Increasing uptake of maternal, newborn, and child health interventions through a group-based health education and microfinance program: a prospective matched cohort study in western Kenya

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Abstract

Background

We launched Chamas for Change (Chamas), a group-based health education and microfinance program for pregnant women and their infants, to address inequities contributing to high rates of maternal and neonatal mortality in western Kenya. In this prospective matched cohort study, we evaluated Chamas’ impact on improving uptake of evidence-based maternal, newborn and child health (MNCH) interventions.

Methods

We prospectively compared MNCH intervention uptake between a cohort of Chamas participants and controls matched for age, parity, and prenatal care location. Between October-December 2012, government-sponsored community health volunteers (CHV) recruited pregnant women in Busia county attending their first antenatal care (ANC) visit to participate in Chamas and enroll in this study. Upon joining, women agreed to attend bi-monthly group health education and optional microfinance sessions for 12 months. We selected controls among non-Chamas participants who attended the same ANC clinics. We collected baseline sociodemographic and reproductive health data at study enrollment. We used descriptive analyses and adjusted multivariable logistic regression models to compare outcomes across cohorts at 6-12 months postpartum, with \( \alpha \) set to 0.05.

Results

Compared to controls \( (n=115) \), a significantly higher proportion of Chamas participants \( (n=211) \) delivered in a facility with a skilled birth attendant \( (84.4\% \ vs. \ 50.4\%, \ p<0.001) \), attended at least four ANC visits \( (64.0\% \ vs. \ 37.4\%, \ p<0.001) \), exclusively breastfed to six months \( (82.0\% \ vs. \ 47.0\%, \ p<0.001) \), and received a CHV home visit within 48 hours postpartum \( (75.8\% \ vs. \ 38.3\%, \ p<0.001) \). In our adjusted models, Chamas participants were nearly five times as likely as controls to deliver in a health facility \( \text{OR} \ 5.07, 95\% \text{ CI} \ 2.74-9.36, \ p<0.001 \). Though not statistically significant, Chamas participants experienced fewer stillbirths than non-participants \( (n=2 \ vs. \ n=6, \ p=0.083) \). Our sensitivity analyses revealed no significant difference in the odds of facility delivery based on microfinance participation.
Conclusions
Chamas participation was associated with increased uptake of MNCH interventions among pregnant women in western Kenya. Our findings demonstrate this program's potential to achieve population-level maternal and infant health benefits; however, a larger study is needed to validate this observed effect.

Background
Addressing preventable maternal and infant deaths is a significant challenge on the global agenda. As part of Sustainable Development Goal (SDG) 3, the World Health Organization (WHO) and United Nations tasked countries with reducing their maternal mortality ratio (MMR) to less than 70 maternal deaths per 100,000 livebirths and neonatal mortality rate (NMR) to less than 12 deaths per 1,000 livebirths by 2030.

1 This is an ambitious target for Kenya, where the MMR and NMR are 362 per 100,000 and 22 per 1,000 livebirths, respectively.

2 Evidence-based strategies that enhance uptake of low-cost, lifesaving Maternal, Newborn and Child Health (MNCH) interventions are urgently needed to meet these SDG targets.

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Per WHO and Republic of Kenya Ministry of Health (MOH) recommendations, these interventions may include: delivering in health facilities with skilled birth attendants (SBA), attending at least four focused antenatal care (ANC) visits, receiving a community health volunteer (CHV) home visit within 48 hours of delivery, and exclusively breastfeeding (EBF) to six months.

5-11 Promoting access and use of long-term family planning (FP) methods may allow women to better space and limit pregnancies, which decreases risk for maternal and perinatal morbidity and mortality.

12-14 Lastly, ensuring infants receive the Oral Polio Vaccination at birth (OPV0) may increase protection against infectious disease mortality during the first year of life.
In rural Kenya, only half of women deliver in a health facility with an SBA (47%), attend at least four ANC visits (51.3%), and receive a CHV visit within the first 48 hours after delivery (53%).

2 EBF beyond the initial months postpartum is uncommon, lasting a median of 3.4 months among rural populations.

16 Less than half of all women currently use a modern method of contraception (39.1%), and among those using, less than 10% are on a long-term or permanent method.

2 From an equity perspective, poor MNCH outcomes are disproportionate across socioeconomic strata. Access to care is generally correlated with economic accessibility; thus, women of lower socioeconomic status often encounter greater barriers to accessing quality care.

In addition to promoting evidence-based MNCH interventions, one of the key enablers in meeting the SDG goals is financial inclusion. The World Bank defines financial inclusion for individuals as “access to useful and affordable financial products and services that meet their needs – transactions, payments, savings, credit and insurance – delivered in a responsible and sustainable way.”

18 The ability to store money, transfer payments and access loans is increasingly recognized as a vital strategy to overcome financial barriers to health. In Kenya, however, it is estimated that up to one-third of the population is excluded from the formal financial sector.

19 This is particularly true among women in rural Kenya, who are disproportionately excluded from participating in formal income generating activities, making it difficult to adequately finance health-related expenditures for themselves or their children.

19 This continued pattern of exclusion of poor and rural women only exacerbates their precarious financial and social position.

To address inequities contributing to high rates of maternal and infant mortality in western Kenya, the
Academic Model Providing Access to Healthcare (AMPATH), in partnership with the Government of Kenya (GOK), launched Chamas for Change (Chamas) in 2012. This CHV-led program offers pregnant women free health and microfinance education in a supportive group setting during the antenatal and postpartum period. Translated from Kiswahili as ‘groups with purpose,’ “chamas” have a longstanding presence in East Africa.

These groups are highly gendered institutions that women have relied on for centuries for social support and resource pooling.

Using this existing cultural script, our solution combines best practices from women’s health and microfinance programs to create an integrated model that strives to not only increase the developmental potential of mothers and infants, but also to interrupt cycles of poverty by empowering women to live healthier, financially secure lives.

In this prospective matched cohort study, we evaluated the effect of Chamas on improving uptake of evidence-based MNCH interventions namely, delivering in health facilities with an SBA, attending at least four ANC visits, receiving a CHV home visit within 48 hours postpartum, EBF to six months, using a long-term FP method, and vaccinating infants with OPV0 at birth. We additionally examined the combined impact of health education and microfinance participation on achieving these outcomes.

Methods
Study setting and design
We conducted our study in Bunyala, a rural sub-county in Busia, Western Province, from September 2012 to June 2014. We selected Bunyala for two primary reasons: (1) the MMR and NMR are much higher than national estimates, and (2) the MOH demonstrated strong interest and support of AMPATH’s programs and collaborations. Women and infants in Western Province suffer from the second highest maternal and neonatal mortality rates in Kenya.

In Busia County, the most recent estimate for infant mortality rate (IMR) is exceedingly high at 125.9 per 1,000 live births.
In Bunyala, MNCH activities, including antenatal and postpartum care led by the GOK and supported by AMPATH, exist across 16 community units and 8 MOH health facilities. To evaluate the impact of Chamas participation on uptake of MNCH interventions, we employed a prospective, matched-cohort study design. We compared outcomes between a cohort of program participants and matched controls recruited during their first ANC visit in a Bunyala public health facility. We followed women prospectively for one year and recorded MNCH outcome and microfinance participation data between 6-12 months postpartum.

Participant selection
We invited all pregnant women attending their first ANC visit at an MOH-sponsored health facility in Bunyala between October-December 2012 to enroll in the Chamas program and to participate in this study (Figure 1). We did not exclude women based on any sociodemographic or reproductive health factors including age, education-level, employment-status, marital status, parity, or prior history of facility delivery. To select our control cohort, we reviewed lists of pregnant women who chose not to enroll in Chamas from clinic registers. A study team member approached eligible women to serve as controls and consented those interested to participate. Women who agreed to participate in either cohort provided baseline sociodemographic and reproductive health data at the time of enrollment and consented to complete a follow-up survey at 6-12 months postpartum. Women enrolled in the control cohort received the current standard MOH care.

Intervention description
In September 2012, we selected 32 GOK sponsored CHVs to participate in a four-day training on Chamas. We trained attendees on how to deliver our evidence-based health curriculum using an illustrated flipchart, facilitate participatory group discussions, and equip program participants with basic microfinance literacy and skills. Throughout the year, CHVs attended regularly scheduled meetings (at months 1-4, 6, 9, and 12) with implementation leads from the Chamas team to provide feedback, as well as receive additional mentorship and support.

Women attending Chamas convened twice per month for 12 months to attend CHV-led group health education and microfinance sessions. Each session consisted of a 60 to 90-minute participatory lesson
on one health (i.e. antenatal care, family planning) and one social (i.e. intimate partner violence, microfinance literacy) topic. Upon joining, women agreed to uphold the goals of the program, namely to: deliver in a health facility, attend at least four ANC visits, EBF to six months, receive a CHV home visit within 48 hours of delivery, consider a long-term method of FP, ensure their infant received OPV0, and save money to finance health expenditures. We tasked each group with writing their own constitution in which they delineated additional individual goals.

Following lessons, members elected to participate in a table-banking program called “Group Integrated Savings for Health and Empowerment” (GISHE). GISHE is an adaptation of the Catholic Relief Services’ *Savings and Internal Lending* model, which encourages a savings-led, group-based microfinance scheme.

25 We deemed participation optional to avoid excluding women that could not afford to contribute the minimum 50 KSH (0.50 USD) share per meeting. Members contributed up to ten times the amount of the minimal share at each Chamas session. The group provided loans that amounted to a multiple of the individual member’s savings and returned a dividend payment based on interest accrued at the end of the year. Profits generated were distributed to the entire group in amounts proportional to individual shares contributed.

Data collection and study variables

Data collection

We collected baseline and outcome data at two time-points for all participants using paper-based, structured questionnaires. We recorded baseline data on participant sociodemographic and reproductive health information at study enrollment, and outcome data on uptake of MNCH interventions between 6-12 months postpartum for each participant. Where possible, we extracted data from Maternal and Child Health (MCH) booklets. If women did not have their MCH booklet available or if booklets missed data, we asked participants to self-report answers.

We additionally assessed maternal and infant morbidity and mortality using program monitoring data, as well as Chamas group process outcomes (i.e. group microfinance participation) using CHV-completed, paper-based forms. Further details on our dependent and independent variables are
Dependent/outcome variables

Our primary outcome of interest was the proportion of women delivering in health facilities with an SBA. We defined SBA as a “health professional – such as a midwife, doctor, clinical officer or nurse.”

2 This was a self-reported measure collected from a structured end-line questionnaire. Our secondary MNCH outcomes included: the proportion of women who attended at least four ANC visits, received a CHV within 48 hours postpartum, EBF to 6 months, adopted a long-term or permanent method of family planning, and the proportion of infants that received OPV0 at birth.

Though not powered to detect significant differences, we also assessed pregnancy-related morbidity and mortality outcomes including: the gestational age (GA) at delivery, the incidence of miscarriage (defined as loss of fetus less than 28 weeks gestation) and stillbirth (defined as loss of fetus between 28 weeks and delivery), as well as the incidence of infant and maternal mortality. Lastly, we assessed secondary outcomes related to microfinance participation within the Chamas cohort (i.e. proportion of Chamas members participating in GISHE, individual loans received, group savings accumulated).

Independent variables/covariates

To assess the modifying effect of covariates at the individual and group level, we collected sociodemographic and reproductive health information for all participants, including: age, education level, employment status, marital status, parity, prior facility delivery (among those who previously delivered), and facility location of first ANC visit. Maternal age may impact worsened maternal and fetal outcomes, increasing the propensity of older women to seek care or establish contact with health facilities earlier in pregnancy.

26 Sociodemographic characteristics such as education level, employment status and marital status may impact the likelihood of facility delivery as these variables serve as proxies for socio-economic status. Previous studies demonstrate women of lower socio-economic status or lower levels of education are less likely to deliver in facilities with an SBA.

27 Reproductive health characteristics such as parity and prior facility delivery may positively or negatively impact a woman’s likelihood of returning to facilities, based on experiences
with the health system.

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29 Lastly, we collected first ANC visit facility location to address potential area-level variance on the likelihood of facility delivery.

**Sample size determination**

To calculate our estimated sample size, we assumed 55% of women who attended at least one ANC visit delivered in a health facility and an intraclass correlation coefficient of 0.34, which accounts for population-level variance due to area-level effects (i.e. contact and proximity to the health system).

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30 With these assumptions, we determined a 2:1 sample of 240 (156 Chamas and 84 Control) participants adequate to detect a 20% difference in the proportion of facility deliveries between intervention and control groups, with a type I error rate (α) of 0.05 and power of 85%. We assumed a 10% loss to follow-up and established a final target sample size of 267 total participants.

**Data analysis**

We tabulated frequencies and calculated descriptive statistics comparing socio-demographic and reproductive health variables between Chamas participants and controls. For all bivariate analyses, we used student’s T tests for continuous variables, Mann-Whitney U tests for continuous variables with non-normal distributions, and Chi-square tests for categorical variables.

Multivariable nested models were used to test the association between Chamas participation and facility delivery independently, with successive inclusion of covariates namely: age, education level, employment status, marital status, parity, and prior facility delivery. We examined age as a continuous variable. We collapsed education level into a 3-level categorical variable (none-some primary, completed primary, some-completed secondary), and employment (unemployed vs. employed), marital status (single/separated/divorced vs. married), parity (primiparous vs. multiparous), and prior facility delivery into dichotomous variables. We performed complete case analyses and excluded records with missing data on the primary outcome variable or covariates. Random effects models, employing the same nested-inclusion technique described above, tested for
significant area-level variance as determined by prenatal care location. We additionally ran an interaction model with ANC attendance (dichotomous variable, <4 visits vs. ≥4 visits) and Chamas participation, as we hypothesized mothers attending at least four ANC visits were more likely to deliver in a health facility than those who attended fewer than four visits.

29 We decided a priori to conduct an additional sensitivity analysis restricting our intervention sample solely to Chamas women who participated in GISHE to examine the impact of combined effect of health education and microfinance participation on MNCH intervention uptake. We conducted all statistical analyses using Stata version 13.1 (StataCorp, College Station, Texas) with α set to 0.05.

Ethical consideration
Our study received ethics approval from the Institutional Research Ethics Committee at Moi Teaching and Referral Hospital (IREC/2013/76), the Office of Research Administration at Indiana University (#1306011628), and the Research Ethics Board at the University of Toronto (# 2907). We obtained written informed consent from all participants prior to data collection.

Results
Among 457 women attending their first ANC visit between October-December 2012, just over half (n=237) joined Chamas and 220 declined participation (Figure 1). Most women in both the control (69.5%) and intervention (95.4%) arms consented to participate in this study. Loss to follow-up rates in the control and intervention arms were 24.8% and 6.6%, respectively. Results are solely reported for our final sample size of 326 women (n=115 control, n=211 intervention participants) who contributed end-line data between 6-12 months postpartum.

Participant demographics
Baseline sociodemographic and reproductive health characteristics by participant group are presented in Table 1. Overall, our cohort and intervention groups were well-matched with few significant differences. Participants averaged 25.2 years of age. Most completed primary school, were married, and attended their first ANC visit at 22.1 weeks gestation. A significantly higher proportion of women in the control cohort were unemployed (56.5% vs. 40.3%, p<0.05) and had previously delivered a liveborn infant (100% vs. 87.7%, p<0.05) than women in Chamas. Among women with a
previous delivery, a significantly higher proportion of Chamas participants had delivered in a health facility (65.3% vs. 47.8%, p<0.05); however, we reported missing data for nearly 20% of controls for this covariate.

**Uptake of MNCH interventions**
Results for uptake of MNCH interventions by cohort are presented in Table 2. Compared to controls, a significantly higher proportion of Chamas participants delivered in a health facility with an SBA (84.4% vs. 50.4%, p<0.05), attended at least 4 ANC visits (64.0% vs. 37.4%, p<0.05), received a CHV home visit within 48 hours postpartum (75.8% vs. 38.3%, p<0.05), and exclusively breastfed to 6 months postpartum (82.0% vs. 47.0%, p<0.05). Though not statistically significant, a higher proportion of Chamas participants adopted a long-term or permanent method of FP (39.0 vs. 34.8%, p=0.07), and a higher proportion of their infants received the OPV0 immunization at birth (91.9% vs. 85.2%, p=0.41). Missing values comprised less than 10% of each cohort across all outcomes measured.

**Maternal and infant morbidity and mortality**
Women in Chamas delivered at a significantly older gestational age than controls (39.4 ± 2.7 vs. 35.5 ± 8.9, p<0.001). Of note, 33% (n=38) of the control cohort missed data for this outcome. We used program monitoring data to record and narratively assess maternal, perinatal and infant deaths during the study period. Though not statistically significant, women in Chamas experienced fewer stillbirths (n=2 vs. n=6), yet a greater number of miscarriages (n=11 vs. n=9) and infant deaths (n=6 vs. n=4) than controls. We reported two maternal deaths in each cohort.

**Association between Chamas participation and health facility delivery**
Fully adjusted results from our multivariable analyses are presented in Table 3. We excluded 19 participants (5.8% of sample) from our analyses as they missed primary outcome data on facility delivery or on a covariate. Excluded participants did not substantially differ in sociodemographic or reproductive health characteristics from those included in our analysis. In our unadjusted model, Chamas participation was associated with over five times the odds of delivering at a health facility with an SBA compared to controls (OR 5.49, 95% CI 3.12-9.64, p<0.001). This effect was only slightly attenuated after controlling for age, education level, employment, marital status, parity, and prior
facility delivery (OR 5.07, 95% CI 2.74-9.36, p<0.001). Following adjustment, prior facility delivery was the only significantly associated covariate; those with a prior facility delivery were roughly four times as likely as those without to deliver in a health facility with an SBA (OR 4.31, 95% CI 2.25-8.25, p<0.001).

We ran random effects models to determine whether significant area-level variance due to prenatal care location impacted the likelihood of facility delivery (Table 4). We grouped women according to the location of their first antenatal visit, which totaled nine sites with one extra group for those with missing data (Table 1). Our null model revealed a significant amount of area-level variance ($\sigma_u^2 = 0.30 \pm 0.24, p<0.05$) in the odds of facility delivery. Following adjustment for covariates, the variance remained statistically significant ($\sigma_u^2 = 0.44 \pm 0.39, p<0.05$); however, the association between Chamas participation and adjusted odds of delivering in a health facility was materially unchanged (OR 5.60, 95% CI 2.91-10.80, p<0.001). Finally, we tested for interaction between ANC attendance and Chamas participation with a likelihood ratio test and did not find an interaction effect based on an a priori significance level of 0.05 (analyses not shown).

Impact of microfinance participation
Among all women participating in Chamas, 71.8% (n=152) also participated in GISHE. A significantly higher proportion of women participating in GISHE completed at least some secondary school (18.9% vs. 3.4%, p<0.05) and were employed (63.5% vs. 48.3%, p<0.05) than those who chose not to participate. On average, six group members received loans per meeting, varying from 200-2000 KSH (2-22 USD). Women primarily used loans to pay for school fees, business start-up costs and health service-related fees. All 16 Chamas groups generated adequate funds to repay group start-up costs of 5000 KSH (50 USD). There were no statistically significant differences in either the primary (facility delivery) or secondary outcomes when we compared GISHE participants to those not participating within the Chamas cohort.

We conducted an additional sensitivity analysis restricting our intervention sample solely to Chamas women who participated in GISHE (n=152) to examine the impact of both health education and microfinance participation on MNCH intervention uptake. Results generated from this model were
materially unchanged from those of our fully adjusted multivariable model (analyses not shown).

Discussion
Major findings
We evaluated the effect of Chamas participation on improving uptake of evidence-based MNCH interventions known to reduce maternal and infant morbidity and mortality. We demonstrated women participating in Chamas had a significantly higher adjusted odds of delivering in a health facility with an SBA than non-participants. We additionally demonstrated a higher proportion of Chamas women attended at least four ANC visits, breastfed exclusively to six months, and received a CHV home visit within 48 hours of birth as compared to controls. Though not statistically significant, a higher proportion of Chamas participants adopted a long-term or permanent method of FP and immunized infants with OPV0. Of note, our adjusted models also demonstrated women with a prior health facility delivery had a significantly higher odds of doing so again. This finding reveals potential for substantially increasing facility deliveries through Chamas among mothers with a subsequent pregnancy and delivery. These promising results suggest the Chamas program may serve as an effective strategy to enhance uptake of low-cost MNCH interventions in western Kenya that are urgently needed to accomplish SDG targets by 2030.

We additionally examined the combined impact of health education and microfinance participation on achieving these outcomes. Recent literature suggests integrating microfinance schemes within women's health education or service delivery programs may enhance positive outcomes.

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Our sensitivity analyses revealed no significant difference in the odds of facility delivery based on GISHE participation; however, non-GISHE participants comprised less than half of the intervention cohort. Additionally, we did not assess participation in microfinance activities apart from GISHE across cohorts, though crude estimates suggest a substantial portion (nearly 30% in some rural western Kenyan counties) of the population is involved in small-scale, table-banking and income generating activities.

33.
It is possible participation in other microfinance schemes across cohorts may nullify the effect of GISHE participation; however, further investigations with larger sample sizes are needed to clarify this association.

Our random effect models revealed significant area-level variance based on location of prenatal care and likelihood of facility delivery. Of interest, the variance remained statistically significant after controlling for covariates. This finding suggests there may be unobserved compositional effects within Chamas groups, or contextual effects between them, that explain some of the remaining variance in our primary outcome. The specific characteristics of our program that promote health care access are out of scope for the present study; however, future work may elucidate the causal pathways through which Chamas involvement influences uptake of maternal, newborn and infant health services.

Strengths and Limitations
Our study has several notable strengths. First, we employed a prospective, matched-cohort design to ensure reasonable comparisons between Chamas participants and controls. Our cohorts were relatively well-matched, with adequate sample sizes to detect significant differences in our primary outcome of facility delivery, as well as our secondary MNCH intervention outcomes. Second, we designed the Chamas program in collaboration with GOK and county-level MOH representatives, which ensured support and investment from local community members. Third, our study investigates the potential impact of a novel, integrated, group-based health education and microfinance program that aligns with current recommendations to mobilize CHVs to address unmet needs of pregnant and postpartum women.

In low- and middle-income country settings across Sub-Saharan Africa and Asia, CHV-based efforts to promote health education through women’s groups demonstrate substantial promise in improving MNCH outcomes, particularly among poor, rural populations.

Microfinance involvement is also associated with improving health outcomes.

Chamas integrates these strategies to provide group-based delivery of MNCH curriculum and microfinance literacy, tailored to the specific needs of rural Kenyan women and infants. Our
findings underscore a need for additional work to clarify whether there is synergistic impact in combining MNCH education and microfinance participation on improving population-level outcomes in health, as well as financial inclusion.

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There are several noteworthy limitations of our study. First, though we were able to detect significant differences in our primary health-related outcomes of interest, we did not adequately power our study to determine the impact of Chamas participation on maternal and infant mortality outcomes or the impact of GISHE participation on improving outcomes. Second, though we intended to conduct end-line assessments with all study participants around 6-12 months postpartum, we assessed most participants close to 9-15 months postpartum due to logistical constraints. This lag in assessment subjected participants to added potential for recall bias, particularly when objective data were not available from MCH Booklets. Third, by solely recruiting women from ANC facilities we likely introduced selection bias, as those who never attended are likely at greatest risk for poor outcomes. We utilized this approach due to similar selective pressures introduced through community-based recruitment strategies, which tend to be more logistically challenging yet still introduce potential for excluding socio-demographically marginalized women. Future studies may attempt to replicate these findings using an alternative recruitment approach to minimize bias. Fourth, our paper-based assessments resulted in substantial missing data on both demographic and outcome indicators. As such, we were unable to include all participants in our analysis of our primary outcome. We intend to employ digital-based data collection methods to improve data quality in future studies. Lastly, we did not record individual-level Chamas attendance, which disabled us from analyzing whether there is an inflection point in program participation for improving MNCH intervention uptake. Future studies should be cognizant of this limitation and investigate whether there may be a threshold-effect associated with Chamas participation.

Implications for Practice
Our findings demonstrate that participation in a group-based health education and microfinance program during the antenatal and postpartum period increased uptake of evidence-based MNCH
interventions known to reduce maternal and infant mortality. Local MOH representatives and policymakers may consider the *Chamas* program when seeking an effective, low-cost strategy to increase facility-based deliveries and enhance uptake of other potentially life-saving interventions in western Kenya. Outstanding questions remain regarding the association between microfinance participation, as well contextual factors that lead to improved outcomes. To clarify the impact of our program on outcomes on a population-level scale, there is need for additional research with larger sample populations.

**Conclusions**

Overall, participating in *Chamas for Change* revealed a five-fold increase in the likelihood of delivering in a health facility, as compared to mothers receiving the current MOH standard of care in Busia County. Our program demonstrates potential to achieve population-level maternal and infant health benefits; however, a larger study is needed to validate this observed effect.

**Abbreviations**

- **AMPATH** – Academic Model Providing Access to Healthcare
- **ANC** – Antenatal Care
- **CHV** – Community Health Volunteer
- **EBF** – Exclusively Breastfeed
- **FP** – Family Planning
- **GA** – Gestational Age
- **GISHE** – Group Integrated Savings for Health and Empowerment
- **GOK** – Government of Kenya
- **IMR** – Infant Mortality Rate
- **SDG** – Sustainable Development Goal
- **WHO** – World Health Organization
- **MMR** – Maternal Mortality Ratio
- **MCH** – Maternal and Child Health

**Declarations**

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**Availability of data and materials**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Authors’ contributions**

ACD, LJR, JJS, and DCC made substantial contributions to the conception and design of this work. JEI, SC, MAO, and CBO played critical roles in the design of data collection instruments and data acquisition process. JWS, LYM, LJR, and CBO led data analysis and interpretation. ACD, LYM, JWS, DCC, and JJS drafted the first iterations of the manuscript. LYM, LJR and ACD substantially revised the article. LYM compiled final author edits to the manuscript, supporting materials, and submitted final draft to the journal. All authors approved the submitted version of this article and agreed both to be personally accountable for the author’s own contributions and ensure that questions related to the accuracy or integrity of any part of the work (even ones in which the author was not personally involved), are appropriately investigated, resolved, and the resolution documented in the literature.

**Ethics approval and consent to participate**

Our study received ethics approval from the Institutional Research Ethics Committee at Moi Teaching and Referral Hospital (IREC/2013/76), the Office of Research Administration at Indiana University (#1306011628), and the Research Ethics Board at the University of Toronto (# 2907).
Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Tables
Table 1. Baseline sociodemographic and reproductive health characteristics by participant group for study population (n=326)
| Variable                      | Study Population (n=326) M ± SD or % (n) | Chamas (n=211) M ± SD or % (n) | Conti M ± ! |
|------------------------------|-----------------------------------------|--------------------------------|-------------|
| Age                          | 25.2 ± 4.8                              | 25.2 ± 5.0                     | 25          |
| Education level              |                                         |                                |             |
| None-some primary            | 14.7 (48)                               | 11.8 (25)                      | 2           |
| Completed Primary            | 73.6 (240)                              | 73.9 (156)                     | 7           |
| Some secondary               | 6.1 (20)                                | 8.1 (17)                       |             |
| Completed secondary          | 5.6 (18)                                | 6.2 (13)                       |             |
| Employment*                  |                                         |                                |             |
| Housewife (unemployed)       | 46.0 (150)                              | 40.3 (85)                      | 5           |
| Self-employed                | 30.3 (99)                               | 36.0 (76)                      | 2           |
| Agricultural worker          | 16.3 (53)                               | 18.0 (38)                      | 1           |
| Other                        | 7.4 (24)                                | 5.7 (12)                       | 1           |
| Marital Status               |                                         |                                |             |
| Married                      | 86.8 (283)                              | 85.3 (180)                     | 86          |
| Single/Separated/Divorced    | 13.2 (43)                               | 14.7 (31)                      | 1           |
| Parity*                      |                                         |                                |             |
| Mean (SD)                    | 2.8 ± 1.8                               | 2.5 ± 1.8                      | 3           |
| Parous                       | 92.0 (300)                              | 87.7 (185)                     | 10          |
| Nulliparous                  | 8.0 (26)                                | 12.3 (26)                      |             |
| Prior facility delivery* 1  m |                                         |                                |             |
| Yes                          | 58.7 (176)                              | 65.3 (121)                     | 4           |
| No                           | 27.7 (83)                               | 25.0 (46)                      | 3           |
| Gestational age at first ANC visit (weeks) | 22.1 ± 8.5                      | 22.4 ± 8.9                     | 21          |
| First ANC visit location m   |                                         |                                |             |
| Port Victoria                | 27.6 (90)                               | 25.6 (54)                      | 3           |
| Budalangi                    | 8.3 (27)                                | 7.6 (16)                       | 6           |
| Sirimba                      | 11.3 (37)                               | 12.8 (27)                      | 1           |
| Sisenya                      | 12.9 (42)                               | 12.8 (27)                      | 1           |
| Mukhobola                    | 13.2 (43)                               | 11.9 (25)                      | 1           |
| Rukala                       | 15.6 (51)                               | 16.1 (34)                      | 1           |
| Bulwani                      | 4.9 (16)                                | 5.2 (11)                       |             |
| Osieko                       | 3.1 (10)                                | 3.3 (7)                        |             |
| Other                        | 2.1 (7)                                 | 3.3 (7)                        |             |

*Significant p<0.05.

1Among those with previous delivery (Chamas group = 185; control group = 115).
mMissing data: prior facility delivery n=18 (Chamas), n=23 (Control); first ANC location n=3 (Chamas).

Table 2. Uptake of maternal, newborn and child health interventions by participant group for study population (n=326)
| Health Intervention | Study Population (n=326) M ± SD or % (n) | Chamas (n=211) M ± SD or % (n) | Co M |
|--------------------|------------------------------------------|---------------------------------|------|
| Delivered in a facility with skilled birth attendant*| 72.4 (236) 22.7 (74) | 84.4 (178) 12.8 (27) | |
| Yes | No |
| Attended ≥ 4 ANC visits* | 54.6 (178) 43.9 (143) | 64.0 (135) 33.7 (71) | |
| Yes | No |
| Received CHV 48-hour postpartum home visit* | 62.6 (204) 32.5 (106) | 75.8 (160) 19.9 (42) | |
| Yes | No |
| Exclusively breastfed ≥ 6 months* | 69.6 (227) 22.7 (74) | 82.0 (173) 11.9 (25) | |
| Yes | No |
| Adopted long-term or permanent method of family planning (IUD, implant, tubal ligation)* | 37.4 (122) 62.3 (203) | 39.0 (82) 61.0 (129) | |
| Yes | No |
| Infant received OPV0 immunization* | 89.5 (292) 3.4 (11) | 91.9 (194) 2.8 (6) | |
| Yes | No |

*Significant p<0.001.

1Among all women; “no” includes women who chose a short-term (i.e. pills, condoms) or no method.

mMissing data: facility delivery n=6 (Chamas), n=10 (Control); ANC visit attendance n=5 (Chamas); 48-hour CHV home visit n=9 (Chamas), n=7 (Control); Exclusively breastfed to 6 months n=13 (Chamas), n=12 (Control); long-term family planning n=1 (Control); OPV0 immunization n=11 (Chamas), n=12 (Control).

Table 3. Multivariable logistic regression model of association between Chamas participation and facility delivery adjusted for sociodemographic and reproductive health covariates (n=307)*
| Variable                        | Facility delivery with skilled birth attendant |
|--------------------------------|-----------------------------------------------|
|                                | OR       | (95% CI) |
| **Chamas participation**       |          |          |
| Did not participate in Chamas  | -        | -        |
| Participated (unadjusted)      | 5.49     | (3.12, 9.64) |
| Participated (adjusted)        | 5.07     | (2.74, 9.36) |
| Age (years)                    | 1.00     | (0.93, 1.08) |
| **Education level**            |          |          |
| None-some primary              | -        | -        |
| Completed primary              | 1.22     | (0.56, 2.66) |
| Some-completed secondary       | 3.24     | (0.74, 14.17) |
| **Employment**                 |          |          |
| Housewife (unemployed)         | -        | -        |
| Self-employed/Agricultural Worker/Other | 1.38     | (0.74, 2.55) |
| **Marital Status**             |          |          |
| Single/Separated/Divorced      | -        | -        |
| Married                        | 1.56     | (0.52, 4.63) |
| **Parity**                     |          |          |
| Multiparous                    | -        | -        |
| Primiparous                    | 1.10     | (0.18, 6.89) |
| **Prior facility delivery**    |          |          |
| No                             | -        | -        |
| Yes                            | 4.31     | (2.25, 8.25) |

*Complete cases only; n=19 participants missing data on primary outcome or covariate.

Table 4. Nested random effects models of association between Chamas participation and facility delivery controlling for prenatal care location (n=307)
| Model variance estimates | Random Effects Model |        |        |
|--------------------------|----------------------|--------|--------|
|                         | Null                | Unadjusted |
| $\sigma_u^2$ (SE)       | $0.30$ ($0.24$)     | $0.51$ ($0.40$) | 0      |
| $\rho$ (SE)             | $0.08$ ($0.06$)     | $0.14$ ($0.09$) | 0      |
| p-value$^\dagger$      | 0.01                | <0.01   |
| -2 log likelihood       | 330.23              | 291.10  |
| Covariates              | OR (95% CI)         | OR (95% CI) | 0      |

**Chamas participation**

| Did not participate in Chamas |           |           |
|-------------------------------|-----------|-----------|
| Participated                  | 6.40 (3.44, 11.76)$^\dagger$ | 5.60 $^\ddagger$ |
| Age (years)                   | 1.00      |           |

**Education level**

| None-some primary |           |           |
| Completed primary | 1.22      |           |
| Some-completed secondary | 3.28 |           |

**Employment**

| Housewife (unemployed) |           |           |
| Self-employed/Agricultural Worker/Other | 1.47 |           |

**Marital Status**

| Single/Separated/Divorced |           |           |
| Married                   | 1.35      |           |

**Parity**

| Multiparous | 1.03      |           |
| Primiparous |           |           |

**Prior facility delivery$^\dagger$**

| No            |           |           |
| Yes           | 4.16      |           |

*$^*$ Complete cases only; n=19 participants missing data on primary outcome or covariate.

$^\dagger$ Likelihood ratio test, $\rho=0$.

$^\ddagger$ Significant $p<0.001$.  

Figures
Figure 1. Study flow diagram

Pregnant women attending first ANC visit in October-December 2012 invited to participate in Chamas program
N = 457

Women who did not enroll in Chamas
n = 220
- Declined study participation
  n = 67
- Pregnant controls (consented to participate and provided baseline data)
  n = 153
- Lost to follow-up
  n = 38
- Women who provided outcome data at 6-12 months postpartum
  n = 115

Women who enrolled in Chamas
n = 237
- Declined study participation
  n = 11
- Pregnant Chamas women (consented to participate and provided baseline data)
  n = 226
- Lost to follow-up
  n = 16
- Women who provided outcome data at 6-12 months postpartum
  n = 211

Figure 1
Study flow diagram