A Community Collaborative Approach to Improving Community Health Worker Performance and Retention in Benin

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The Partnership for Community Management of Child Health (PRISE-C) in the Sao, Dagla, and AZT Health Zones of Benin is supported by the American people through the United States Agency for International Development (USAID) through its Child Survival and Health Grants Program. PRISE-C is managed by the Center for Human Services under Cooperative Agreement No. AID-OAA-A-10-00047-00.The views expressed in this material do not necessarily reflect the views of USAID or the United States Government.

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QIT members prepare to share their results at a learning session. A.Antayhua

Key Findings:

- **CHWs in the intervention zone have 11.5 times the odds of having a high performance score as compared to the control zone**
- **High retention in both zones resulted in non-significant retention findings.**
- **The incremental cost-effectiveness ratio was 650,000 FCFA per CHW who achieved a high performance score.**

Testing a community-based quality improvement collaborative to improve community health worker performance in Benin

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Background and Setting

Motivating CHWs to high performance and retaining them in their position have been long-standing challenges for ministries of health, and countries have responded with a variety of strategies and approaches. In Benin, CHWs have been in place for over 20 years and are seen as an essential part of the health system. They provide a package of high-impact interventions focused on treatment of priority child illnesses as well as health education and promotion, although there are low rates of care seeking for child illness, with less than 40% of mothers of children under 5 with acute respiratory infection, fever, or diarrhea seeking care with a health care worker.

Within this context, Center for Human Services implemented a USAID Child Survival and Health Grants Program-funded initiative from 2010-2014, working with community health workers and their supervisors in three health zones of Benin. The objectives of the project were to increase community engagement with the community health delivery system, increase demand for community preventive and curative services, and strengthen performance and sustainability of the community health delivery system. These CHWs served a population of over 13,500 children under 5 years of age, and over 18,000 women of reproductive age (15-49).

Problem and Solution

In 2010, Benin implemented a policy to provide a performance-based financial motivation to their community health workers, in an attempt to address evidence of low performance of CHWs in the country. According to previous data, there was a lack of satisfaction of the community with the work of the CHW and insufficient acknowledgement of the work of CHWs by the community. This was reflected in the PRISE-C baseline Knowledge, Practices, and Coverage survey which showed that less than 50% of mothers who knew of the CHW in their village actually participated in any of the CHW's activities.

The quality improvement collaborative is an approach which has been shown to be effective in improving performance at the health facility level, but there was limited data on its application at the community level.

The project sought to test whether the addition of a community level quality improvement collaborative to the performance-based financial motivation would result in higher performance and retention as compared to the financial motivation alone. The project also assessed the incremental cost-effectiveness of implementing the collaborative approach and the financial motivation policy.

Intervention

CHS implemented a community-level quality improvement collaborative intervention in 31 villages in the SAO health zone, using structured mutual learning and sharing of experiences to rapidly improve and scale-up quality health services. The team used formative research was used to identify members of the village-level quality improvement teams (QIT). The QITs would assess village performance on certain health indicators, identify and implement appropriate strategies to improve upon low indicators, then come together at quarterly quality improvement collaborative meetings to chart their performance on key indicators and share lessons learned as well as strategies which had an impact and those which did not with the larger collaborative.

In DAGLA, the control zone, the PRISE-C team convened annual meetings with community leaders and members of the community health and development committee to develop an annual health workplan based on priority areas for intervention.

CHWs from both the intervention and control zones received a refresher training on the package of high-impact community interventions. The performance-based financial motivation was provided quarterly to CHWs in both health zones. In addition, all supervisors received supervision refresher training, and routine supervisions were conducted in both zones.

Methods

The research was conducted in the SAO and DAGLA health zones of Benin from December of 2011 until April of 2014. The study used a quasi-experimental study design, with assignment to intervention (SAO) and control (DAGLA) groups made based on a coin toss.

CHW performance data was collected by CHW supervisors, and was measured by a composite score consisting of 12 performance outcomes. Retention data was also reported by CHW supervisors throughout the study period. Qualitative data were also collected with CHWs, their supervisors, and

community members, including CHW beneficiaries. Cost data for both the intervention and control zone were collected by the CHS staff throughout the project period.

Statistical analyses were conducted to determine if there was a statistically different change in performance and retention in the two zones. Incremental cost-effectiveness analysis was conducted to calculate a cost per high-performing CHW, as well as to determine the influence of each of the cost inputs on the cost-effectiveness model.

Findings

Performance

CHWs in the intervention zone had over 11 times the odds of having a high performance score as CHWs in the control zone. The mean CHW performance scores were significantly different over time, with greater differences early in the study, and variable differences later.

Retention

Retention levels in both intervention and control zones were very high, so no statistically significant differences could be identified between them.

Cost-Effectiveness

The incremental cost-effectiveness ratio was 650,000 FCFA per CHW who achieved a high performance score (95% CI 463,000 – 964,000).

Conclusions

The results of this operations research study shed a new light on how to motivate community health workers to remain committed to their work, and to reach and maintain strong performance. This study results demonstrate that in a low-resource setting a community-level quality improvement collaborative combined with financial incentives provided to the health works is a feasible and effective strategy to improve CHW performance as compared to financial incentives alone in a low-resource setting, though further research is needed to ensure that improved performance can be sustained over time.

Recommendations

- Scale up of community-based quality improvement collaboratives could be a key component of future effective community health worker programs.

- Future operations research in this area is recommended to better understand the processes of performance improvement. Including the use of existing community structures as QITs

Use of Evidence

PRISE-C worked closely with the Ministry of Health throughout the operations research, from the development of the concept through the period of implementation. The findings of the OR will be shared with them for consideration, although the national MOH as well as zonal health teams have already shown great interest in replicating the quality improvement collaborative.

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For more information about PRISE-C, visit: www.chs-urc.com

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Study Team

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Introduction

Motivating Community Health Workers (CHWs) to high performance and retaining them in their position have been long-standing challenges for ministries of health. Countries have responded with a variety of strategies and approaches (Bhattacharyya K et al., 2001). Since CHWs can be formal or informal members of the health system, volunteer or paid, and can provide different packages of services depending on the program, finding a standardized response can be a complicated exercise (George et al., 2012). In addition, motivation and retention are themselves the result of a complex combination of psychological, interpersonal, and contextual factors (Colvin, CJ, 2013). Many of the strategies to improve motivation and retention have focused on providing some kind of incentive to CHWS, either financial or non-financial. Financial incentives have been linked with higher rates of retention, although their link with motivation and performance is not clear (Alam et al., 2012; Gray, DHH and Ciroma J, 19897; Wubneh H, 1999). There are other programmatic challenges that arise when providing financial incentives, such as sustainability of the payments and an expectation of increasing the incentive over time. Non-financial incentives address other factors that have an influence on the performance of the CHW. These strategies may focus on improving supervision structures, providing growth and development opportunities, or strengthening the relationship between the CHW and the community. Non-monetary factors motivating individual CHWs, such as community recognition and respect of CHW work, as well as peer support, have been shown to have a large impact on CHW motivation for performance and retention in countries across the globe (Banek et al., 2014; Kaseje et al., 1987; Ludwick et al., 2014; Walt et al., 1989). Community-level factors, such as a structured approach to community engagement in CHW work, can also play a role in motivating individual CHWs (Greenspan et al., 2013; Olayo et al., 2014). It has been postulated that multiple incentives, potentially combining financial and non-financial approaches, would be required to maximally motivate CHWs, and this hypothesis is supported by the systems approach developed by Bhattacharyya and colleagues (2001).

In Benin, community health workers (or *relais communautaires* in French) have been in place for over 20 years and are seen as an essential part of the health system, providing a link between the formal health sector and their communities. Despite this important role, they are not formal members of the health sector. Benin's 2011 Operational Plan for National Scale-up of High Impact Interventions for the Reduction of Maternal, Neonatal and Child Mortality states that one of the main gaps in the health care system concerns CHWs, whose work is an absolute necessity in the implementation of community family health activities. The 2010 National Directives for Community Based Health Promotion for the first time clearly defines community structures involved in the community health delivery system, roles and responsibilities of a CHW, CHW performance indicators, and a policy on motivation of CHWs. This financial incentive includes both a base incentive of 10,000 FCFA[a] per quarter as well as a performance-based incentive up to a maximum of an additional 5,000 FCFA per quarter. The amount of money received out of this 5,000 FCFA is calculated based on performance as measured by a set of performance outcomes. Each outcome

[a] Average exchange rate of 492 FCFA= $ 1. 10,000 FCFA= $20.32.

measure is assigned a monetary value, and once the CHW achieves above 50% on any individual outcome, they receive money. The 50% cut-off for incentives is the same across outcome measures, for all CHWs. CHWs collect data on their activities using Ministry of Health registers, but supervisors conduct quarterly on-site data collection and verification visits for quality control and to ensure that reports are accurate. These financial incentives were operationalized in project zones for the first time through the PRISE-C project.

This incentive policy was an attempt to implement a successful motivation strategy for CHWs, in response to data reflecting low performance of CHWs in the country. According to an assessment done by PISAF, a USAID-funded project implemented by URC-CHS in Benin from 2006-2012, there was a lack of satisfaction of the community with the work of the CHW and insufficient acknowledgement of the work of CHWs by the community (PISAF, 2011). This was reflected in the PRISE-C baseline Knowledge, Practices, and Coverage survey which showed that less than 50% of mothers who knew of the CHW in their village actually participated in any of the CHW's activities.

Financial incentives alone are unlikely to sustain high levels of CHW performance and retention without other non-financial complementary approaches. The quality improvement collaborative approach to quality improvement has been successfully applied at the health center level in Benin under numerous previous projects, and has been demonstrated as an effective means for creating an environment where sustained behavior change can be achieved, specifically with malaria prevention (Catsambas T et al., 2008; Lynn Miller-Franco and Lani Marquez, 2011; Mamadou A and Anato M, 2009; University Research Co., LLC, 2012). We will examine the application of the quality improvement collaborative approach at the community level, in combination with the financial incentives, to motivate CHWs for improved performance and retention. Results will be analyzed in comparison to CHWs performance and retention with financial incentives alone.

The objectives of this research are:

Objective 1: To determine if the addition of a community-level quality improvement collaborative to the Ministry of Health's financial incentive policy results in higher performance than the financial incentives alone.

Objective 2: To determine if the addition of a community-level quality improvement collaborative to

What is an improvement collaborative?

In a collaborative, multiple quality improvement teams work independently to test changes in how services can be delivered, implementing best practices and accepted standards for the collaborative's topic area. Teams use a common set of indicators to measure the quality of the care processes in which the collaborative is trying to improve and, where possible, the desired health outcomes. The collaborative organizes regular sharing of results among teams through learning sessions in which teams learn from each other about which changes have been successful and which were not. This results in a dynamic improvement strategy in which many teams working on related problem areas can learn from each other in a way that facilitates rapid dissemination of successful practices.

the Ministry of Health's financial incentive policy results in better retention of CHWs than the financial incentives alone.

Objective 3: To determine the incremental cost-effectiveness of implementing the collaborative and the Ministry of Health's financial incentive policy.

Methods

Setting

The research was conducted in the SAO and DAGLA health zones of Benin, with SAO receiving the intervention and DAGLA serving as the control. Assignment to the intervention group or the control group was made based on a coin toss at the beginning of the project. The two zones are both principally rural, with similar ethnic and religious population breakdown as well as similar languages. SAO has a total of 14 health centers with 14,832 inhabitants per health center , and DAGLA has 18 health centers with 16,797 inhabitants per health center (2013 Population Estimates, Ministere de la Sante, Benin).

Study Design and Methods

The study used a quasi-experimental study design, with an intervention and a control group.

Eighty-seven (87) trained community health workers were recruited to participate in the study; 48 in DAGLA, and 39 in SAO. This accounts for approximately one-third of all CHWs in the zones. CHWs were chosen based on prior training. In both zones, CHWs previously trained as comprehensive CHWs through the prior PISAF project or as malaria CHWs through Africare's malaria program were selected. All CHWs consented to participate at the initiation of the study or when they were recruited as a CHW during the study period. Additional respondents who participated in qualitative data collection also completed informed consent forms. Approval was obtained from University Research Company IRB and from the Comité d'Ethique at the Benin Ministry of Health.

The study took place over 28 months, from December of 2011 until April of 2014.

Intervention

This operations research was embedded within overall project activities in two of the three project intervention zones. The quality improvement collaborative intervention uses structured mutual learning and sharing of experiences to rapidly improve and scale-up quality health services. Formative research was used to identify appropriate members of the communities' quality improvement teams (QIT). Each village had an 8-10 member QIT. These QITs received a 5-day training on quality improvement methodology from the PRISE-C staff. Teams were to conduct team meetings at a minimum once a month to review indicators and identify strategies to improve upon low indicators. The team would then implement these strategies in their community. At 1-2 day quarterly quality improvement collaborative meetings, the different quality improvement teams would come together and review the data from the past 3 months. Teams would chart

their performance on key indicators and share lessons learned with the larger collaborative, strategies which had an impact and those which did not. Graphs of the team's performance would be posted at the health center to encourage transparency and accountability to the community. Two members of the QIT and the CHW attended these meetings, and they received a per diem. Quarterly coaching visits were conducted with CHWs and QITs by certain supervisors and CHWs who were chosen based on their good results and ability to mentor others. These coaching visits were stopped for financial reasons after March of 2013.

In the control zone, the PRISE-C team convened annual meetings with community leaders and members of the community health and development committee to develop an annual health workplan based on priority areas for intervention.

Both the intervention and control zones received support from the project to provide a 5 day refresher training on the package of high-impact community interventions, as well as to provide routine supervision to CHWs. CHW supervisors, typically a MOH nurse or health staff from the nearest health center, received a 3 day supervision refresher training at the project outset. Routine supervisions were conducted in both zones. This consisted of monthly grouped supervisions[b] and quarterly on-site supervisions. The monthly grouped supervisions were stopped for financial reasons after March of 2013, while the quarterly on-site supervisions continued through the life of the study. The team also developed guidelines for implementation of the performance-based financial incentives, which were implemented in both zones starting in 2011 and managed by the mayor's offices. Table 1 lists the program inputs by intervention and control zones.

Table 1: Differences between intervention and control zones

Program Inputs	Intervention	Control
- Training on IMCI-C	Yes	Yes
- Supervision refresher for head of health center team	Yes	Yes
- Supervision refresher for head of commune focal person	Yes	Yes
- Monthly supervision meetings at health facilities[c]	Yes	Yes
- Quarterly on-site supervisions	Yes	Yes
- PRISE-C zonal staff member providing support	Yes	Yes
- Performance-based incentives	Yes	Yes
- Annual meetings to develop community health action plan	No	Yes
- Community level collaborative	Yes	No
- Monthly QIT meetings	Yes	No
- QI methodology training	Yes	No
- Coaching Visits[d]	Yes	No

[b] Grouped supervisions were meetings of all the CHWs who reported to one supervisor. The CHWs would meet at the supervisor's health center, where the supervisor would review the registers of each CHW and address any common issues they were having.
[c] Stopped after March 2013 due to financial reasons
[d] Stopped after March 2013 due to financial reasons

- Learning Sessions[e]	Yes	No

PRISE-C staff participated in monitoring the intervention and reported on the implementation and outcome of all activities through the project period.

Data on CHWs' performance were collected, monitored, and validated during routine on-site supervisory visits by CHW supervisors. During these on-site supervisions, there were four data validation activities:

1. Supervisor would directly observe the CHW with a case
2. Supervisor would review all data collection forms and inquire about any suspicious entries
3. Supervisor would validate a recent case with a visit to the home of the sick child and interview with the child's mother
4. Supervisor would validate one of the home visits with a visit to the home

These measures allowed the supervisor to ensure that the data collected were valid and to limit fraud and inflation of indicators.

Outcome Variables

Outcome
1. % of mothers of children 0-23 months in the catchment area can name two danger signs
2. % of children estimated to have malnutrition monitored for acute malnutrition
3. % of children from 0-59 months who live in a household with a handwashing station at/near the latrine
4. % of children ages 0-59 months who live in a household who drink water from a pump or who treat their drinking water with Aquatabs
5. % of children ages 0-59 months in the catchment area who sleep under LLIN
6. % of infants less than 1 year old who were vaccinated during outreach activities
7. % of health education talks held

[e] Quarterly learning sessions conducted until December 2012, then activities were integrated into zonal indicator review sessions

8.	**% of children under 5 who had a home visit from a CHW in the quarter**
9.	**% of children 6-59 months correctly treated for malaria**
10.	**% of children 2-59 months correctly treated for diarrhea**
11.	**% of children 2-59 months correctly treated for ARI**
12.	**% of referrals for malaria, diarrhea, ARI, and malnutrition in children 2-59 months which were justified**

Table 2: CHW performance outcomes

The dependent variables were:

- **CHW performance**, as measured by a composite score consisting of 12 performance outcomes related to CHW health promotion and case management activities. The 12 performance outcomes, taken directly from the 2010 National Directives for Community Based Health Promotion, are the outcomes upon which the CHW is assessed in order to determine his/her performance-based financial incentive. The CHW performance score was calculated by first assessing whether or not CHWs had achieved the target for the specific performance outcome in that quarter. Targets for each performance outcome were set at the beginning of the project based on baseline levels and planned project effort in each area. These targets were the same for all CHWs and were not modified throughout the project period. CHW performance on each indicator was coded "1" if the target was achieved in the quarter, and "0" if the target was not achieved. The composite performance ratio scale was then created by allocating weight to each of the 12 performance outcomes as were assigned to calculate the value of the performance-based incentive. The home visit, vaccination, referral, potable water, and home visit outcomes were weighted heaviest, with the other outcomes having weights of less than half of those. (See **Error! Reference source not found.** for complete list of the 12 performance outcomes)

- **Number of CHW who permanently left their post during the study period**. This drop-out was reported by CHW supervisors throughout the study period and was defined as "CHWs who declare or who are confirmed to no longer be working".

Quantitative and qualitative methods were used to assess the effectiveness of the community-level collaborative on CHW performance and retention. Quantitative data were collected through the routine quarterly collection of the CHW performance outcomes mandated by the MOH. Community Health Workers routinely entered data into 6 different Ministry of Health data collection forms (Child Case Management, Home Visits, Pregnant Women, Recently delivered women, Newborns, and Medicine Stock) based on the kind of activity they performed. Each quarter, the CHW supervisor would collect the data from these forms and send this report to the PRISE-C team for data entry and analysis. The health zone would then review the data received from PRISE-C. For performance outcomes which have a population level denominator (eg, number of children from 0-59 months), the zonal statisticians provided an appropriate denominator on an annual basis.

Qualitative data were collected through four rounds (July 2012, March 2013, Jan 2014, and July 2014), of focus groups and in-depth interviews with CHWs, their supervisors, and community members, including CHW beneficiaries. For each round of data collection, villages were classed as high, medium, or low performing according to a MOH recognized "tracer" indicator: the "percentage of children ages 0-59 months in the catchment area who sleep under LLIN." Within each classification a random sample of 3 villages was selected. In each village, in-depth interviews were conducted with the CHW and his/her

supervisor as well as 2 members of the quality improvement team (in the intervention zone) and 2 members of the village health and development committee (in the control zone). In each village, a focus group was also held with 4 mothers of children under the age of 5.

Data were also collected on the costs of implementing the intervention, the community collaborative in addition to the financial incentive program, as well as the costs of implementing the financial incentive program alone in the control group, in order to calculate the cost-effectiveness of the improvement intervention when used in combination with the performance-based incentive program for CHWs compared to using only the performance-based incentive without additional intervention (**Error! Reference source not found.**). Costs and effects were considered from the point of view of the program funder; therefore, the effects on the patients and others in the health care system and society in general were not included in the calculations.

The program outcome used was the difference in the proportion of CHWs achieving a high performance score (defined as above 50% of the performance score) at end line compared to the proportion achieving a high score at baseline. We used statistical analysis to estimate the effect of higher performance scores attributable to the intervention. Cost data were collected from the project's accounting records and divided by the number of CHWs involved in the incentive program alone or the incentive program with the improvement intervention. We used sensitivity analysis to determine how much influence each of the cost inputs had on the cost-effectiveness model.

Results

Intervention Monitoring

In order to develop the intervention, formative research was conducted in the research area to determine the demographic characteristics of both the CHWs and the beneficiary populations in the intervention and control zones. Key community stakeholders were interviewed to develop quality improvement teams whose composition was contextually appropriate.

In December 2011, the 31 villages in the intervention zone were divided into 4 collaboratives, and each collaborative received a training in quality improvement. Thirty-four (34) of the 40 CHWs in the intervention zone received the quality improvement training, along with approximately 2 community representatives from each village. In January 2012, the project team traveled to each village to establish the village Quality Improvement Teams, which would participate in the collaborative. One village had 2 QITS. Each QIT was composed of:

- Community Health Worker
- Village Chief
- Secretary and Treasurer of the Village Health Committee
- Representative of the women
- Representative of the youth
- Representative from each village hamlet

- Representative from each ethnic group
- Representative from each religious group

PRISE-C monitored QITs from January 2012 until April 2014. Over the period, 75% of QITs held monthly meetings with the CHW to review community health data, prioritize community health issues, and identify strategies to address them.

Supervisors in the intervention zone received a 2 day coaching training in July of 2012, and worked with the QIT at least once a month to present the performance outcome data back to the QIT.

Baseline

At baseline, there were no significant differences in number of trainings received, number of children covered by each CHW, or number of households covered by each CHW between the two zones (Table 3). Age was found to be significantly different, with the control zone having a slightly higher mean age than the intervention zone (44 vs 37, $p<.05$).

Table 3: CHW background information

	DAGLA		SAO		
	Total N=48		Total N=39		
	N	Mean	N	Mean	p
Age	44	37	37	33	***0.0283***
Number of trainings received	44	3	37	3	*0.1321*
Number of children covered by each CHW	44	111	31	100	*0.5489*
Number of households covered by each CHW	44	74	31	83	*0.5771*

Gender, occupation, and years of service as a CHW were all additionally found to be statistically different at baseline. The control zone had more male CHWs and more farmer CHWs than the intervention zone. The CHWs in the control zone also had been serving as CHWs for a longer period of time (Table 4).

Table 4: CHW socio-demographic information

	DAGLA (Control)	SAO (Intervention)

	Total N	N	%	Total N	N	%	x2	p
Gender	48			39			7.8219	***0.005***
Male		34	70.83%		16	41.03%		
Female		14	29.17%		23	58.97%		
Occupation	48			38			10.5959	***0.014***
Farmer		34	70.83%		18	47.37%		
Health Aide		1	2.08%		0	0%		
Small Business		5	10.42%		15	39.47%		
Housewife		8	16.67%		5	13.16%		
Education Level	47			38			1.5221	*0.467*
Literate		2	4.26%		1	2.63%		
No schooling		4	8.51%		1	2.63%		
Attended School		41	87.23%		36	94.74%		
Marital Status	47			37			3.6614	*0.16*
Single		3	6.40%		0			
Divorced		0			1	2.70%		
Married		44	93.60%		36	97.30%		
Income Level	44			37			0.6602	*0.883*
<10,000 cfa		9	20.45%		7	18.92%		
10,000-29,000 cfa		13	29.55%		14	37.84%		
30,000-50,000 cfa		17	38.64%		12	32.43%		
>50,000 cfa		5	11.36%		4	10.81%		
Years as a CHW	43			37			8.5586	***0.014***
< 1 year		8	18.60%		16	43.24%		
1-3 years		20	46.51%		7	62.16%		
>3 years		15	34.88%		14	37.84%		

Performance

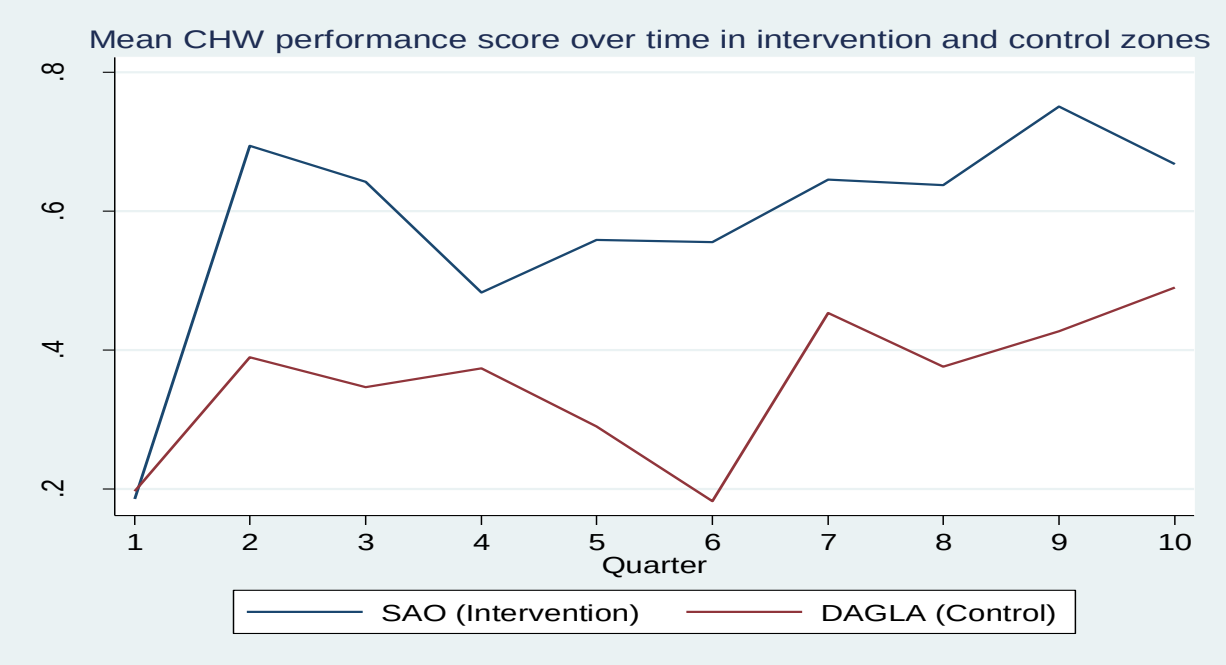
The mean CHW performance scores in the 2 zones were compared using a t-test, and no statistical difference was found at baseline (*p=0.7723*). Mean CHW performance scores were statistically different at endline (*p=0.0003*) (Table 5). Trends over time in mean CHW performance score are shown in Figure 1.

Table 5: Mean CHW Performance Score

	Baseline		**Endline**	
	Mean CHW performance score	Range	Mean CHW performance score	Range
Dagla (Control)	n=48		n=42	
	0.197	.0014-.8874	0.490	.1094-.8874
Sao (Intervention)	n=39		n=39	
	0.186	.0014-.5734	0.668	.1634-.9634

Since we were looking to see if there was a difference in the mean CHW performance over time between the two groups, a repeated-measures analysis of variance (ANOVA) was used to examine the effects of the intervention, time, and the interaction between them. Results showed a significant effect of the interaction between the intervention and time on CHW performance score ($F_{9, 86}=8.23$, $p < .01$). There was also a significant effect of time ($F_{9, 86}=34.59$, $p < .01$), but the effect of the intervention alone, not taking time into account, was not significant ($F_{1, 86}=0.39$, $p = 0.535$).

Figure 1: Mean CHW performance score over time



Based on the results showing a significant effect of the interaction of time and the intervention, we conducted post-hoc logistic regression to further explore the data (Table 7). We converted the CHW performance score data to a dichotomous "high score/low score" based on a cut-off of 50%. Fifty percent (50%) is the threshold at which the Ministry of Health has directed that CHWs begin receiving a financial incentive for any individual performance outcome, and therefore we applied this same threshold here to be able to have a dichotomous outcome "high score/low score". The number of high performing CHWs in each quarter is presented in Table 6. In order to assess the relationship between this outcome variable and a number of independent variables, we used one multivariable logistic regression model to estimate odds ratios and 95% confidence intervals. This generalized estimating equations (GEE) model is preferable for this type of data as it accounts for correlations between the CHWs in each zone. The model treated baseline performance level as well as time post-baseline as covariates. A variable for intervention zone was included in the model.

Since CHWs were not randomized to the intervention zone, it was important to account for potential confounders in the model. Data were collected on a number of other aspects that might confound the outcome if the two groups varied on these aspects by zone. These included age, sex, marital status, education, number of trainings attended (training related to CHW position), number of other CHWs in a catchment area, number of children under the age of 5 in a catchment area, number of households in a catchment area, occupation, salary level, duration of service, or CHW supported by other projects. Chi square and t-tests were used to determine if statistical differences existed on these variables between the two zones at baseline. Statistically significant variables included: age, sex, number of households in a CHWs catchment area, duration of service, and occupation. These were then included in the model. Additional variables considered by the project team to strongly affect performance were also included in the model. These variables were number of trainings attended, education, and the existence of other CHWs in a CHW's catchment area.

Table 6: Number of high performing CHWs

Number of high performing CHWs				
Quarter	***SAO***	*N*	***DAGLA***	*N*
1	2	39	4	48
2	33	39	18	48
3	30	38	11	44
4	22	39	15	48
5	25	39	4	48
6	21	37	2	38
7	30	39	21	48
8	28	39	14	48
9	35	39	23	48
10	31	39	22	42

Table 7 : The adjusted effect of intervention/control group and baseline CHW performance on endline CHW performance

Variable	Adjusted Odds Ratio	95% CI	p-value
Intervention zone REF: DAGLA (Control Zone)	11.56	6.21-21.52	**0.00**
Baseline high performance score (Yes/No) REF: No high score at baseline	6.33	2.41-16.62	**0.00**
Time (Quarter)	1.09	1.02-1.17	**0.01**
Age[f]	1.05	1.01-1.10	**0.007**
Number of trainings received[g]	0.92	0.78-1.10	0.364
Number of other CHWs in the village	1.19	0.79-1.77	0.405
Education level[h] REF: No schooling	3.35	0.75-14.96	0.113
Sex REF: Female	1.04	0.46-2.35	0.918
Number of households in the catchment area	1.00	.99-1.00	0.535
Years of service as a CHW	1.22	0.87-1.71	0.247
Occupation[i] REF: Farmer	1.17	0.83-1.64	0.369

We also conducted analyses for each of the performance outcomes in the overall performance indicator. We used t-test analysis to determine if there was a statistically significant difference between the means of each indicator at baseline (quarter 1) and endline (Quarter 10) (Table 8). Statistically significant differences in the means at each quarter are bold.

[f] Age in years at initiation of study
[g] Number of trainings related to the CHW's work that he/she ever has participated in
[h] No schooling(REF)/Literate/Attended school
[i] Farmer/Health Aide/Small Business Person/Housewife

Table 8: Mean Performance Outcomes at Quarter 1 and 10

Performance Outcome	Zone	Mean at Quarter 1	Mean at Quarter 10
% of mothers of children 0-23 months in the catchment area can name two danger signs	SAO	63%	97%
	DAGLA	62%	93%
% of children estimated to have malnutrition monitored for acute malnutrition	SAO	0%	5%
	DAGLA	0%	0%
% of children from 0-59 months who live in a household with a handwashing station at/near the latrine	SAO	0%	3%
	DAGLA	.3%	3%
% of children ages 0-59 months who live in a household who drink water from a pump or who treat their drinking water with Aquatabs	SAO	27%	**55%**
	DAGLA	20%	**18%**
% of children ages 0-59 months in the catchment area who sleep under LLIN	SAO	31%	**56%**
	DAGLA	22%	**26%**
% of infants less than 1 year old who were vaccinated during outreach activities	SAO	34%	**92%**
	DAGLA	41%	**26%**
% of health education talks held	SAO	**41%**	**87%**
	DAGLA	**63%**	**46%**
% of children under 5 who had a home visit from a CHW in the quarter	SAO	19%	**55%**
	DAGLA	21%	**22%**
% of children 6-59 months correctly treated for malaria	SAO	75%	**98%**
	DAGLA	70%	**83%**
% of children 2-59 months correctly treated for diarrhea	SAO	31%	69%
	DAGLA	19%	52%
% of children 2-59 months correctly treated for ARI	SAO	30%	**68%**
	DAGLA	31%	**39%**
% of referrals for malaria, diarrhea, ARI, and malnutrition in children 2-59 months which were justified	SAO	15%	**34%**
	DAGLA	8%	**3%**

We also looked at the effect of the intervention on the performance outcomes over time by using a repeated measures ANOVA (Table 9).

Table 9: Repeated Measures ANOVA for the performance outcomes

Performance Outcome	Variables	F-statistic	p-value
% of mothers of children 0-23 months in the catchment area can name two danger signs	Intervention	$F_{(1, 86)}$=0.57	0.45
	Time	$F_{(9, 86)}$=13.35	**0.00**
	Time*Intervention	$F_{(9, 86)}$=3.10	**0.00**
% of children estimated to have malnutrition monitored for acute malnutrition	Intervention	$F_{(1, 86)}$=0.00	1.00
	Time	$F_{(9, 86)}$=6.26	**0.00**
	Time*Intervention	$F_{(9, 86)}$=7.16	**0.00**
% of children from 0-59 months who live in a household with a handwashing station at/near the latrine	Intervention	$F_{(1, 86)}$=0.00	1.00
	Time	$F_{(9, 86)}$=7.01	**0.00**
	Time*Intervention	$F_{(9, 86)}$=7.00	**0.00**
% of children ages 0-59 months who live in a household who drink water from a pump or who treat their drinking water with Aquatabs	Intervention	$F_{(1, 86)}$=0.51	0.48
	Time	$F_{(9, 86)}$=12.25	**0.00**
	Time*Intervention	$F_{(9, 86)}$=2.59	**0.01**
% of children ages 0-59 months in the catchment area who sleep under LLIN	Intervention	$F_{(1, 86)}$=0.42	0.52
	Time	$F_{(9, 86)}$=13.43	0.00
	Time*Intervention	$F_{(9, 86)}$=1.42	0.18
% of infants less than 1 year old who were vaccinated during outreach activities	Intervention	$F_{(1, 86)}$=0.91	0.34
	Time	$F_{(9, 86)}$=4.58	**0.00**
	Time*Intervention	$F_{(9, 86)}$=4.77	**0.00**
% of health education talks held	Intervention	$F_{(1, 86)}$=3.50	0.06
	Time	$F_{(9, 86)}$=6.51	**0.00**
	Time*Intervention	$F_{(9, 86)}$=9.46	**0.00**
% of children under 5 who had a home visit from a CHW in the quarter	Intervention	$F_{(1, 86)}$=0.26	0.61
	Time	$F_{(9, 86)}$=29.25	**0.00**
	Time*Intervention	$F_{(9, 86)}$=4.56	**0.00**
% of children 6-59 months correctly treated for malaria	Intervention	$F_{(1, 86)}$=3.47	0.07
	Time	$F_{(9, 86)}$=7.13	**0.00**
	Time*Intervention	$F_{(9, 86)}$=2.95	**0.00**
% of children 2-59 months correctly treated for diarrhea	Intervention	$F_{(1, 86)}$=0.02	0.88
	Time	$F_{(9, 86)}$=12.20	0.00
	Time*Intervention	$F_{(9, 86)}$=1.22	0.28
% of children 2-59 months correctly treated for ARI	Intervention	$F_{(1, 86)}$=0.09	0.76
	Time	$F_{(9, 86)}$=16.38	**0.00**
	Time*Intervention	$F_{(9, 86)}$=2.72	**0.00**
% of referrals for malaria, diarrhea, ARI, and malnutrition in children 2-59 months which were justified	Intervention	$F_{(1, 86)}$=0.00	1.00
	Time	$F_{(9, 86)}$=7.49	**0.00**
	Time*Intervention	$F_{(9, 86)}$=4.35	**0.00**

The qualitative data reveal how the CHWs, supervisors, and beneficiaries feel about the different approaches to CHW motivation; the different ways that the approaches served to engage the community with the CHW; and how the approaches impacted the performance of the CHWs.

One CHW in a high performing village in SAO (intervention zone) said:

> *"In the process of our work, we conduct evaluations (learning sessions). During the first evaluation (learning session), I was ranked x[j] out of 9 CHWs. I wasn't ready for that. Because of this, I reapplied myself to my work to be able to be first or to keep my place in the rankings."*

A CHW from a high performing village in SAO (intervention zone) said:

> *"After each training, I come back and brief the QIT, and they help me to spread the message among the population as well as do the work. The QIT members help a lot so that during the next learning sessions we can remain on top. We can't allow our activities to slip; we have to continue to do better."*

Two beneficiaries, mothers of children under the age of 5, in a focus group in a high performing village in SAO said:

> *"The members of the QIT also play their role…They come with me to conduct health education sessions. If there are certain members of the community who don't want to adopt healthy behaviors, they lead the way to help convince them."*

And:

> *"When it was only her telling us, we ignored her; sometimes we would send her away. But now that she works with the community members, we understand that [what she is telling us] is for our own good."*

A CHW from a high performing village in DAGLA (control zone) said:

> *"(What motivates me?)…The first thing is training; the second is the financial incentives; and the third is the support of the CVS (Village Health Committee), which manages everything."*

A supervisor from DAGLA (Control zone) observed:

[j] Rank not indicated to anonymize the data.

"There is a change in the CHWs, which has to do with the incentives they now receive. In addition, there is supervision during which we tell them that we're assessing the best performers and that their incentive will be increased [if they perform]. Then they do their work better."

A CHW from a low performing village in DAGLA (control zone) said:

"The fact that I am referred to as a health worker even though I am not, I am honored. When they bring me a sick or malnourished child, I can care for them; that makes me happy, I have never been so honored."

Qualitative data on performance were also collected at regular intervals throughout the study period.
Table 10 presents the themes that emerged in interviews on determinants of CHW performance, as cited by the CHWs over the period of the research.

Table 10: Determinants of CHW performance (Key themes)

	DAGLA (Control Zone)		SAO (Intervention Zone)	
	Early in project	Late in the project	Early in the project	Late in the project
High Performing CHWs	• Financial motivation • Community support • Self-respect	• Supervision • Support of the village health committee • Financial motivation • Improved health of the community	• Recognition by the community • Sense of competition between CHWs • Financial motivation* • Training/Learning sessions • Community support	• Supervision • Community engagement • Improved health of the community • Increased competency (of CHW)
Low Performing CHWs	• Lack of community support • Problems with transport for the CHW	• Medicine stock-outs • Low financial motivation • Lack of community support • CHW motivation	• Lack of community support • Difficult accessibility of populations	• Medicine stock-outs • Difficult accessibility of populations • Sense of defeatism from QITs

*Financial motivation was mentioned by supervisors as a determinant of CHW performance in SAO early in the project but not by CHWs themselves.

Retention

During the study period, 5 of the 87 CHWs left their post (Table 11), with no statistically significant difference between the zones (*p=0.3741*).

Table 11: CHW attrition

	DAGLA (Control Zone)	SAO (Intervention Zone)
CHWs leaving their post	4	1
CHWs retained	44	38

The qualitative data revealed that the majority (4/5) of CHWs left their post because they no longer lived in the village of service. This was due to marriage, starting a job in another city, and other unspecified reasons. The remaining CHW left his post because of a health problem with his eyes, which left him unable to read and complete the registers. Four CHWs were able to be located to be asked further follow-up questions about their decision to leave. All responded that the financial incentives were not bad but were insufficient. Two out of the four (1/2) stated that their community encouraged them while they were in their role as CHW, while the other two (1/2) stated that their community did not encourage them.

Cost-Effectiveness

The baseline proportion of CHWs who had a high performance score was 0.069. The increase in the proportion attributable to the improvement intervention when combined with the incentive program was 0.92 compared to the effect of incentives alone. The cost of training and providing performance-based incentives to the 48 CHWs in the control group was 5.3 million FCFA or 110,000 FCFA per CHW. The cost of the training, performance-based incentive package, and improvement intervention combined was 13 million FCFA for the 39 CHWs or 340,000 FCFA per CHW participant (Table 12). Incremental cost-effectiveness analysis allows us to determine the marginal or incremental cost for an additional unit of health benefit when looking at two different interventions. The incremental cost-effectiveness ratio (ICER) in this case tells us the cost per CHW achieving a high performance score. The ICER result was 650,000 FCFA per CHW who achieved a high performance score (95% CI 463,000 – 964,000).

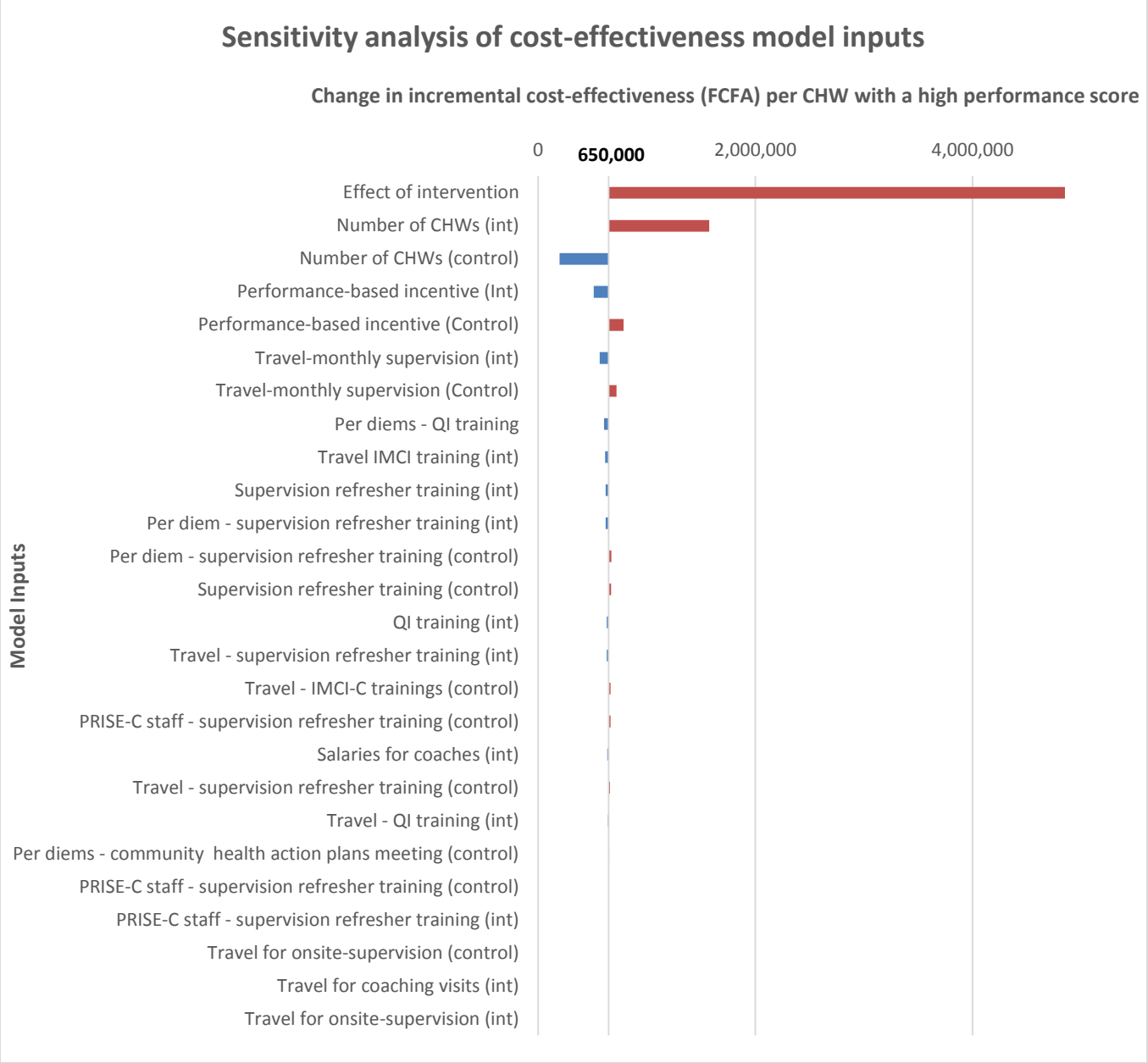
Table 12: Observed costs in the intervention and control regions

	Cost Item	Costs (X 1,000 FCFA)	Costs (USD)
DAGLA (Dassa-Glazoue) Control Zone	Travel - community health action plan meeting	84	$ 178
	Per diems - community health action plan meeting	242	$ 512
	Travel - IMCI-C trainings	288	$ 609
	Travel & material - supervision refresher training	168	$ 355
	Per diem - supervision refresher training	408	$ 863
	Meals etc - supervision refresher training	349	$ 738
	PRISE-C staff - supervision refresher training	264	$ 558
	Travel / per diem - monthly supervision meetings	1176	$ 2,487
	Travel - onsite-supervision	18	$ 38
	PRISE-C staff providing support	32	$ 68
	Performance-based incentives	2240	$ 4,737

Total Costs DAGLA		5269	$	11,142
SAO (Save-Ouesse) **Intervention Zone**	Travel - IMCI-C trainings	432	$	914
	Per diem - supervision refresher training	384	$	812
	Travel & material - supervision refresher training	239	$	505
	Meals etc - supervision refresher training	392	$	829
	PRISE-C staff - supervision refresher training	264	$	558
	Travel / per diem - monthly supervision meetings	1103	$	2,332
	Travel - onsite-supervision	25	$	53
	PRISE-C staff providing support to on-site supervisions	32	$	68
	Performance-based incentives	1822	$	3,853
	Travel for QI training	114	$	241
	Per diems for QI training	591	$	1,250
	Meals and other costs for the QI training	260	$	550
	Travel for coaching visits	34	$	72
	Salaries for coaches	178	$	376
	PRISE-C staff providing support to on-site coaching visits	63	$	133
	Travel for learning sessions	1121	$	2,370
	Per diems for learning sessions	2607	$	5,513
	Meals and other costs for learning sessions	2126	$	4,496
	PRISE-C staff providing support to learning sessions	1468	$	3,104
	Communication costs for learning sessions	20	$	42
Total Costs SAO		13273	$	28,067

The tornado diagram in Figure 2 shows the relative effect of each variable on the incremental cost-effectiveness ratio as the specified input decreases from the value in the model down to 0. The variable with the greatest influence on cost-effectiveness is the effect of the intervention: as the effect of the intervention diminishes to 0, the incremental cost-effectiveness ratio increases significantly from the baseline of 650,000 FCFA per CHW who achieved a high performance score to nearly 5,000,000 FCFA per CHW who achieved a high performance score, holding all other variables constant. The number of CHWs trained in both the intervention and control groups has the next most significant effect on the overall result. All of the cost variables considered individually have a relatively insignificant effect on the overall result, with performance-based incentives cost being the most influential.

Figure 2: Sensitivity analysis of cost-effectiveness model inputs



Discussion

Performance

The study demonstrates that it is possible to improve CHW performance through application of a community-level quality improvement collaborative approach. The data demonstrate that the mean CHW performance score differed significantly over time between the intervention and control group, and that this

pattern held for 10 of the 12[k] performance outcomes included in the overall performance score. Based on observing the trend lines for mean CHW performance over time in the two zones (Figure 1) we can see a large difference initially which then varies over time, diminishing in certain quarters. This variability in the difference between performance in the two zones is likely the reason behind the significance of the intervention over time, but the lack of significance of the intervention alone in the Repeated Measures ANOVA analysis.

CHWs who received the community-level quality improvement collaborative intervention have over 11 times the odds of achieving a performance score above 50% as compared to CHWs who received financial incentives alone. These results are likely due to certain activities of the intervention that drove an appropriation of the indicators and by extension, the work of the CHWs, by the community itself. The creation of the quality improvement team created a new kind of engagement for community. As opposed to simply discussing community health activities once a year as a part of the annual work planning, as is generally the case with the Village Health Committees (CVSs), the QIT is engaged in monthly meetings with the CHW to analyze their indicators with the CHW and together make decisions on how to improve on those indicators. In addition, QIT members expressed a feeling of responsibility for the health status of the community, and provided instrumental support to the CHW to do his or her work. This instrumental support was guided by discussions during coaching visits by supervisors, which allowed for facilitated identification of problems and development of improvements which the QIT and CHW could undertake. The quarterly learning sessions were a venue for CHWs and QITs to share experiences, and accelerated up-take of improvements which worked. The learning sessions also created a sense of healthy competition between the communities towards improvement on the indicators.

The two performance outcomes which did not show significant differences at endline were for proportion of children under 5 sleeping under a long-lasting insecticide treated bednets and proportion of children correctly treated for diarrhea. During data collection in both zones, it was observed that many mosquito nets being used were damaged, which excluded them from being counted in the numerator. Unfortunately, there was no distribution campaigns for nets after the initiation of the research, and health centers did not have any in stock. The low performance on correct treatment for diarrhea may also be attributed to challenges in the stock of ORS across the zones. These issues would have limited the number of CHWs in either zone who could achieve a "high score" in each outcome.

Plateaus or drops in performance were observed over certain time periods, as mentioned above, typically in both SAO and DAGLA. In quarters 2 through 4 of the study period, there were challenges in facilitating the payments for some of the CHWs which caused delays in their payments and may have demotivated them. Additionally this period coincides with critical harvest and planting seasons for staple crops (cashew nuts and ignames) in Benin, and this may have resulted in CHWs not being able to carry out their

[k] Means for % of children sleeping under a LLIN and % of children correctly treated for diarrhea were not significantly different over time.

responsibilities. During this period there were also a number of supervisors who were not available to conduct their monthly supervision visits, and so these visits did not occur with the required frequency during this time.

The dramatic decline in mean performance in DAGLA during quarter 4 through 6 of the study period need to be further explored. The drop-off in performance in both SAO and DAGLA from quarter 9 of the study period is likely due to the circulation of the news of the end of the project. Many CHWs and supervisors communicated that this was demotivating to them, since they did not know if the support they received, through supervision visits, QIT encouragement, and financial incentives would be sustained after the end of the project.

Qualitative data bear this out, as the sense of competition and community recognition were determinants of CHW performance at the start of the intervention. Over the life of the intervention, though, these determinants were replaced with community engagement and improved competency of the CHW. Interestingly, supervision emerged as a determinant for both the intervention and control zone. This is likely due to the overall project focus on strengthening the CHW supervisory system.

Our overall findings are in line with past evaluations in Benin, which have demonstrated that the collaborative approach can show results in CHW performance indicators (Freeman P et al., 2012), as well as findings that have shown the success of the collaborative approach to improve health worker performance in health centers and hospitals in developing country settings, including Benin (Catsambas T et al., 2008; Lynn Miller-Franco and Lani Marquez, 2011). This accomplishment is likely due to the way in which the collaborative approach fosters the engagement of both the community health worker and the community itself in the process of improvement and helps both sides understand how processes work and how to make changes at the community level that have the potential to improve the community's health (Catsambas T et al., 2008). Furthermore, the sharing of changes and results motivates communities to work hard and produce good results in a sustained manner.

It is important to note, however, that CHWs who started out with a high score at baseline have 6.33 times the odds of having a high score at endline. This indicates that independent of the intervention, there is a pattern in CHW performance that high performing CHWs at the beginning of this intervention are likely to sustain that high performance throughout the intervention. There was no significant difference in the proportion of CHWs with a high performance score at baseline between the intervention and control zone.

Retention

The study results do not demonstrate that the intervention is associated with higher rates of CHW retention. Attrition rates for CHWs from 3.4% to 77% have been reported in the literature, with higher rates generally associated with volunteer CHWs (Bhattacharyya K et al., 2001). Previous findings from other areas of Benin report a 7% CHW annual attrition rate (Freeman P et al., 2012), although it is unclear how this number was calculated. Our findings reflect even lower annual attrition rates (1%-3%) in the study zones

over the study period. With these low attrition rates, it would be difficult for an intervention to demonstrate significant change in CHW retention.

The qualitative data show that the primary reason for the limited attrition in CHWs in the study zones is relocation because of a new/different job which would provide a more consistent salary. Since the reason behind the majority of the attrition was financial, it is logical that the intervention would not have a significant impact on attrition. If alternatively, the reason for most of the attrition was poor motivation or lack of community support, in that case, we would expect to see differences in the levels of attrition between the intervention and control zones.

The fact that economics were the main driver for CHW attrition in this study reinforces the idea that one of the challenges of the CHW role as it currently exists is that it is not a formal salaried position. The limited financial incentive provided under the performance based incentives is primarily a recognition of time and effort expended and is not sufficient to allow the worker to be able to support themselves. It is important to differentiate these financial reasons for attrition which were seen in this study, from reasons which have more to do with lack of interest in the content.

These data also demonstrate that the CHW is seen to be the holder of certain knowledge in the community, and that this affords him or her a certain status in the community, which can motivate them to perform well as shown in some of the qualitative data, and also keep the CHW in their position for a longer period of time. This can have positive or negative impacts, depending on the level of performance of the CHW over time. For example, if a CHW gained a high status in the community and then stated performing poorly, their high status could make it difficult to replace them, unless the poor performance then resulted in a diminished status in the community.

Cost-Effectiveness

Even though CHW programs are expected to improve the cost-effectiveness of health care systems by reaching large numbers of previously underserved people with high-impact services at low cost, there is a dearth of cost-effectiveness data on community health worker programs (Berman et al., 1987; Lehmann U and Sanders D, 2007). This study found that the cost per additional CHW achieving a high performance score is 650,000 or $1 290 USD, which is slightly less than two times the Gross Domestic Product per capita of Benin (World Bank). The World Health Organization's guidance states that for a health intervention to be considered "highly cost-effective," the cost-effectiveness must be less than the gross domestic product per capita for each disability adjusted life year saved. This would mean that for the program to be considered highly cost-effective, each CHW achieving a high performance score would need to avert 1.7 DALYs more than a CHW achieving lower than the high score.

The Ministry of Health recently trained 100 additional CHWs in the intervention zone. These CHWs did not participate in the intervention during the study period, but if these 100 additional CHWs were included in a future improvement intervention, the cost-effectiveness would improve to approximately 30,800 FCFA

per CHW who achieved a high performance score (95% confidence interval: 23,000 – 39,000). The large difference between this scenario and the one observed is because one of the main determinants of the result is the number of CHWs participating at a given cost. The overall cost of the intervention is dependent on a number of fixed costs which do not increase based on the number of participants, therefore increasing the number of CHW participants from 39 to 139 for the same cost made for a dramatically more efficient improvement intervention.

If 100 additional CHWs participate in the improvement intervention at no additional expense, the high-scoring CHW would then only need to avert 0.07 DALYS, because the ICER drops to 30,000 CFA or $61 per additional CHW achieving a high score. With the current data available, we cannot estimate the value in DALYs for improved CHW performance. Therefore we rely heavily on the validity of the performance score in measuring their effectiveness at improving health outcomes among those under their care. A more extensive, long term study is required to firmly establish the link between participation in the improvement intervention with the incentive program and health outcomes among those served by the CHWs. Without this additional information, we can only state that, with higher levels of CHW participation, cost of the intervention per high performing CHW would decrease, which would increase the likelihood that the improvement intervention may be acceptable to the Ministry of Health. Further assessment would be needed to establish the number of CHWs needed for this intervention to be cost-effective according to the Ministry of Health

From the sensitivity analysis, it appears that the cost of the performance-based incentives is a small part of the overall cost of the intervention. Since the beginning of project activities, PRISE-C worked closely with the mayor's office in each zone, setting up the payment systems for the performance-based incentives in collaboration with the mayor's office, with the end goal of ultimately transitioning the budget for the performance-based incentives to the mayor's office in order to make the system more sustainable. This effort has been successful, as it is planned, and has been budgeted, that the costs of the performance-based incentives will be borne by the mayor's offices in the project research zones starting in the next calendar year. We believe that this contributes to the sustainability of these payments, since the mayor's office is a permanent structure, unlike project which are time-bound. Future funders of this intervention, be they external or the MOH, would therefore likely see very little difference in the cost-effectiveness result, as compared with results presented here, if they continue with implementing the intervention. The difference would increase, though, if for some reason the mayor's office is unable to cover the costs of the performance-based incentives in the future.

Limitations

This research has several limitations. The study was limited by the choice of intervention and control zone based on the zones in which the overall project was working. SAO and DAGLA share a border and the control zone could potentially have been contaminated through hearing of the collaborative and its activities. Choosing zones further apart could have reduced the likelihood of contamination. Furthermore,

the zones of SAO and DAGLA may not adequately represent the overall population of CHWs throughout Benin.

A general limitation of the project is that since CHWs are not a part of the formal health system and are not salaried workers, but rather receive a limited financial incentive to do their work, the level of effort they can expend on CHW duties is often limited by the needs of their family. As seen in the sociodemographic data, 52 of the 86 CHWs are farmers, who need to dedicate a significant amount of time to their fields. Therefore, the performance of these farmer CHWs may be hampered by these competing activities and it may never be able to reach the targets proposed by the project.

A limitation of the data analysis methodology is also that the chi-square tests for independence are based on an assumption of randomization in the study design, which we were not able to do for this study.

As noted above, there was no direct way to link the performance of the CHWs with the health outcomes of those whom they served. Having this information would have made for a more compelling case for the efficiency of the intervention and allowed comparison with other health interventions. The economic analysis considered only the perspective of the intervention funder or the health system and did not take into account the broader economic impacts on beneficiaries receiving care from the CHWs, such as changes in their out-of-pocket health spending. It is not clear whether inclusion of these amounts would have increased or decreased the cost-effectiveness result.

Despite these limitations, there has already been strong interest in incorporating findings from this study into local practice. The research team is working with the zonal health coordinator in the intervention district to include several of the study's indicators in routine supervisions of the CHWs. In addition, the National Department of Public Health (DNSP) is examining how to scale-up the community empowerment aspects of the community quality improvement collaborative.

Implications

The results of this operations research study shed a new light on a question which has remained elusive: how to motivate community health workers to remain committed to their work, and to reach and maintain strong performance. This study results demonstrate that in a low-resource setting a community-level quality improvement collaborative combined with financial incentives provided to the health works is a feasible and effective strategy to improve CHW performance as compared to financial incentives alone.in a low-resource setting.

Inherent in the use of the improvement collaborative process are several features which are critical for future program design and scale up of community health worker programs:

- Engaging the community in a way that ensures responsibility for their own health situation: The community-based improvement teams have proven to be an effective mechanism to do so as they

manage their own data, develop solutions that are doable and provide support for the CHWs to achieve results.

- The support and engagement on the part of the communities is embedded within the very process of the collaborative- data review, finding their own solutions and ensuring that they are implemented. The population has discovered that they could make improvements that were within their reach, at low cost and that they could manage, pay for and continue implementing them.

There are several potential angles for future related operations research. Among these are:

- Community-based Quality Improvement Teams requires significant investment in time and additional resources. A follow-on strategy worth studying would be the use of existing community structures such as the Comité Villageois de Santé in Benin to assume similar roles and responsibilities as a Quality Improvement Team. As such structures already often exist and have legal status, there is a higher chance that they will continue carrying out measurement and improvement activities.
- Incorporation of psychosocial measures for the CHWs such as on self-efficacy would allow researchers to better assess the mechanisms through which the intervention acts to improve performance.
- Testing additional modifications to the model used to reduce the number of learning sessions from once a quarter to twice a year. Each arrondissement can hold its own review of results during regular grouped supervision which would provide select lessons learned for the larger learning sessions. If similar performance improvements are observed, this modified intervention would be more cost-effective than the original.
- When calculating the cost-effectiveness of a CHW intervention, it would be valuable to be able to speak to the number of disability adjusted life years (DALYs) saved by high performance vs low performance of the CHW package of services. Further research in this area would provide important economic evidence to potentially allow for more effective advocacy for CHW programming.
- Testing the effects of the quality improvement collaborative as compared to a cadre of non-paid volunteer CHWs. While not possible in Benin where payment of CHWs is now mandated by the MOH, it would be interesting to measure the differences in the differences between performance and retention of non-paid CHWs when they receive the quality improvement collaborative intervention, and how that compares to the results seen here.

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