conclusion of this study.[24] Third, the additional training we provided to health-care providers may have increased the perceived quality of care by pregnant women.[25] Improved quality of care has been shown to increase services use in other studies; however, we found no evidence in our quantitative or qualitative evaluations to support this hypothesis.[18,26,27] Finally, increased training, frequent health facility visits, and scrutiny of services performed by our implementation and evaluation teams may have motivated nurses to provide more humane care to pregnant women, which in turn, could have elicited increased service use. Poor treatment of obstetric patients, which has been documented in the literature and verified in the news media in Kenya, has been a barrier to care for many women.[14,28,29]

Women in this program also reported increases in other important reproductive health behaviors, such as exclusive breastfeeding, and access to other interventions, including family planning advice, iron supplements, and IPT2. These increases likely result from women having more ANC visits, and therefore more opportunities to receive education, iron supplements, and IPT from trained health-care providers.[30,31] We were not able to detect a statistically significant increase from baseline to follow-up in access to

TABLE 5

Adjusted* OR and 95% CI for ANC4+ visits, health facility deliveries, and postnatal care visits among women from a maternal health incentive program in 12 health facilities, rural western Kenya, 2010–2012

	ANC4+ visit	Health facility delivery	Postnatal care visit
Intervention			
Baseline	Reference	Reference	Reference
Follow-up	2.96 (1.94–4.51)	5.30 (3.40–8.25)	2.84 (1.94–4.17)
Age (years)	1.06 (1.01–1.11)	1.02 (0.98–1.07)	1.04 (0.99–1.09)
Education			
Did not complete primary school	Reference	Reference	Reference
Completed primary school	1.79 (1.11–2.89)	4.23 (2.50–7.13)	1.54 (0.97–2.46)
Distance to clinic			
> 2.5 km	Reference	Reference	Reference
≤ 2.5 km	0.94 (0.58–1.54)	2.44 (1.46–4.08)	1.64 (1.03–2.61)
Wealth index			
First tertile (poorest)	Reference	Reference	Reference
Second tertile	1.51 (0.90–2.55)	0.53 (0.30–0.94)	0.85 (0.50–1.45)
Third tertile (wealthiest)	1.28 (0.54–3.06)	0.66 (0.28–1.56)	0.88 (0.38–2.01)

ANC4+ = more than four antenatal care visits; CI = confidence interval; OR = odds ratio.
*Multivariable logistic regression included age, education, distance to clinic, and wealth index as factors. Separate analyses for each health outcome (ANC4+ visit, health facility delivery, postnatal care visit) were conducted.

TABLE 6

Ratio estimate of pregnant women with ANC4+ visits, health facility deliveries, postnatal visits, IPT1, and IPT2, using ANC1 as a proxy for a denominator, from baseline to follow-up using maternal register data in 21 health facilities, maternal health incentive program, rural western Kenya, 2010–2012

	Baseline* (March 2010–February 2011)		Follow-up† (March 2011–February 2012)		
Indicator	Total	Ratio (range)	Total	Ratio (range)	*P* value
ANC4+	1,475	0.34 (0.25–0.44)	1,987	0.52 (0.37–0.67)	0.04
Health facility delivery	1,866	0.32 (0.22–0.41)	2,593	0.57 (0.47–0.67)	< 0.001
Postnatal care visit	2,507	0.65 (0.40–0.91)	2,397	0.70 (0.50–0.89)	0.79
IPT1	3,535	0.83 (0.75–0.92)	3,486	0.92 (0.84–1.01)	0.12
IPT2	2,619	0.60 (0.52–0.68)	2,738	0.76 (0.65–0.87)	0.02

ANC = antenatal care; ANC1 = at least one ANC visit; ANC4+ = more than four ANC visits; IPT = intermittent preventive treatment of malaria.
*ANC1 = 4,693 total visits.
†ANC1 = 3,932 total visits.

IPT1; this might be expected because IPT1 is usually delivered during the first antenatal visit, which almost all pregnant women attend.[32,33]

Among the barriers to care that this program tried to address were maternal education, distance from health facilities, and socioeconomic status. We did observe that women with higher levels of education were more likely than less educated women to have ANC4+ visits, health facility deliveries, and postnatal visits, so it appears that the incentives may not have fully eliminated the education barrier.[34,35] Similarly, women who lived closer (≤ 2.5 km) to health facilities were more likely to have health facility deliveries or postnatal care visits than women who lived further away (> 2.5 km), findings that are consistent with results from other studies, and suggest that this program did not fully overcome the barrier of distance.[2,34] Two possible explanations for this barrier are lack of availability and cost of transportation to health facilities. Both explanations were noted by women who participated in this study, and participants in the qualitative evaluation associated with this project.[18] We were unable to determine whether a relationship exists between wealth tertiles and service use. In no case was maternal health service use significantly higher between the wealthiest and poorest tertiles, suggesting that relative wealth of mothers was not an important factor, or that our methods did not accurately capture socioeconomic status.[36]

Despite significant increases in maternal health service use, we found no difference in the uptake of water treatment from baseline to follow-up. These results are in contrast to a similar program in Malawi that found large, statistically significant increases in water treatment over the course of a year-long evaluation.[20,21] There are several possible explanations for this discrepancy. While WaterGuard was more of a novelty in the Malawi population resulting from lower levels of knowledge and use, the product has been on the market in Kenya since 2003 and has been frequently distributed at health facilities by NGOs.[9,37–39] It is possible that WaterGuard was not as highly valued by Kenyan mothers.[8] Alternatively, because of a saturation of water treatment marketing in the population, its use may have plateaued.[8,40–42] Finally, it is possible that lack of product acceptability might have influenced uptake by mothers. We did not collect data on acceptability of WaterGuard, but it is possible that issues of taste, product cost, or beliefs that water did not need to be treated may have limited use; similar barriers have been noted in other studies.[8,43] A similar study in Uganda found only a modest increase in confirmed water treatment and no change in maternal health service use, perhaps in response to a water treatment product that was not a sufficiently desirable incentive to motivate pregnant women to attend clinic.[44]

In contrast to water treatment, we found that most households had soap for handwashing at baseline, and observed a statistically significant increase from baseline to follow-up only in the percentage of mothers able to demonstrate correct handwashing technique. Similar results were observed in studies in Malawi and Kenya.[9,21,43,45]

This study had several important limitations. First, because time, distance, and financial constraints limited our survey to women in 12 (48%) of 25 health facilities, the surveyed population may not have been representative of the entire project population. However, findings from antenatal and delivery registries, which included all mothers from the 21 (84%) facilities that were accessible and had complete data, were consistent with survey results, suggesting that increased service use occurred broadly across the targeted population. Second, because the project took place in only two districts of western Kenya, our population was not necessarily representative of Kenya's population. Third, 93 women surveyed at baseline were lost to follow-up, and it was not possible to determine whether they were missing at random because characteristics of their households differed from mothers included in the study. In our analysis, household characteristics did not appear to influence our main findings. Finally, because of resource limitations, the small study population and brief period of observation, we were unable to measure impacts on maternal or neonatal health.

CONCLUSION

Results of this study suggest that a package of hygiene, nutritional, and clean delivery interventions, in particular protein-fortified flour and clean delivery kits, motivated an increase in the use of maternal health services by pregnant women, with the greatest impact observed in those with higher education and closer geographical proximity to a health facility. Further research could help determine how to prioritize and scale up similar interventions in a cost effective manner, and measure the impact on maternal and neonatal health.

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