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Original Article

Improving health facility delivery rates in Zanzibar, Tanzania through a large-scale digital community health volunteer programme: a process evaluation

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Abstract

The utilization of community health worker (CHW) programmes to improve maternal and neonatal health outcomes has become widely applied in low- and middle-income countries. While current research has focused on discerning the effect of these interventions, documenting the process of implementing, scaling and sustaining these programmes has been largely ignored. Here, we focused on the implementation of the Safer Deliveries CHW programme in Zanzibar, a programme designed to address high rates of maternal and neonatal mortality by increasing rates of health facility delivery and postnatal care visits. The programme was implemented and brought to scale in 10 of 11 districts in Zanzibar over the course of 3 years by D-tree International and the Zanzibar Ministry of Health. As the programme utilized a mobile app to support CHWs during their visits, a rich data resource comprised of 133 481 pregnancy and postpartum home visits from 41 653 women and 436 CHWs was collected, enabling the evaluation of numerous measures related to intervention fidelity and health outcomes. Utilizing the framework of Steckler *et al.*, we completed a formal process evaluation of the primary intervention, CHW home visits to women during their pregnancy and postpartum period. Our in-depth analysis and discussion will serve as a model for process evaluations of similar CHW programmes and will hopefully encourage future implementers to report analogous measures of programme performance.

Keywords: evaluation, maternal health, community health, implementation, technology

Introduction

Worldwide improvements in maternal and neonatal health indicators have been reported since the Millennium Development Goals of 1990. However, progress has been uneven among and within countries, with many regions still experiencing high maternal and neonatal mortality rates (Prata *et al.*, 2011; UN, 2015). A large proportion of maternal and neonatal deaths are attributable to complications during labour, delivery or 24 h postpartum, which are highly preventable and treatable if adequate care is available (Campbell *et al.*, 2006; Say *et al.*, 2014). The presence of a skilled birth attendant at delivery, delivering in a health facility and safe transfer to hospitals with higher-level care, are often recommended

KEY MESSAGES

- The Safer Deliveries programme successfully recruited and trained community health workers (CHWs) in order to deliver their digital community health intervention at scale.
- The Safer Deliveries programme saw an increase in health facility delivery rates over the programme tenure across all districts with variation due to baseline rates
- The integration of digital technology provided detailed documentation of the programme implementation and allowed for real-time innovations within the app.
- Our in-depth analysis will serve as a model for process evaluations of large-scale CHW programmes in low- and middle-income countries, where guidance is currently lacking.

to reduce the risk of maternal and neonatal mortality in low- and middle-income countries (LMICs) (Koblinsky *et al.*, 2008). To accelerate the decline of these preventable deaths, innovative interventions that can lower the risk of mortality and morbidity should be evaluated, optimized and scaled-up (Say *et al.*, 2014).

Community health workers (CHWs) are utilized in LMICs to support women during perinatal periods and address barriers to care (Koblinsky *et al.*, 2008; Kyei-Nimakoh *et al.*, 2017). Typically, CHWs visit pregnant or postpartum women in their homes to screen for health danger signs and connect families to facility-based services (Campbell *et al.*, 2006). More recently, health programmes in LMICs have used digital technology to improve maternal and neonatal health outcomes and facilitate constant monitoring of health indicators (Lee *et al.*, 2016; Feroz *et al.*, 2017). Most digital interventions support women via SMS or voice calls on mobile phones. Some interventions are coupled with CHW programmes to assist health workers; specific examples include an SMS-based monitoring system in Rwanda (Hategeka *et al.*, 2019) and a mobile application used by CHWs in India (Ilozumba *et al.*, 2018).

CHW-based intervention effectiveness in LMICs has received much attention over the past decade (Gilmore and McAuliffe, 2013; Yousafzai *et al.*, 2014; Lassi and Bhutta, 2015). However, two major gaps persist in the literature. First, CHW programmes are rarely evaluated when functioning at scale. Instead, studies evaluating effectiveness typically involve cluster-randomized trials containing small study populations (Lewin *et al.*, 2010; Hategeka *et al.*, 2019). Furthermore, digitally supported CHW programmes tend to function at an even a smaller scale and often lack evidence-based design (Lee *et al.*, 2016; Long *et al.*, 2018). Second, the published research often focuses on the efficacy of the intervention instead of how the intervention was delivered (Kendall and Langer, 2015). Indeed, programmes deemed ineffective could have had an effective intervention, but experienced major gaps in recruitment or intervention delivery. Such lapses can only be identified by a formal process evaluation.

We report a process evaluation of the Safer Deliveries programme, a large CHW-based digital maternal health programme functioning at scale in Zanzibar, Tanzania from January 2016 to September 2019. We explore the implementation of CHW visits, which includes home visitation with health promotion during pregnancy and postpartum periods. This evaluation focuses specifically on the delivery of this one programme intervention; the programme included other aspects not presented in this article. We utilize the process evaluation framework formalized by Steckler *et al.* (2002) to evaluate if the intervention has been implemented as intended and assess the programme's outcomes. Our evaluation criteria consist of targets set by the implementers, D-tree International and Zanzibar Ministry of Health, in annual workplans.

Although process evaluations have been conducted for programmes in LMICs (Sranacharoenpong *et al.*, 2009; Munodawafa *et al.*, 2018), few have been applied to large, at-scale CHW programmes, and these authors found none conducted for digital maternal health programmes. Furthermore, most programmes do not report their original targets or performance on recruitment, retention and intervention fidelity measures, which are essential to benchmark future implementations. This analysis will serve as a model for process evaluations of similar interventions and, hopefully, encourage future programme implementers to openly report measures of programme performance.

Materials and methods

Safer deliveries program in Zanzibar, Tanzania

Programme overview

Zanzibar is a semi-autonomous region of Tanzania with a population of 1 303 569 (as of 2012) living on the two main islands of Unguja and Pemba (Supplementary Figure S1). Prior to the programme start in 2016, Zanzibar experienced high rates of facility antenatal care—over 99% of pregnant women attended at least one antenatal care (ANC) visit and 53% of pregnant women went for four or more ANC visits during pregnancy (Tanzania/DHS, 2016). In 2012, the Zanzibar government made deliveries and related supplies and services free (Yussuf, 2012). Despite this, 34% of all deliveries occurred at home without a skilled attendant and 66% of women failed to receive postpartum care at a health facility within 2 days of birth (Yussuf, 2012).

The objective of the Safer Deliveries programme, implemented from 2016 to 2019, was to increase health facility delivery and post-delivery follow-up rates with a goal of reducing maternal and neonatal morbidity and mortality. Broadly, the programme engaged community health volunteers, equipped with a smartphone app, to enrol pregnant women and counsel them during pregnancy and postpartum periods. Importantly, the programme referred to these volunteers as community health volunteers to emphasize their engagement on a volunteer basis. However, to align with prior literature, we will henceforth refer to them as community health workers or CHWs.

D-tree International developed the app using Mangologic software running on low-end Android smartphones to provide case management and decision support for the CHWs. CHWs were incentivized to sync their data at least once per month in order to receive their monthly payment based on performance, with a maximum stipend of TSH 35 000 (~USD 17.50) per month.

Programme implementation and scale-up

The programme was based on a successful pilot (2011–12) and 2-year expansion (2013–14) which reached over 14 000 pregnant

women with 50% increase in facility delivery in implementation areas (Battle *et al.*, 2015). The current programme aimed to reach 10 out of 11 districts in Zanzibar at scale, accounting for 80% of the pregnant women in those districts (62% of pregnant women in Zanzibar) (NBS/Tanzania and OCGS/Zanzibar, 2014). Supplementary Figure S2 details the timeline for programme scale-up by district. Although there was not a costing exercise for the Safer Deliveries programme, the national community health programme, which is a digitally supported programme building upon Safer Deliveries with an expanded scope including child health and development, is estimated to cost approximately $0.80 per capita per year to implement.

CHW recruitment and training

The Safer Deliveries programme engaged local communities to nominate individuals to be considered for the health volunteer position. All CHWs attended a 5-day training course, which included a 1-day maternal and newborn health training focused on recognizing and referring for risk factors and danger signs and basic first aid. The remaining 4 days were spent learning to use the smartphone-based app and how to conduct home visits. The application includes all of the health content CHWs need to provide quality home counselling, and step-by-step instructions for the CHW as they conduct their home visits (Supplementary Figure S3). The use of the application reduces the amount of health content CHWs need to memorize during training and allows them to focus on how to effectively deliver services and counselling.

The programme aimed to train 400 CHWs. Each district had health facility-based clinical supervisors who were responsible for a group of 4–8 CHWs. In addition, each district was supported by the government's District Health Management Team. This team was responsible for overseeing the general work of the CHW supervisors as well as community health in the district.

Enrolment of pregnant women

CHWs worked with community leaders, staff at health facilities and through word-of-mouth to identify and register interested pregnant women in the programme. During registration, the CHW met with the woman, her husband and/or other family members to discuss the programme and obtain the woman's consent (and family's consent, if present) to enrol in the programme.

Core pregnancy and postpartum visits

The CHW visited the woman at home three times during pregnancy and three times during the postpartum period. Visits were scheduled to occur before 28 weeks, between 29 and 32 weeks and after 33 weeks gestational age. Postpartum visits were scheduled to occur within 3 days of delivery, between 3 and 8 days, and between 8 and 42 days. D-tree and the Zanzibar Ministry of Health decided the visit timing to ensure feasible CHW workload, alignment with the high-risk postpartum period, and consistent pregnancy follow-up to encourage timely ANC visits.

Visit timing during pregnancy was scheduled by the mobile app based on her estimated delivery date. If the CHW referred a woman or infant to a health facility, the CHW was directed by the app to make a 'referral follow-up' visit and ensure that the referral to the health facility was completed within 3 days.

Programme dashboard and supervisor app

Dashboards customized for district health teams provided visualized data for monitoring, programmatic quality improvement and decision-making. The performance of the CHWs was closely monitored by their supervisors via a supervisor app, which supported the supervisors to carry out monthly group CHW meetings and view CHWs' overdue visits, open referrals and performance for the month.

Process evaluation framework

For this process evaluation, we utilized the theoretical framework of Steckler *et al.* (2002). The Safer Deliveries programme was evaluated across the key components of process evaluation: *context* (socio-political and environmental factors that influence the intervention), *reach* (proportion of intended target audience that participates), *recruitment* (procedures used to attract participants), *dose delivered* (number of intended units of each component delivered), *dose received* (extent to which participants actively engage with the component) and *fidelity* (extent to which the intervention was delivered as planned). The intervention was the pregnancy and postpartum CHW visits supported by the mobile application.

The logic model in Figure 1 details all programme activities and highlights those directly applicable to the evaluation. We asked four overarching questions to assess intervention delivery, which we mapped to the key components of the framework in Table 1:

1. Was the original recruitment plan followed?
2. Were the women enrolled in the programme representative of the target population?
3. How did the programme perform on barriers that undermine intervention fidelity?
4. Did women receive the intended quantity and quality of visits?

Study population

CHWs collected data through the mobile app during visits, which was synchronized to the Safer Deliveries server at least monthly. The study population included all women enrolled in the programmed between 1 January 2016 and 1 January 2019 ($N = 41\,653$). We also considered a sub-population of women that delivered by 1 January 2019 ($N = 29\,221$) as they should have received the full intervention. As late enrolments (after 28 weeks gestational age) and 'early' deliveries (due to incorrect estimated delivery dates or preterm births) impacted receipt of intervention, the population was restricted to women who were eligible to receive all visit types ($N = 15\,475$) for some analyses. That is, women who enrolled before 28 weeks estimated gestation age and delivered after 36 weeks estimated gestational age.

Process evaluation measures analysis

Q1. Was the original recruitment plan followed?

D-tree set targets for CHW recruitment and training by district and time period with consideration of a district's population and geography, which were compared with actual recruitment targets. The number of CHWs active dictated the enrolment of women in the programme. We compared actual enrolment to the target of six new women per CHW per month. As the district rollout was staggered, the results were aggregated and split by district. We also reported attrition rate of CHWs.

Q2. Were the women enrolled in the programme representative of the target population?

We compared the distribution of age, parity, education and household electricity status for women enrolled in the programme to the Tanzania Demographic Health Survey from 2015 to 2016. In the programme, information on woman's education and household electricity status was only collected for women who were active in the

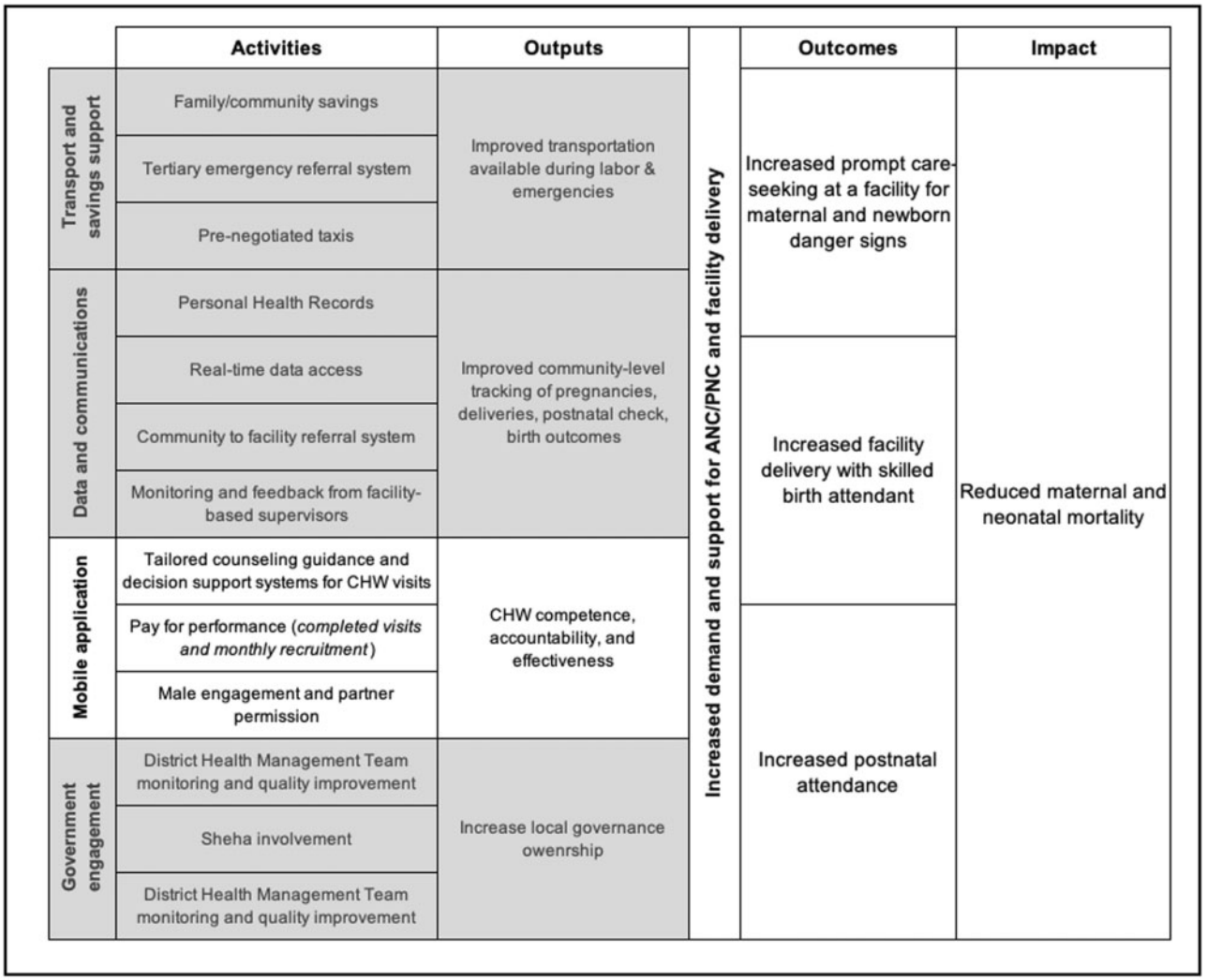

Figure 1 Logic model for Safer Deliveries programme with aspects not directly included in the evaluation in grey.

program during or after May 2017 (58% of total population). As such, missing values were at random. Formal statistical tests were not conducted as the two populations were not independent.

Q3. How did the programme perform on barriers that undermine intervention fidelity?

Women were considered lost to follow-up (LTFU) if 9 months had passed since their enrolment and they had no recorded delivery. We reported the proportion of women who were LTFU and those who planned to move to a new district for their delivery (only available after March 2018). We reported the number and proportion of women who attended at least one ANC visit prior to enrolment, after 28 weeks (ineligible for the first core visit) and delivered well before their estimated delivery date (ineligible for the second or third core pregnancy visits).

Q4. Did women receive the intended quantity and quality of visits?

We assessed if women received three pregnancy and three core postpartum home visits, regardless of the visit timing. Furthermore, we assessed if these visits occurred during the targeted gestational age or age range. We also reported summary statistics for the phone usage during a visit—the time between session start and end on the mobile app. D-tree monitored the length of CHW phone usage during a visit and flagged phone usage time under 5 min, which was an internal estimate for the minimum expected length of time a CHW may utilize the app during a visit. D-tree staff or supervisors followed-up on visits <5 min.

Key outcome indicators analysis

We reported the five outcome indicators listed in D-tree's annual work plans: per cent of women delivering in a health facility, per cent of women who attended a postnatal care visit and per cent of women who completed a health facility referral for each danger sign (pregnancy, postpartum and neonatal) among women who had that referral type. Each year the D-tree programmatic team established targets for the subsequent year in an effort to improve continually. Ambitious targets for these measures were set in order to push the boundaries of what was achievable (Table 2). Performance indicators were reported among women who delivered in that year.

Results

Process evaluation results

Q1. Was the original recruitment plan followed?

The original training target was 400 CHWs, which was achieved with 436 CHWs trained in total by September 2017 (Figure 2). The

Table 1 Process evaluation questions, measures and components

Process evaluation question	Measure(s)	Context	Reach	Recruitment	Dose delivered	Dose received	Fidelity
Q1. Was the original plan for recruitment followed?	Alignment between target and actual number of CHWs trained (by month)		X	X			
	Attrition rate for CHWs (year after scale-up)	X					
	Alignment between target and actual number of persons enrolled (by month and district)		X	X			
	% CHWs met enrolment targets (by month and district)			X			
Q2. Were the women enrolled in the programme representative of the target population?	Distribution of age, parity, education and household electricity among women (*alignment with DHS data*)		X				
Q3. How did the programme perform on barriers that undermine intervention delivery?	% of women LTFU	X		X			
	% of women who planned to move to a new location	X		X			
	% of women with at least one antenatal care visit prior to enrolment	X	X	X			
	% of women ineligible for first core visit due to a late enrolment	X		X	X	X	
	% of women who became ineligible for a third core visit due to an early delivery	X			X	X	
Q4. Did women receive the intended quantity and quality of visits?	% of women with three core visits (for pregnancy and postpartum)				X	X	X
	% of women who received core visit in the correct time interval (by visit type)				X	X	X
	Median and interquartile range for length of CHW phone usage during visit (by mode of visit)					X	X
	% of women with CHW phone usage under 5 min during visit (by month and mode of visit)					X	X

Table 2 Safer Deliveries programme key outcome indicators and targets

Indicator	Year 1 (%)	Year 2 (%)	Year 3 (%)	Year 4 (%)
Per cent of women who delivered in health facility	60	70	80	80
Per cent of women who attended postnatal care visit	60	60	70	80
Per cent of women who completed referral visits for danger signs				
Pregnancy	75	75	90	90
Postpartum	75	75	80	90
Neonatal	75	60	85	90

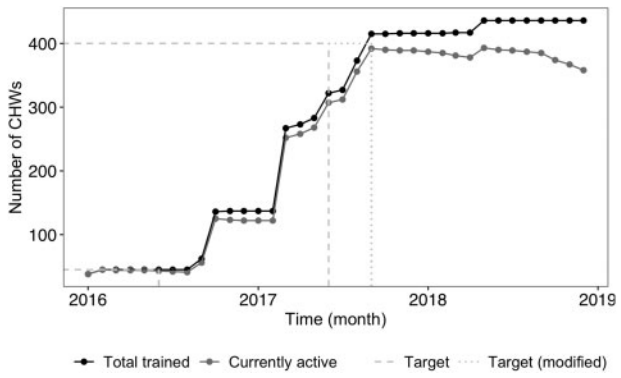

Figure 2 Total number of trained and active CHWs by month in the programme. Dashed line denotes original target. Dotted line denotes modified target due to a strategic delay in expanding to final Pemba districts.

attrition rate was 8.7% the year after scale was reached (September 2017 to September 2018) with a dropout of 34 CHWs during that period. The proportion of active CHWs remained above 95% of the target during this period (at least 383 out of 400 CHWs active). At the end of 2018, 41 653 women had enrolled, representing an average monthly enrolment of about 1200 women. The number of women currently active remained steady once the programme reached scale (Figure 3). In Unguja districts, there were substantial deviations from enrolment targets, while in Pemba, CHWs largely met their targets (Supplementary Figure S4). The proportion of active CHWs that met target enrolment increased from 11% to 64%, stabilizing after September 2017 (Figure 4). At least 70% of the CHWs enrolled at least four women per month after September 2017. There was variation by district with Pemba districts enrolling more women per month compared with Unguja (Supplementary Figure S5).

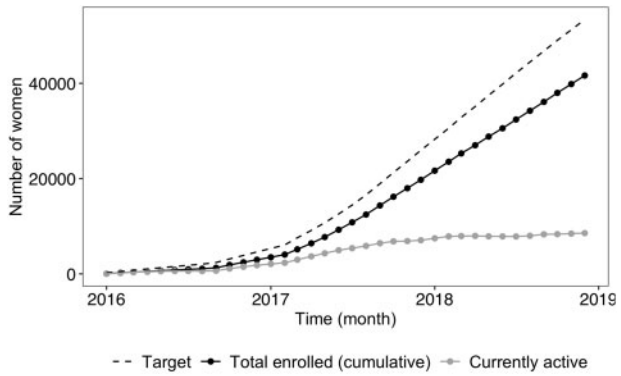

Figure 3 Total number of enrolled where dotted line denotes enrolment target based on number of active CHWs. Currently, active women by month refer to women who are currently pregnant or still receiving postpartum visits.

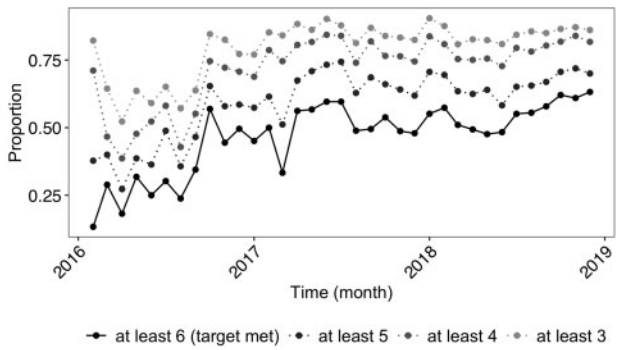

Figure 4 Proportion of CHWs who met enrolment target (6+ women enrolled) by month.

Q2. Were the women enrolled in the programme representative of the target population?

The distribution of age, parity, highest education-level attained and household electricity status is given for women enrolled in the programme. The median age was 27 (IQR: 23–31) and median parity was 2 (IQR: 1–4). The majority of women (60%) had a primary or lower educational attainment level. When compared with the DHS Tanzania data, the distribution of age, parity and electricity status was comparable (Table 3) (Tanzania/DHS, 2016). There were differences in the distribution of educational attainment, but extremes were similar: 31.0% (Safer Deliveries) vs 32.0% (DHS) of women did not complete primary school and 1.2% vs 1.1% completed some form of higher education.

Q3. How did the programme perform on barriers that undermine intervention fidelity?

Overall, 4000 (12.0%) of women were LTFU before they delivered (Table 4). The majority of women (78.5%) attended at least one facility-based ANC visit prior to enrolment with a median estimated gestational age at first ANC of 18 weeks (IQR: 14–22). The median estimated gestational age for enrolment in the CHW programme was 22 weeks (IQR: 16–27]). Only 13.5% of women enrolled after 28 weeks making them ineligible for a timely receipt of the first core visit (Table 4). Due to errors in estimation of gestational age or preterm births, 13.8% of women had a delivery prior to 32 weeks making them ineligible for the third visit (Table 5).

Table 3 Comparison of baseline characteristics for women aged 15–49 to Tanzania DHS 2015–2016

Indicator	Safer Deliveries[a]		DHS 2015–2016[b]
	%	(*n*)	%
Age category			
<19	8.8	(3653)	7.4
20–24	27.9	(11 596)	24.0
25–30	36.9	(15 361)	29.5
31–35	15.1	(6279)	15.6
36–40	9.1	(3799)	10.5
>40	2.2	(913)	13.1
Parity category			
0	24.4	(10 154)	17.5
1–2	33.6	(13 985)	34.3
3–4	22.4	(9304)	24.3
5–7	15.2	(6318)	18.3
>8	4.4	(1840)	5.6
Highest level of education[c]			
Some primary or none	31.0	(5423)	32.0
Completed primary	28.5	(4981)	12.9
Some secondary	17.0	(2975)	35.2
Completed secondary	22.2	(3882)	18.8
Higher education	1.2	(211)	1.1
Has electricity[c]	34.0	(5934)	35.3

[a]Based on 41 601 women in the Safer Deliveries programme aged 15–49.
[b]Based on 753 pregnant, recently pregnant or soon-to-be pregnant women who answered DHS survey in Unguja or Pemba (excluding Urban district).
[c]The question was only collected for 42% of women in the Safer Deliveries programme.

Table 4 Barrier measures for all women enrolled in the Safer Deliveries programme ($N = 41\,653$)

	Overall, *n* (%)	
Lost to follow-up[a]	4000	(12.0)
Planned to move to a new location for delivery[b]		
Yes	21 396	(51.4)
No	3890	(9.3)
Missing	16 367	(39.3)
Ineligible for first core visit[c]	5605	(13.5)
Attended an ANC visit prior to enrolment	32 685	(78.5)
Gestation age (weeks) by LMP at first ANC visit[d]		
Median [IQR]	18	[14–22]
Gestation age (weeks) by LMP at enrolment		
Median [IQR]	22	[16–27]

[a]Only includes women who have either delivered or been enrolled for >280 days ($N = 33\,355$).
[b]Variable not collected until March 2018 hence 'Missing' category.
[c]Enrolment occurred after 28 weeks.
[d]Only among those who had an ANC visit ($N = 37\,587$; 90.2%).

Q4. Did women receive the intended quantity and quality of visits?

Among women who delivered, 68.2% received two or more visits during pregnancy from a CHW—50.9% received two visits from a CHW and 17.3% received three or more pregnancy visits (Table 6). Among the restricted population—women who were eligible for all CHW visits—numbers were higher; 94.3% of women received two or more visits and 28.0% received at least three pregnancy visits. There were no differences by district in number of visits distribution in the restricted population (Supplementary Figure S6).

Table 5 Barrier measures among women enrolled in the Safer Deliveries programme who delivered ($N = 29\,221$)

	Overall, *n* (%)	
Ineligible for third core visit[a]	4037	(13.8)
Delivered >28 days before estimated delivery date	10 318	(35.3)
Number of days between actual and estimated delivery date (Median [IQR])	15	(1, 41)

[a]Delivery occurred at or before an estimated gestational age of 32 weeks.

Table 6 Distribution of women by number of pregnancy and postpartum CHW visits received

	Delivered ($N = 29\,221$)		Restricted[a] ($N = 15\,475$)	
Pregnancy visits				
1	9278	(31.8)	873	(5.6)
2	14 872	(50.9)	10 457	(67.6)
3+	5071	(17.3)	4145	(26.7)
Postpartum visits				
0	93	(0.3)		–
1	8258	(28.3)		–
2	11 152	(38.2)		–
3+	9718	(33.3)		–

[a]Only includes women who were enrolled before 28 weeks and delivered after 36 weeks estimated gestational age.

Most women (84.4%) were enrolled before 28 weeks estimated gestational age and had a final visit after 32 weeks and prior to delivery (65.2%) (Table 7). Only 20.8% of women received their second core visit within the span of 29–32 weeks estimated gestational age. Taken together, few women (2.9%) received all three core pregnancy visits precisely within the expected time frame. The proportion of women who received three postpartum visits within the planned time frame was much higher (32.8%) (Table 7). Almost all women (95.3%) received a postpartum visit between 8 and 42 days after delivery. Seventy-three per cent of women received a visit in the first week after delivery.

Prior to March 2018, the proportion of under 5-min phone usage was 46%, and the median length of phone usage was 5.5 min (IQR: 2.9–10.3]) (Table 8). D-tree realized women move away during the late months of pregnancy to be closer to their families or a desired delivery facility. As such, phone-based visits, with abbreviated content, were introduced in March 2018, and D-tree was able to track phone vs in-person visits. After March 2018, the median length of phone usage during an in-person visit was 8.6 min (IQR: [4.7–15.6]) and 3.3 min (IQR: 1.8–6.8) among phone visits.

Performance on key outcome indicators

The proportion of women who delivered in a health facility increased substantially from 58.2% in Year 1 to 76.3% in Year 4, almost meeting targets for Years 3 and 4 of 80% (Figure 5). Results varied by district (Supplementary Figure S7). The proportion of women that attended a postnatal care visit at a facility increased from 34.8% in Year 1 to 92.6% in Year 4 and exceeded the targets in Years 2–4 (Figure 6). For postpartum referrals, the proportion completed increased from 57.1% to 80.6% (Figure 7). At the end of September 2016, a referral for postnatal care visits was added to the app; Figure 8 shows an increase in postnatal care visit attendance before and after this update. The proportion of completed

Table 7 Proportion of women who received pregnancy and postpartum core visits

	Delivered ($N = 29\,221$)		Restricted[a] ($N = 15\,475$)	
Received core pregnancy visit by type				
<28 weeks	24 669	(84.4)	15 475	(100.0)
29–32 weeks	6090	(20.8)	1157	(7.5)
>32 weeks	19 062	(65.2)	14 227	(91.9)
Received core postpartum visit by type				
<3 days after delivery	14 824	(50.7)		-
3–7 days after delivery	16 122	(55.2)		-
8–28 days after delivery	27 843	(95.3)		-
Received all core pregnancy visits on time	851	(2.9)	806	(5.2)
Received all core postpartum visits on time	9580	(32.8)		-

[a]Only includes women who were enrolled before 28 weeks and delivered after 36 weeks estimated gestational age.

Table 8 Summary statistics for core visits by visit type ($N = 133\,481$).

	Overall	
Number of visits, *n*		
Unclassified[a]	71 467	
Phone visit	7244	
In-person	54 770	
Visit length, median [IQR]		
Unclassified[a]	5.45	[2.88–10.13]
Phone visit	3.30	[1.77–6.75]
In-person	8.58	[4.65–15.63]
Visit length under 5 min, *n* (% visit type)		
Unclassified[a]	33 063	(46.3)
Phone visit	4726	(65.2)
In-person	15 117	(27.6)

[a]Visits that occurred prior to 6 March 2018 may also include phone visits that were not logged as such.

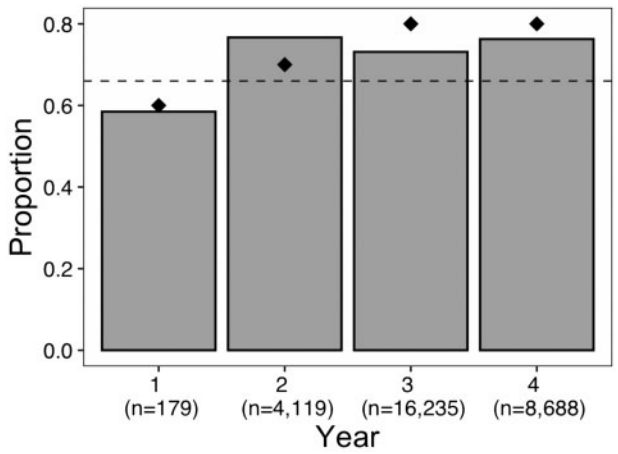

Figure 5 Proportion of health facility deliveries by year. Dotted line is the percentage of live births in past 5 years delivered in health facility for Zanzibar (DHS 2015–16 data). Diamonds are annual D-tree performance targets.

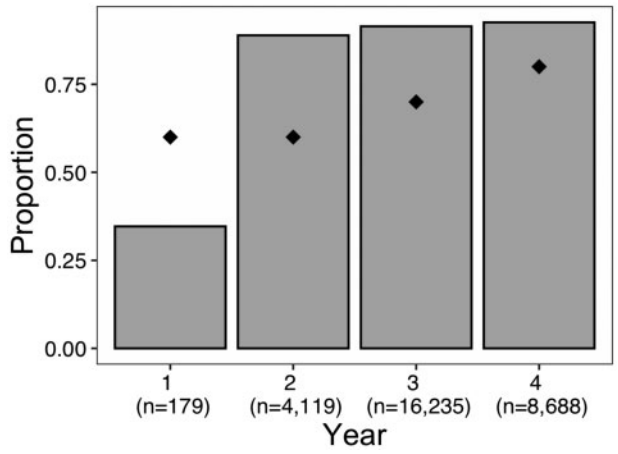

Figure 6 Proportion of facility postnatal care visits within 7 days of delivery by year. Diamonds are annual D-tree performance targets across all districts.

pregnancy referral follow-ups slightly decreased from 92.9% to 87.4%. For neonatal referrals, the proportion completed increased from 37.5% to 93.4% and the targets were met for Years 2 through 4.

Discussion

CHW recruitment and retention was a strength of the programme implementation, with attrition rates considerably lower than similarly sized CHW programmes (Nkonki *et al.*, 2011; Ngugi *et al.*, 2018). Attrition of health workers is a critical problem for such programmes leading to increased costs and lack of continuity between the health worker and community (Bhattacharyya *et al.*, 2001). A complementary qualitative report from this programme found that CHWs cared deeply about their work and felt valued by the community (Beckmann, 2019)—both associated with increased retention rates (Rahman *et al.*, 2010; Abbey *et al.*, 2014). The Safer Deliveries programme likely succeeds in these areas due to selection of CHWs by community members, in-depth training and adequate support structures via the supervisory model. The qualitative report also found that almost all CHWs were dissatisfied with remuneration as they felt they should be paid more—the most commonly cited reason for attrition in similar programmes (Chevalier *et al.*, 1993; Khan *et al.*, 1998). Unfortunately, as is often the case in community health programmes, increasing the salary of the CHW may not be feasible for long-term programme sustainability if the government is to take over ownership and sponsorship of the programme. Programmes should thus bolster other factors that contribute to CHW retention, such as positive community relations, appropriate training and preparation, transparency in scope of work and non-monetary benefits (Alam *et al.*, 2012; Pallas *et al.*, 2013).

Although the programme achieved its CHW recruitment goals and the majority of CHWs were enrolling at least four women per month, many CHWs did not meet their monthly enrolment goal of six women per month. We have identified two potential reasons for this. The first is the misalignment of fertility rates and monthly enrolment expectations in a CHW's catchment area resulting in unattainable target numbers. This is supported by findings from the qualitative report as CHWs were confident in their ability to identify and enrol almost all pregnant women in their catchment area (Beckmann, 2019). In addition, the deviation from target occurs several months after rollout suggesting that the pregnancy rate may not align with the expected enrolment rate in certain districts. Furthermore, the total fertility rate is significantly higher in Pemba (6.8 children per woman) than Unguja (4.4 children per woman), which could explain why Pemba CHWs met their enrolment targets (Tanzania/DHS, 2016). To ensure fair enrolment targets are set, programmes should utilize fertility rates specific to the region.

The second potential reason for lower than expected enrolment was that certain CHWs may have difficulty identifying and/or enrolling pregnant women. The qualitative report found that CHWs had problems registering women due to the culture of secrecy surrounding personal matters (e.g. pregnancy) in Zanzibar. CHWs addressed this by developing creative strategies to build rapport with women and their families (Beckmann, 2019). However, the ability to navigate such challenges may vary by CHW. Previous literature has found that health worker characteristics, such as sex,

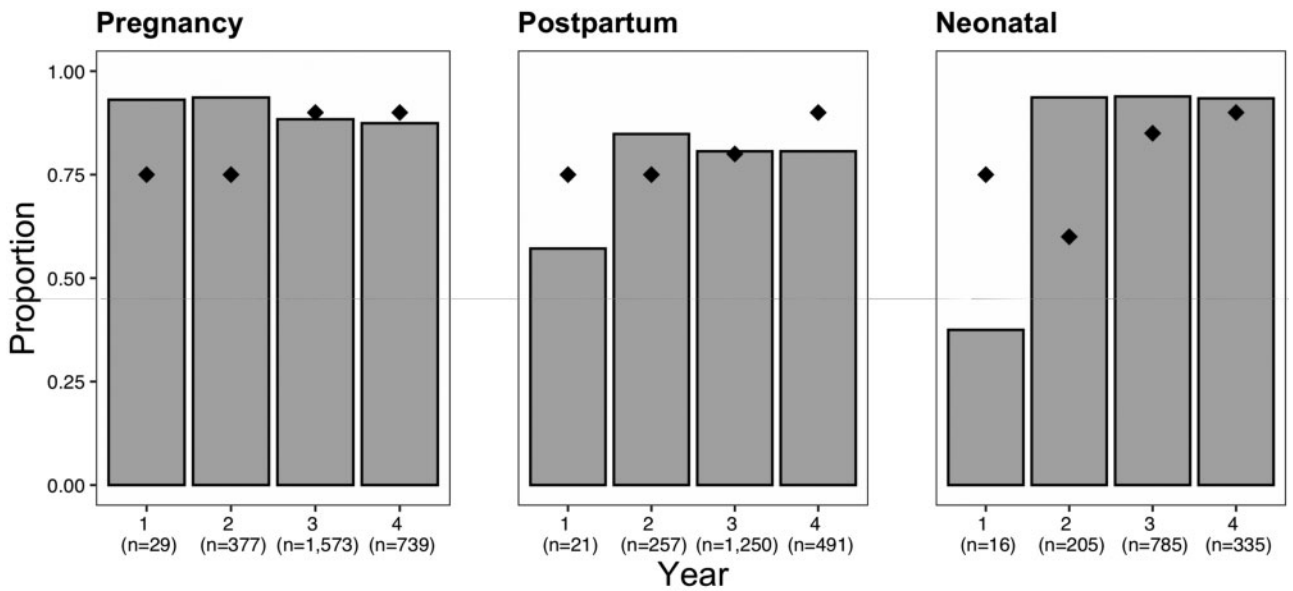

Figure 7 Proportion of complete referral follow-ups by year and referral type. Diamonds are annual D-tree performance targets across all districts.

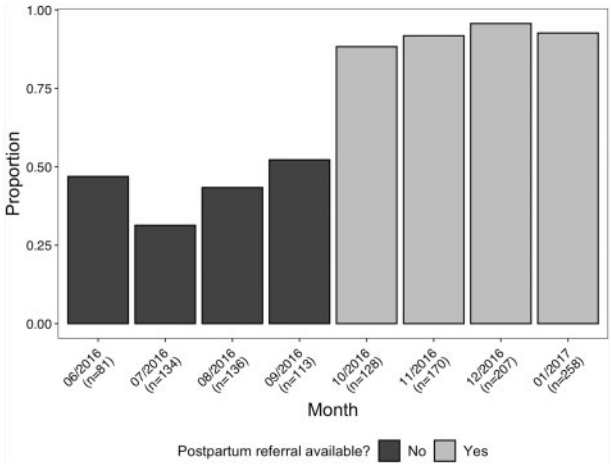

Figure 8 Proportion of women recieving postpartum facility visits four months before/after postpartum referral integrated in app in October 2016.

prior work experience, age and marital status, impact their relationships with women (Crispin *et al.*, 2012; Houle *et al.*, 2016; Kambarami *et al.*, 2016). Future programmes should be aware of potential characteristics that are associated with negative outcomes and either counsel CHWs to overcome such barriers, train CHWs on community entry and building trust, or, where appropriate, consider qualifications during recruitment procedures.

The programme performed well on barriers that may undermine intervention delivery. There was a small, but non-negligible, number of women LTFU prior to delivery (12%). In similar CHW programmes, the LTFU rates were either higher (around 20%) or, concerningly, not reported (Mbuagbaw *et al.*, 2015; Lee *et al.*, 2016). The major reason for dropout in this programme was attributed to women moving to a new location for delivery, a common occurrence in Zanzibar (Beckmann, 2019). If the CHW did not have prior knowledge of a woman's intent to move, she would not be able to obtain contact information to follow-up with the woman around delivery. To address this, D-tree adapted the intervention to ask women about their intent to move, provide contact information on the new location and allow for an abbreviated version of the in-person visit over the phone starting in March 2018. After this date, 15% of women reported that they planned to move for delivery, which was close to the 12% LTFU and supports the suspicion that most LTFU was due to women moving to a new location for delivery. The impact of this adjustment was also visible in the lengths of phone usage time after March 2018, which were significantly longer for in-person visits and shorter for phone visits (as expected). Although the programme was modified so that the CHW continued to support women after they moved, further research is needed to assess the impact of replacing in-person visits with phone visits. There is currently no evidence surrounding the efficacy of CHW visits conducted over the phone; however, programmes that deliver health information directly to expectant mothers via mobile technology have been well-received (Sondaal *et al.*, 2016). Future programmes should explore the technological feasibility of reassigning women who move to CHWs in the new location so that in-person visits can continue.

For the quantity and quality of the intervention delivered, the majority of women received two or more core CHW visits during each of the pregnancy and postpartum periods. The observed number of CHW visits during pregnancy aligns with recommended guidelines from a recent WHO and UNICEF training manual (UNICEF and WHO, 2015). For postpartum visits, the majority of women received at least one postpartum visit in the first 3 days of delivery—again, aligning with recommended guidelines for postpartum visits (Strategy, 2009). For pregnancy visits, only 17% of women received three core visits, which was likely driven by a low proportion of women receiving a visit between 29 and 32 weeks estimated gestational age. It is possible that this timeframe is too short for the CHWs to schedule around. Further complicating matters, the abundance of mis-estimated dates of delivery greatly reduces the ability of the CHW to deliver a third and final visit, which remains a potential barrier that undermines intervention delivery(Fulcher *et al.*, 2020). There are three potential solutions. First, improvements should be made at health facility level to better estimate gestational age; the use of recall activities for last menstrual period dating and equipping health centres with ultrasound technology has been shown to improve dating (Ambrose *et al.*, 2015; Cherniak *et al.*, 2017). Over half of women in the programme attended their first ANC visit after 18 weeks, which could significantly compromise recall of last menstrual period (Neufeld *et al.*, 2006). Second, pregnant women should be identified and enrolled as early as possible in their pregnancy for ample spacing of visits and continuity of care throughout the pregnancy. However, this is a recognized challenge in the Zanzibar context, given the culture of secrecy around pregnancies. Third, the visit schedules should be optimally spaced from a CHW perspective in order to promote feasibility while still ensuring that women receive an appropriate number of well-timed visits for positive health outcomes (Brunskill and Lesh, 2010). Further research is needed to evaluate an optimal balance of these potentially competing interests.

Finally, the key outcome indicators all improved from Year 1 to Year 4—the most dramatic increase was in postnatal care visits at a facility. Due to the very low proportion (<50%) of postnatal care attendance in the first 9 months of the programme, D-tree updated the app to include a 'postnatal care visit referral' so that CHWs could refer women who had not yet attended a postnatal care visit to a facility and then follow-up on this referral within 3 days. Immediately after this update at the end of September 2016, the proportion of women who completed postnatal care visits at the health facility increased to over 90%, which persisted for the remainder of the programme. In addition, facility delivery rates increased from 58.2% in Year 1 to 76.3% in Year 4, just missing the target of 80%. All districts in Unguja exceeded this target, but Pemba districts remained lower than the target despite constant improvement each year. This was not surprising as Pemba districts had much lower baseline facility delivery rates (75% in Unguja vs 51% in Pemba in 2016).

Importantly, as demonstrated by the differences between Pemba and Unguja, the same programme (and programme implementers) can result in drastically different conclusions about programme performance and implementation success. As such, implementers should vary their targets by region depending on the prevalence of key indicators at baseline and other population characteristics. However, varying targets by region or district may not be feasible in certain technologies or settings, such that an overall target must be set for the population.

Limitations

This process evaluation had several limitations. First, information was not consistently collected on the number of women who refused to enrol in the program or reasons for refusal given the logistical difficulty of collecting data from women who refuse to enrol. As such, we

could not evaluate a key aspect of the *reach* component. Second, the evaluation does not assess acceptability of the intervention among the CHW or women; however, in-depth qualitative interviews with CHWs and women provided insights and recommendations for the programme delivery (Beckmann, 2019). Third, several barriers for delivery of intervention were not captured in our data: distance from the CHW's home to woman's home and woman's access to a mobile phone, which would reduce her ability to receive CHW visits over the phone if she moved for delivery. Partner permission for health facility delivery may also impact the receipt and effectiveness of CHW visits. Although receipt of partner permission for health facility delivery (yes/no) was recorded in the app, we could not differentiate between the partner not being home during CHW visit versus explicit refusal. Lastly, length of CHW time using the app during a visit may not be a valid measure for quality of the intervention; CHWs sometimes reported that they entered information after the visit due to software crashes or connectivity issues, which would significantly shorten the recorded time that a CHW utilized the app.

Conclusion

The Safer Deliveries programme successfully recruited and trained CHWs in order to deliver their digital community health intervention at scale. CHWs had a high retention rate and enrolled pregnant women at a constant rate after the programme reached scale with a small LTFU among women. There were regional differences in enrolment rates, which were likely due to variations in total fertility rates, highlighting the need for consideration in future health programmes. The majority of women received at least two visits during pregnancy, despite most women being enrolled in their second trimester. The appropriate schedule for CHW visits should be investigated further as it is unclear how the number and timing of visits impact health outcomes.

We strongly encourage CHW-based programmes to undertake process evaluations to measure alignment between initial programme plans and programme implementation. As demonstrated by the Safer Deliveries programme, such evaluations, in the form of programme monitoring during the programme implementation period, enabled D-tree to make several crucial updates to their implementation approach and app. Importantly, these app updates resulted in modified CHW–woman interactions during the home (or phone) visits, which could translate into better health outcomes, such as the increase in proportion of postnatal care visits at a facility. Additionally, post-programme evaluations aid shaping the design of future programmes. Importantly, evaluations can only occur if information about recruitment, participant refusal, participant demographics and intervention delivery is systematically collected. The integration of digital technology provides detailed documentation of the program and rich patient-level information, in addition to improving programme delivery.

Supplementary data

Supplementary data are available at *Health Policy and Planning* online.

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Conflict of interest statement. This paper was developed by multidisciplinary team, including representative from the organization included in the process evaluation.

Ethical approval. The data used for this research consisted of maternal health and community health worker service provision information collected by community health workers as part of routine care. The research was carried out using de-identified data and was originally approved by the Harvard Human Research Protection Programme on 24 May 2017 (IRB16-1024). A modification to include newly collected data was approved in March 2019. On 24 December 2018, this work also recieved ethical approval from the Zanzibar Health Research Institute (ZAHREC/02/DEC/2018).

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