

## OPEN

# Community Health Workers to Improve Antenatal Care and PMTCT Uptake in Dar es Salaam, Tanzania: A Quantitative Performance Evaluation

Irene A. Lema, MD, MPH,\* David Sando, MD, MPH,\* Lucy Magesa, MD,\*  
Lameck Machumi, MD, MPH,\* Esther Mungure, MSc,\* Mary Mwanyika Sando, MD, MPH,\*  
Pascal Geldsetzer, MD, MPH,† Dawn Foster, PhD,† Deborah Kajoka, MD,‡ Helga Naburi, MD,§  
Anna M. Ekström, MD, PhD, MPH,|| Donna Spiegelman, ScD,† Nan Li, PhD,†  
Guerino Chalamilla, MD,\* Wafaie Fawzi, MBBS, DrPH,† and Till Bärnighausen, MD, ScD†¶

**Background:** Home visits by community health workers (CHW) could be effective in identifying pregnant women in the community before they have presented to the health system. CHW could thus improve the uptake of antenatal care (ANC), HIV testing, and prevention of mother-to-child transmission (PMTCT) services.

**Methods:** Over a 16-month period, we carried out a quantitative evaluation of the performance of CHW in reaching women early in pregnancy and before they have attended ANC in Dar es Salaam, Tanzania.

**Results:** As part of the intervention, 213 CHW conducted more than 45,000 home visits to about 43,000 pregnant women. More than 75% of the pregnant women identified through home visits had not yet attended ANC at the time of the first contact with a CHW and

about 40% of those who had not yet attended ANC were in the first trimester of pregnancy. Over time, the number of pregnant women the CHW identified each month increased, as did the proportion of women who had not yet attended ANC. The median gestational age of pregnant women contacted for the first time by a CHW decreased steadily and significantly over time (from 21/22 to 16 weeks, *P*-value for test of trend <0.0001).

**Conclusions:** A large-scale CHW intervention was effective in identifying pregnant women in their homes early in pregnancy and before they had attended ANC. The intervention thus fulfills some of the conditions that are necessary for CHW to improve timely ANC uptake and early HIV testing and PMTCT enrollment in pregnancy.

**Key Words:** maternal and child health, community health workers, antenatal care, performance evaluation, Tanzania

(*J Acquir Immune Defic Syndr* 2014;67:S195–S201)

From the \*Familia Salama Trial Unit, Management and Development for Health, Dar es Salaam, Tanzania; †Department of Global Health and Population, and Departments of Epidemiology and Biostatistics (D.S.), Harvard School of Public Health, Huntington Avenue, Boston, MA; ‡PMTCT Department, Ministry of Health and Social Welfare, Dar es Salaam, Tanzania; §Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania; ||Department of Infectious Diseases, Karolinska University Hospital, Karolinskaavägen, Solna, Stockholm, Sweden; and ¶Wellcome Trust Africa Centre for Health and Population Studies, Mtubatuba, South Africa.

Supported by the Elton John AIDS Foundation and Comic Relief, United Kingdom. The National Institute for Medical Research in Tanzania approved the study in July 2012 and the Institutional Review Board of the Harvard School of Public Health approved it in January 2013. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the article.

The authors have no conflicts of interest to disclose.

I.A., D.S., P.G. and T.B. wrote the draft manuscript. I.A. led the implementation of the C.H.W. intervention and supported data collection and analysis. D.F. conducted literature searches and provided summaries of previous research studies. All authors contributed to the study concept and implementation and have read, edited, and approved the final manuscript.

Correspondence to: Irene A. Lema, MD, Management and Development for Health, Plot #802, Mwai Kibaki Road, Mikochei, P.O. Box 79810, Dar es Salaam, Tanzania (email: iandrew@mdh-tz.org).

Copyright © 2014 by Lippincott Williams & Wilkins. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## BACKGROUND

Antenatal care (ANC) is a critical maternal health service as it prepares pregnant women for delivery and provides an opportunity to prevent, diagnose, and treat conditions that can complicate pregnancy or birth. A further purpose of ANC is to identify HIV-infected women and to refer them to prevention of mother-to-child HIV transmission (PMTCT) services.

The World Health Organization recommends that pregnant women make their first ANC visit in the first trimester of pregnancy and attend a total of at least four ANC visits during pregnancy.<sup>1</sup> Although most pregnant women in developing countries attend ANC at least once during their pregnancy, much fewer attend within the first trimester of pregnancy and attend four or more visits.<sup>2</sup> In Tanzania, an estimated 98% of women attended ANC at least once during pregnancy but only 43% attended ANC four times or more in 2010.<sup>3</sup> In addition, only a small proportion of the pregnant women in Tanzania, including in Dar es Salaam where this study took place,<sup>3–5</sup> attended ANC during the first trimester of pregnancy. Late and inconsistent attendance at ANC is an important public health problem, because it will delay the detection of conditions that predate, or arise during

pregnancy, which increases the rate of adverse outcomes resulting from these conditions for both the mother and the baby.<sup>6</sup> In particular, late and inconsistent ANC attendance implies missed opportunities for early HIV testing in pregnancy and timely referral to PMTCT services and decreases the population effectiveness of PMTCT in preventing vertical transmission of HIV.<sup>7</sup> Mother-to-child transmission of HIV remains a major public health problem in Tanzania and in particular in Dar es Salaam. Eight percent of women of reproductive age in Dar es Salaam were HIV-infected in 2011.<sup>8</sup> Overall in Tanzania, about one in six infants born to HIV-infected mothers become HIV-infected.<sup>9</sup> In 2010, 25% of Tanzanian women and 33% of men did not know that mother-to-child transmission of HIV can be reduced through the use of antiretroviral treatment (ART) during pregnancy.<sup>3</sup>

Community health workers (CHW) can successfully perform a variety of services and activities, including the delivery of basic health care, health education, and promoting uptake of facility-based health care.<sup>10,11</sup> Reviews of the literature show that CHW programs can be effective in reducing maternal and child mortality in low-income settings by providing a variety of interventions, such as home-based malaria treatment,<sup>10</sup> food safety education,<sup>11</sup> and promotion of exclusive breastfeeding.<sup>12</sup>

The evidence on CHW effects on the performance of ANC and PMTCT is limited. A complex community intervention in Northern Uganda included a CHW component to track mothers who had missed ANC appointments.<sup>13</sup> Although the program as a whole significantly improved ANC attendance, it is unclear whether the effect could be attributed to the CHW intervention as compared to the other activities included in the program, such as community sensitization to promote early ANC uptake and male partner access clubs to promote partner involvement in ANC.<sup>13</sup> A study in South Africa found that CHW home visits increased adherence to some PMTCT-related activities, such as infant ART prophylaxis and exclusive breastfeeding, but not to others, such as maternal ART to prevent vertical transmission.<sup>14</sup>

We implemented a large-scale CHW intervention to improve ANC and PMTCT uptake and retention within the Dar es Salaam public-sector health system. The overall study was a cluster-randomized controlled trial, which is described elsewhere.<sup>15</sup> Here, we present the results of a quantitative performance evaluation of the CHW intervention with the dual objective of describing the intervention and assessing its achievements during the first 16 months of implementation.

## Theory of Change

When designing a complex intervention, such as a CHW program, it is important that the plausibility of the intervention is supported by a convincing Theory of Change describing the hypothesized mechanisms linking the intervention to outcomes.<sup>16,17</sup> We postulated that the CHW would improve ANC and PMTCT uptake through the following pathways. First, the *counseling* by CHW raises awareness of ANC and can also provide a source of motivation for attending ANC as CHW explain that it can improve health outcomes for the mother and the newborn. CHW counseling may also increase

ANC attendance by simply informing women of the location of the nearest ANC clinic. This could be a particularly relevant factor in an urban setting such as Dar es Salaam, where many women may have moved to the city recently from other parts of the country and may not yet be familiar with the location of ANC clinics. A randomized controlled trial in Canada has shown that counseling by CHW can improve uptake of different antenatal and community services.<sup>18</sup>

Second, the CHW visit itself may serve as a *reminder* or a *“nudge”* to women who were already planning to attend ANC at the time of the CHW visit. The potential of CHW to successfully “nudge” people has recently been demonstrated by a study that investigated the use of CHW for improving adherence to medications by patients with acute coronary syndrome.<sup>19,20</sup> Third, CHW visits may also be a source of *normative social influence*. In order to be liked and accepted, people tend to conform to social expectation, such as the expectation that pregnant women should attend ANC and to test for HIV.<sup>21</sup> CHW can set such expectations and monitor adherence during re-visits.<sup>22</sup>

## METHODS

### Study Setting

The study took place in the Kinondoni and Ilala districts of Dar es Salaam, Tanzania, with a population of 4.4 million in 2012 (or 69% of the total population in the city).<sup>23</sup> The study was performed in the context of a cluster-randomized controlled trial. This health systems implementation trial, called “Familia Salama” (Kiswahili for “safe family”), started in January 2013 and was completed in April 2014. The trial protocol has been described in detail elsewhere.<sup>15</sup> As part of the trial, all of the 60 wards of the two study districts were randomly allocated to either the CHW intervention (36 wards) or the standard of care (24 wards). In early 2013, at the start of the trial, the average population size of a ward was about 50,000 people.<sup>23</sup> This performance evaluation took place in the 36 wards assigned to the CHW intervention.

The trial was performed by Management and Development for Health (MDH) in partnership with the Tanzanian Ministry of Health and Social Welfare, the Harvard School of Public Health, Muhimbili University of Health and Allied Sciences (MUHAS), and Karolinska Institutet. The National Institute for Medical Research in Tanzania granted ethical approval for the overall trial in June 2012; the Institutional Review Board of the Harvard School of Public Health approved the study of the CHW intervention in January 2013.

### Quantitative Performance Evaluation

As a performance evaluation,<sup>24</sup> this study focuses on the content of the intervention, how and to what extent it has been implemented, and what it has achieved.<sup>25</sup> A performance evaluation can complement an evaluation of causal impact in several important ways<sup>25,26</sup>; it can (1) elucidate how and why an intervention works, (2) distinguish between design and implementation failure if an intervention does not lead to the anticipated effects,<sup>24,27</sup> (3) provide information for

For all pregnant women visited:

- Date of household visit
- Full name
- Date of birth
- Date of last normal menstrual period
- Whether the woman had attended ANC at the time of the visit
- Whether the CHW counseled the woman to attend ANC

For women who had attended ANC at the time of the CHW visit:

- ANC identification number
- Date of last ANC attendance
- Name of ANC clinic attended

For women who had not attended ANC at the time of the CHW visit:

- Identification number for referral to ANC<sup>1</sup>
- Name of ANC clinic that the woman was referred to

<sup>1</sup> provided by the CHW with the referral form

**FIGURE 1.** Variables recorded by CHW during home visits. ANC, antenatal care; CHW, community health workers.

intervention replication in other settings through detailed description of implementation processes and context.

## Data Collection and Analysis

The CHW recorded information on the pregnant women they identified during the home visits in the community, including whether a pregnant woman had already attended ANC and the date of her last menstrual period (Fig. 1). We calculated each woman's gestational age at the time of the home visit as the difference between the date of the visit and the date of the last menstrual period. We tested for time trend in gestational age at first CHW home visit using the generalized estimation equation method.<sup>28</sup> Data on the cost of training the CHW, the cost of implementing the CHW intervention, and CHW job retention was obtained from administrative records at MDH.

## RESULTS

Following commonly used health systems performance evaluation frameworks,<sup>29,30</sup> we structure the performance evaluation into inputs (the resources available and accessible for the intervention), processes (what was done and how), and outputs (what was achieved in terms of health systems outcomes).

### Inputs

#### Human Resources

The CHW intervention was performed by two cadres of health workers that already exist in the public-sector health system in Tanzania. The first cadre, the CHW, is locally referred to as "home-based carers." The second cadre is community outreach nurses (locally called "community-based health workers") who are assigned to clinics but are tasked to oversee a range of community activities to improve health. Two hundred thirteen CHW, who already worked in Dar es Salaam's public health system before the study, were allocated to the CHW intervention wards, usually to the wards in which they lived. Most of the CHW

were women (81%) and middle-aged (74% were 30–49 years old).

Between one and three CHW were assigned to each neighborhood in the intervention wards, depending on neighborhood population size. A neighborhood (or *mtaa*) is the smallest administrative division in Dar es Salaam. Each ward in the study districts consisted of between two and ten neighborhoods. In addition to the 21 community outreach nurses that already worked in the intervention wards before the beginning of the study, the research team and the municipal council health management team re-allocated 33 additional community outreach nurses to health care facilities in the wards to lead and manage the CHW. One community outreach nurse supervised three CHW.

### Training

CHW and community outreach nurses received a five-day training in the delivery of the intervention plus a two- to three-day training on the monitoring and evaluation tools used as part of the intervention. The trainings were based on the national Tanzanian Community Home-Based Care Curriculum, with additional training content on ANC and PMTCT. Trainings were conducted by members of the research team over the course of two weeks and consisted of six modules. In addition to specific knowledge about pregnancy and maternal and child health, the training included communication and counseling skills, monitoring and evaluation of health interventions, and data collection and management. A refresher training was provided to CHW and community outreach nurses one year into the project.

### Costs

Table 1 presents both the startup and running cost estimates for the CHW intervention. We converted all Tanzanian shilling cost estimates into purchasing power parity dollars (PPP\$) for the year 2012 (for the start-up costs) and for the year 2013 (for the running costs). One PPP\$ had the same purchasing power in Tanzania as one US\$ would have had in the USA in the respective years. The total startup costs were PPP\$38,959, and the annual running costs were PPP\$477,036. Startup costs accounted for only 8% of the total costs in the first year of the intervention; 65% of the startup costs were spent on CHW training. Salary costs accounted for 61% of the total running costs and 56% of the total costs of the intervention. One CHW earned PPP\$63 per month; each community outreach nurse received a salary supplement of PPP\$88 per month as compensation for additional work responsibilities due to this trial, ie, supervision, management, and mentorship of CHW.

### Processes

#### Intervention Plan

CHW in the intervention wards had the following responsibilities:

**TABLE 1.** Startup and Running Costs of the Community Intervention in the First Year of Implementation\*

Startup Costs	No.	Cost per Person (PPPS)	Total Cost (PPPS)
<b>Trainings</b>			
Basic CHW training	136†	70	9520
M&E training for community outreach nurses	54	60	3240
M&E training for CHW	213	60	12,780
Mobile phones	213	63	13,419
Total startup costs			38,959
Running Costs	No.	Cost per Person per Month‡ (PPPS)	Total Cost per 12 Months (PPPS)
<b>Salary costs</b>			
Community intervention coordinator (full salary)	1	6033	72,396
CHW (full salary)	213	63	161,028
Community outreach nurses (salary supplement)	54	88	57,024
Mobile phone credit	213	45	115,020
Monthly CHW meeting	213	28	71,568
Total annual running costs			477,036

All dollar amounts shown are adjusted for purchasing power parity (PPP) using a PPP conversion factor of 0.4.

\*The start-up costs were incurred in 2012; the running costs were incurred in 2013. The cost estimates were not adjusted for inflation.

†The remaining 77 CHW had already received the basic training in the routine public health care system prior to the trial.

‡The data presented here is for 12 months.

M&E = Monitoring & Evaluation; PPPS, purchasing power parity-adjusted dollars.

1. Visit all homes in the neighborhoods in which they worked once every three months and providing education to all household members on maternal health, the benefits of delivering at a health care facility, the importance of testing for HIV in ANC, PMTCT, breastfeeding, postnatal care, and more general health issues that are relevant to maternal and child health (nutrition, immunization, and sanitation).
2. Identify pregnant women during home visits and refer them to ANC (by providing a referral form to the woman with a referral identification number and the name of the nearest ANC clinic). All pregnant women who were identified during the CHW home visits were specifically counseled by the CHW on the importance of early ANC visits and HIV testing during ANC, as well as on the effectiveness of PMTCT and the potentially positive effects of disclosure of HIV status to partners and male involvement in ANC and PMTCT. This counseling was only performed if privacy could be ensured, ie, if the other family members could not overhear the conversation between CHW and the pregnant woman.
3. Routinely revisit all identified pregnant women to verify whether they have visited ANC and to promote ANC uptake through information and education. CHW were instructed to routinely revisit all pregnant women they

identified in the community within two weeks after the initial visit.

4. Follow up pregnant women who missed a scheduled ANC or PMTCT appointment. The community outreach nurses who supervised the CHW were instructed to review weekly the scheduled ANC or PMTCT appointments, using the clinic registration books for these visits. During the weekly routine meeting with the CHW, they then requested the CHW who worked in the neighborhood where a pregnant woman who had missed a scheduled appointment lived, to specifically follow up with that woman and to remind and encourage her to return to the ANC or PMTCT facility.
5. Follow up women and their children postnatally through home visits to promote early childhood intervention uptake and continued PMTCT, if the woman is HIV-infected.

## Management

A full-time CHW intervention coordinator liaised with the local government authority (the Ward Development Committee), the local Department of Health (the Council Health Management), and traditional and political leaders to obtain support for the CHW intervention. In addition, she organized monthly meetings with the CHW and the community outreach nurses in each of the two study districts. At these meetings, the CHW shared and discussed obstacles they were facing in performing their work and possible approaches to overcome them. In addition, the coordinator shared with the intervention team the latest data on the number of pregnant women visited in each ward. She also coordinated supportive supervision and a mentorship program for the CHW.

At the district level, the project was coordinated by the community outreach nurses who were employed by the municipality. At the ward level, the community outreach nurses were in charge of the community activities and responsible for the coordination of all community health services of the project; specifically, they supervised and mentored the CHW working in their wards, ensured that pregnant women who missed clinic appointments received CHW visits, and served as a conduit between the CHW, clinic staff, municipal authorities, and the trial project team at MDH.

## Health Worker Retention

Two hundred thirteen CHW and 54 community outreach nurses delivered the intervention. Over the course of the first year of implementation, only 19 CHW dropped out of the study (mostly for personal reasons, such as taking care of sick family members) and needed to be replaced. All community outreach nurses were retained throughout the study period.

## Outputs

The CHW conducted a total of 45,095 home visits to pregnant women in the first 16 months of implementation. The mean number of pregnant women visited per month was

2666 (12.5 women per CHW per month); the mean number of pregnant women who had not yet attended ANC at the time of the CHW visit was 2036 (9.6 women per CHW per month) (Fig. 2). Both the number of monthly home visits conducted by CHW and the number of pregnant women visited per month more than doubled over the first year of implementation (from 1683 to 3844 and from 1606 to 3641, respectively) (Table 2). Concurrently, the percentage of pregnant women visited who had not yet attended ANC at the time of the CHW visit also more than doubled from 43% in January 2013 to 87% in December 2013. The median gestational age at the first ANC visit of pregnant women in the community intervention areas decreased significantly over time, from 21 weeks in January 2013 to 16 weeks in April 2014 (Table 2). The number of repeat visits increased steadily over time, but because of the increasing absolute numbers of pregnant women who were newly identified by the CHW, the number of repeat visits relative to all newly identified pregnant women increased only slightly, from about 5% overall in the first half of the observation period to about 6% in the second half of the observation period (Table 2).

In addition to the CHW home visits data, we also collected data from the ANC and PMTCT facilities in the intervention area. No clear trend could be identified in the number of ANC visits or in the percentage of HIV testing and HIV and PMTCT counseling in ANC. Similarly, no clear trend could be identified in the number of women seeking care in PMTCT facilities and the percentage receiving prophylaxis for PMTCT (Table 2).

### DISCUSSION

This performance evaluation provided several important insights. First, CHW can be successfully recruited and retained at large scale and low cost to work in an intervention aimed at improving ANC and PMTCT uptake in Tanzania. A main strength of this study lies in the fact that it evaluated a large-scale intervention that was implemented directly through the public-sector health system. The study was possible at low cost because it was performed by cadres of

health workers that already existed in the Tanzanian health system and who were employed at the salaries they would normally receive in public-sector employment.

Second, CHW can successfully identify pregnant women in the community before they self-identify as pregnant to the public-sector health system. Over a 16-month period, 213 CHW in the study identified more than 45,000 pregnant women in their homes. More than 75% of these pregnant women had not yet presented to the health system for ANC. On average, each month every CHW identified about 10 pregnant women who had not yet attended ANC. Moreover, large proportions of these women had not yet reached 14 weeks of pregnancy, indicating that this CHW intervention has the potential to significantly improve adherence to the World Health Organization recommendation that pregnant women should attend ANC for the first time in the first trimester.

Third, over time, the CHW became increasingly effective in identifying pregnant women in the community. This observation could be explained by several types of learning. The CHW might have learned how to best approach women and families in the community and elicit information on pregnancy status; the community outreach nurses might have learned how to best mentor and motivate the CHW, increasing the intervention effectiveness; community members might have learned that the CHW were working hard to support pregnant women in the community and thus in turn have become increasingly willing to work with the CHW.

Fourth, over time, the proportion of pregnant women who had not yet attended ANC at the first CHW home visit increased while the median gestational age decreased. Both findings could be explained by improvements in the CHW's ability to elicit pregnancy status early in pregnancy. Additionally, the decrease in gestational age could be explained by a change in gestational age composition of pregnant women in the community who are reached by a CHW for the first time. Initially, CHW identified pregnant women in all stages of pregnancy; as the intervention continued they increasingly identified women in early pregnancy stages because they have already met the women in advanced stages of pregnancy.

Fifth, although the data indicate that the CHW were successful in identifying pregnant women during home visits, based on the small percentage of repeat visits the CHW conducted each month, it is clear that they largely failed to perform the routine repeat home visits to follow up with the pregnant women to ascertain ANC uptake after the initial identification. Research currently underway is aimed at elucidating the reasons for this failure and whether the repeat visits that were performed were routine visits or were targeted visits to follow up with women who had missed scheduled ANC and PMTCT appointments.

This study is a quantitative performance evaluation and as such has several limitations. For one, it cannot establish causal effects of the CHW intervention on ANC uptake, HIV testing in pregnancy, and PMTCT uptake and effectiveness. A necessary condition for such effects is that the CHW can identify pregnant women in the community before these women have presented to ANC; this study proves that this condition is met. Although the CHW thus reached and

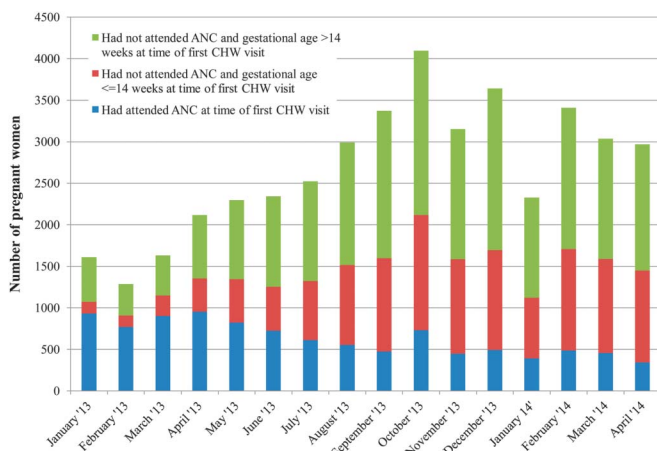


FIGURE 2. Number of pregnant women visited per month by ANC attendance status.

TABLE 2. CHW Visits to Pregnant Women, ANC Visits and PMTCT Visits, by Month

Month	Year	CHW Home Visits				Health Facility				
		No. of Home Visits to Pregnant Women	No. of Pregnant Women Visited	Repeat Visits Within a Month,* %†	Median Gestational Age at First CHW Visit,‡ Weeks (IQR)	ANC Visits§		PMTCT Visits§		PMTCT Coverage, %¶
						No. of Pregnant Women	HIV Testing Coverage, %¶	HIV and PMTCT Counseling Coverage, %¶	Total Visits, No.	
January	2013	1683	1606	5	21 (16, 29)	5075	97	96	282	96
February	2013	1348	1286	5	22 (15, 29)	3959	95	90	258	96
March	2013	1717	1629	5	21 (14, 29)	4366	86	86	188	92
April	2013	2219	2113	5	19 (14, 26)	4759	85	86	231	91
May	2013	2365	2297	3	18 (13, 24)	4655	89	89	252	90
June	2013	2454	2341	5	18 (13, 23)	3631	91	91	191	90
July	2013	2663	2524	5	18 (12, 23)	4497	91	91	193	94
August	2013	3201	2991	7	16 (12, 21)	4441	88	87	226	85
September	2013	3549	3373	5	16 (12, 21)	5342	93	91	262	82
October	2013	4356	4098	6	16 (12, 21)	6172	86	84	303	88
November	2013	3342	3153	6	16 (12, 21)	6025	89	89	298	83
December	2013	3844	3641	5	17 (12, 22)	5962	91	90	302	86
January	2014	2329	2190	6	17 (12, 23)	6628	93	91	396	88
February	2014	3640	3409	6	16 (11, 22)	5752	88	86	311	85
March	2014	3218	3038	6	16 (11, 21)	5666	93	90	145	88
April	2014	3167	2969	6	16 (12, 21)	4823	93	91	36	94

\*This is the number of visits to a pregnant woman who has already been visited that month.

†The denominator is the number of home visits to pregnant women in each month.

‡Gestational age decreased significantly over time ( $P < 0.0001$ ). IQR = interquartile range.

§ANC and PMTCT visits are shown for those clinics that are located in the wards where the CHW intervention took place. The PMTCT visits data from the last month available for this table (April 2014) had not been fully entered at the time when this article was completed; the 36 PMTCT visits listed for this month are thus an underestimate.

||Total number of pregnant women who visited the ANC clinics for the first time that month.

¶Coverage (in percent) among all pregnant women who visited the ANC clinics for the first time that month.

#Coverage with effective PMTCT (in percent) among all HIV-infected women attending the PMTCT services for the first time that month.

CHW, community health workers; ANC, antenatal care; PMTCT, prevention of mother-to-child transmission of HIV; No., number; IQR, interquartile range.

counseled large numbers of pregnant women at points in time when it was possible to improve their ANC and PMTCT uptake, based on the data collected in the ANC and PMTCT facilities in the study area, it is unclear whether such improvements did indeed occur. The number of ANC or PMTCT visits does not seem to have increased substantially in these facilities. However, these data do not allow for any strong conclusions because the pregnant women living in the community intervention area could have sought care outside the study area. Moreover, the effectiveness of ANC and PMTCT could have improved without major increases in the numbers of ANC and PMTCT visits if these visits occurred earlier in pregnancy on account of the intervention. The cluster-randomized controlled trial that this performance evaluation is nested in will establish the causal effects of CHW home visits on health systems and health outcomes.<sup>15</sup>

## CONCLUSIONS

This performance evaluation of the first 16 months of implementation of a CHW intervention to improve uptake of ANC, HIV testing and PMTCT in urban Tanzania showed that such an intervention is feasible at large scale and low total cost. CHW can be effective in identifying and counseling pregnant women in the community long before they attend ANC for the first time. This community-based contact

early in pregnancy has the potential to substantially improve the timeliness of ANC uptake and to ensure that women are tested for HIV early in pregnancy. Given that this intervention was implemented in the public-sector health system using only cadres of health workers that already exist in Tanzania, we believe that these findings will prove useful for planning similar interventions in other sub-Saharan African countries.

## REFERENCES

- Lincetto O, Seipati MA, Gomez P, et al. Antenatal care. In: Lawn J, Kerber K, eds. *Opportunities for Africa's Newborns: Practical Data, Policy and Programmatic Support for Newborn Care in Africa*. Geneva, Switzerland: WHO; 2006:51–66.
- WHO. Global health observatory data repository. 2014. Available at: <http://apps.who.int/gho/data/view.main.1610?lang=en>. Accessed June 12, 2014.
- National Bureau of Health Statistics. *Tanzania Demographic and Health Survey*. Dar es Salaam: National Bureau of Health Statistics; 2010.
- Mosha TC, Philemon N. Factors influencing pregnancy outcomes in Morogoro Municipality, Tanzania. *Tanzan J Health Res*. 2010;12:249–260.
- Gross K, Alba S, Glass TR, et al. Timing of antenatal care for adolescent and adult pregnant women in south-eastern Tanzania. *BMC Pregnancy Childbirth*. 2012;12:16.
- World Health Organization. *Antenatal Care in Developing Countries—Promises, Achievements and Missed Opportunities*. Geneva, Switzerland: WHO; 2003.

7. World Health Organization. *Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection*. Geneva, Switzerland: WHO; 2013.
8. Tanzania Commission for AIDS (TACAIDS). *HIV/AIDS and Malaria Indicator Survey 2011-2012*. Dar Es Salaam, Tanzania: TACAIDS; 2012.
9. UNAIDS. *Global Report: UNAIDS Report on the Global AIDS Epidemic*. Geneva, Switzerland: UNAIDS; 2013.
10. Ahorlu CK, Koram KA, Seakey AK, et al. Effectiveness of combined intermittent preventive treatment for children and timely home treatment for malaria control. *Malar J*. 2009;8:292.
11. Sheth M, Obrah M. Diarrhea prevention through food safety education. *Indian J Pediatr*. 2004;71:879–882.
12. Agrasada GV, Ewald U, Kylberg E, et al. Exclusive breastfeeding of low birth weight infants for the first six months: infant morbidity and maternal and infant anthropometry. *Asia Pac J Clin Nutr*. 2011;20:62–68.
13. Ediau M, Wanyenze RK, Machingaidze S, et al. Trends in antenatal care attendance and health facility delivery following community and health facility systems strengthening interventions in Northern Uganda. *BMC Pregnancy Childbirth*. 2013;13:189.
14. le Roux IM, Tomlinson M, Harwood JM, et al. Outcomes of home visits for pregnant mothers and their infants: a cluster randomized controlled trial. *AIDS*. 2013;27:1461–1471.
15. Sando D, Geldsetzer P, Magesa L, et al. A cluster-randomized controlled health systems implementation trial of a Evaluation of a community health worker intervention and the World Health Organization's Option B versus Option A to improve antenatal care and PMTCT outcomes in Dar es Salaam, Tanzania: study protocol for a cluster-randomized controlled health systems implementation trial. *Trials*. 2014;15:359.
16. Van Belle SB, Marchal B, Dubourg D, et al. How to develop a theory-driven evaluation design? Lessons learned from an adolescent sexual and reproductive health programme in West Africa. *BMC Public Health*. 2010;10:741.
17. Chen H. *Practical Program Evaluation*. Thousand Oaks, CA: SAGE Publications; 2005.
18. Tough SC, Johnston DW, Siever JE, et al. Does supplementary prenatal nursing and home visitation support improve resource use in a universal health care system? A randomized controlled trial in Canada. *Birth*. 2006; 33:183–194.
19. Rabasseda X. Cardiovascular health: highlights from the 15th World Congress of Cardiology. *Timely Top Med Cardiovasc Dis*. 2006;10:E27.
20. O'Riordan M. *Use of Non-docs Improves Adherence Following ACS. World Congress of Cardiology (WCC) Scientific Sessions 2014*. Melbourne, Australia: 2014.
21. Aronson E, Wilson T, Akert A. *Social Psychology*. 7th ed. Upper Saddle River, NJ: Prentice Hall; 2010.
22. Satterfield D, Burd C, Valdez L, et al. The “in-between people”: participation of community health representatives in diabetes prevention and care in American Indian and Alaska native communities. *Health Promot Pract*. 2002;3:166–175.
23. National Bureau of Statistics. *Population and Housing Census*. Dar es Salaam, Tanzania: National Bureau of Statistics; 2012.
24. Stern E, Stame N, Mayne J, et al. *Broadening the Range of Designs and Methods for Impact Evaluations*. London: DFID; 2012.
25. USAID. *USAID Evaluation Policy*. Washington, DC: USAID; 2011.
26. Khagram S, Thomas C. Toward a platinum standard for evidence-based assessment by 2020. *Public Adm Rev*. 2010;70:S100–S106.
27. Barahona C. *Randomised Control Trials for the Impact Evaluation of Development Initiatives: A Statistician's Point of View*. Rome: Institutional Learning and Change Initiative; 2010.
28. Fitzmaurice G, Laird N, Ware J. *Applied Longitudinal Analysis*. Hoboken, NJ: John Wiley & Sons; 2011.
29. USAID. *The Health System Assessment Approach: A How-to Manual*. USAID; 2012.
30. Massoud R, Askov K, Reinke J, et al. *A Modern Paradigm for Improving Healthcare Quality*. Bethesda, MD: Center for Human Services; 2001.