

# Promoting positive maternal, newborn, and child health behaviors through a group-based health education and microfinance program: a prospective matched cohort study in western Kenya

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## Research article

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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 the association between Chamas participation and uptake of evidence-based, maternal, newborn and child health (MNCH) behaviors. **Methods:** We prospectively compared the uptake of MNCH behaviors 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 attending their first antenatal care (ANC) visits at health facilities in Busia County to participate in Chamas. Women enrolled in Chamas agreed to attend bi-monthly group health education and optional microfinance sessions for 12 months. We collected baseline sociodemographic data at study enrollment for each cohort. 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 (OR 5.07, 95% CI 2.74-9.36,  $p<0.001$ ). Though not statistically significant, Chamas participants experienced a lower proportion of stillbirths (0.9% vs. 5.2%), miscarriages (5.2% vs. 7.8%), infant deaths (2.8% vs. 3.4%), and maternal deaths (0.9% vs. 1.7%) compared to controls. Our sensitivity analyses revealed no significant difference in the odds of facility delivery based on microfinance participation. **Conclusions:** Chamas participation was associated with increased practice of evidence-based MNCH health behaviors among pregnant women in western Kenya. Our findings demonstrate this program's potential to achieve population-level MNCH 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.<sup>1</sup> This is an ambitious target for Kenya, where the MMR and NMR are 362 per 100,000 and 22 per 1,000 livebirths, respectively.<sup>2</sup> Evidence-based strategies that enhance uptake of low-cost, lifesaving Maternal, Newborn and Child Health (MNCH) behaviors and interventions are urgently needed to meet these SDG targets.<sup>3,4</sup>

Per WHO and Republic of Kenya Ministry of Health (MOH) recommendations, these health behaviors 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) infants to six months.<sup>5-11</sup> Promoting access and increasing 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.<sup>12-14</sup> Lastly, ensuring infants receive the Oral Polio Vaccination at birth (OPV0) may increase protection against infectious disease mortality during the first year of life.<sup>15</sup>

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%).<sup>2</sup> EBF beyond the initial months postpartum is uncommon, lasting a median of 3.4 months among rural populations.<sup>16</sup> 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.<sup>2</sup> 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.<sup>2,17</sup>

In addition to promoting positive, evidence-based MNCH behaviors, one of the key enablers in meeting the SDGs 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.”<sup>18</sup> 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.<sup>19</sup> 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.<sup>19</sup> 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-facilitated 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.<sup>20</sup> These groups are highly gendered institutions that women have relied on for centuries for social support and resource pooling.<sup>21</sup> 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 association between *Chamas* participation and uptake of evidence-based MNCH behaviors 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 effect 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 July 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.<sup>2,22,23</sup> In Busia County, the most recent estimate for infant mortality rate (IMR) is exceedingly high at 125.9 per 1,000 live births.<sup>24</sup> 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 association of *Chamas* participation on uptake of positive MNCH behaviors, we employed a prospective, matched-cohort study design. We compared outcomes between a cohort of *Chamas* program participants, who we recruited during their first ANC visits at public health facilities in Bunyala, and non-participating controls matched for age, parity, and prenatal care location who we identified through health facility registers. We followed both cohorts prospectively for one year and recorded outcome data between 6-12 months postpartum for all participants.

### *Participant selection*

We employed a facility-based recruitment strategy to enroll women to our intervention cohort. 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 recruit our control cohort, we retrospectively identified pregnant women who attended the same health facilities for their first ANC visits in the three months preceding *Chamas* enrollment (July-September 2012) from clinic registers. We matched controls based on three criteria: age, parity, and prenatal care location (health facility). We tasked CHVs with approaching eligible women at their homes, if they provided an address; we then enrolled women who CHVs successfully located and agreed to participate (**Figure 1**). Women in both cohorts 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.

## *Community Health Volunteers in Kenya*

The *Chamas* program leverages the important role of CHVs in the community to deliver health and microfinance education in a safe and familiar setting. As delineated by Kenya's community health strategy, CHVs are members of the community, nominated from within, who are tasked with improving the community's health and well-being as well as linking individuals to primary health care services.<sup>25</sup> CHVs are considered part-time government volunteers and are supervised by Community Health Extension Workers (CHEWs) who are salaried frontline healthcare providers integrated within government health facilities.<sup>26</sup> CHVs involved in this study across both intervention and control cohorts were connected to eight health facilities, specifically: five dispensaries, two health centers, and one sub-county level hospital.

Nationally, the Kenyan government delineates a CHV's scope of work to include: monthly household visits within a defined catchment area of 20 households in rural areas and 100 households in urban areas.<sup>27</sup> During routine visits, CHVs collect basic health information, identify health problems, and refer individuals needing additional services to health facilities. All CHVs are required to complete a 10-day, MOH-led basic training session prior to beginning work during which they are introduced to a broad array of health topics, including MNCH. With regard to MNCH, CHVs are provided with a handbook that covers basic information on caring for mothers during and after pregnancy, instructions on facilitating the creation of an individualized birth plan, and lists of specific health behaviors CHVs are encouraged to promote (i.e. attend ANC, deliver in health facilities, adopt family planning).<sup>27</sup> CHVs are also expected to recognize danger signs during pregnancy as well as perform basic nutritional assessments, aid in growth monitoring, and recognize when infants require further evaluation for malnutrition. This basic training is often supplemented by specific technical training that align with local priorities; however, technical sessions are variable and implemented by local governments or non-governmental organizations.<sup>27</sup>

In September 2012, we selected 32 GOK sponsored CHVs to participate in an additional four-day technical training session on *Chamas*, sponsored by AMPATH and the Busia County MOH. During these sessions, 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. In addition to conducting didactic sessions, CHVs also received additional training on conducting basic health interventions, such as taking vitals, assessing for hemorrhage and infections at the 48-hour postpartum home-visit, supporting mothers in exclusively breastfeeding, counselling participants on options for family planning, and adopting safe sleep practices. Throughout the year, CHVs attended regularly scheduled check-in 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.

## *Intervention description*

We designed the *Chamas* program and curriculum in collaboration with the GOK and county-level MOH representatives to ensure the support and investment of local community members. The *Chamas* curriculum was designed by a diverse group including AMPATH researchers, community members, and local MOH representatives with the intent to: highlight evidence-based health interventions and topics delineated by international authorities (i.e. WHO), bolster training provided through the existing CHV handbook, and respond directly to the needs of and questions asked by the local community. Though the curriculum combines lessons from existing evidence-based curricula, this study served as a debut platform for our curriculum.

Women attending *Chamas* convened twice per month for 12 months to attend a total of 24 CHV-facilitated group health education and microfinance sessions. Each group was typically comprised of 15-30 women and 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 (**Table 1**). Upon joining the program, women also agreed to practice key MNCH behaviors, 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 for their own health and well-being.

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.<sup>28</sup> 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.

In contrast to our intervention cohort, our control cohort received the current standard of care as delineated by the MOH (described under *Community Health Volunteers in Kenya*). As such, they received monthly, individual CHV household visit, but did not participate in structured, evidence-based health and microfinance education sessions or experience the group-based platform provided through the *Chamas* program.

### *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 employed AMPATH research assistants trained in paper- and electronic-based data entry to collect data at both time-points. 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. Interview location differed depending on the participant's cohort assignment. At baseline, we interviewed and collected data on intervention participants at health facilities on the day they enrolled. Conversely, we conducted baseline assessments on controls at their homes after identifying them from clinic registers. We collected end-line data from both the control and intervention cohorts at participant homes. During both baseline and end-line assessments, we made every effort to collect data individually and privately so as to minimize potential for response bias.

We additionally assessed maternal and infant morbidity and mortality using program monitoring data as well as group process outcomes (i.e. microfinance participation). CHVs collected program monitoring and evaluation data at each *Chamas* meeting using a paper-based log. CHVs reported data monthly to trained research assistants who electronically transcribed and uploaded outcomes to a protected database.

#### 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."<sup>2</sup> 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 worsen maternal and fetal outcomes, increasing the propensity of older women to seek care or establish contact with health facilities earlier in pregnancy.<sup>29</sup> 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. We defined "employment" as earning the national daily minimum wage of 450 Kenyan

Shillings and allowed participants to self-report status by selecting a categorical descriptor (i.e. housewife/unemployed, self-employed, agricultural worker, other).<sup>26</sup> Previous studies demonstrate women of lower socio-economic status or lower levels of education are less likely to deliver in facilities with an SBA.<sup>30</sup> Further, 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.<sup>31,32</sup> 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 intra-class 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 and CHVs, clustering by health facility catchment area).<sup>2,33</sup> 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 ( $\alpha$ ) 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, two-sample Z-score tests for proportions, 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.  $\geq 4$  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.<sup>32</sup> 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  $\alpha$  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 who attended their first ANC visit between July-December 2012, nearly half attended their first visit between July-September and the other half between October-December 2012 (**Figure 1**). Most eligible women in both the control (69.5%) and intervention (95.4%) arms agreed to participate in this study. Though a larger proportion of eligible controls did not enroll in our study as compared to intervention participants, we were unsuccessful in locating the majority of those unenrolled (77.6%). Furthermore, fewer than 10% of women successfully contacted in the control and intervention cohorts declined to participate (6.8% and 4.6%, respectively). 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 2**. 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 live-born 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 3**. 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 modern method of contraception (58.2 vs. 55.6%,  $p = 0.46$ ) and among method adopters, a higher proportion chose a long-acting or permanent FP method (66.7 vs. 62.5%,  $p = 0.58$ ) as compared to controls. Lastly, a higher proportion of infants born to women participating in *Chamas* 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 ( $39.4 \pm 2.7$  vs.  $35.5 \pm 8.9$ ,  $p < 0.001$ ). Of note, 33% ( $n = 38$ ) of the control cohort missed data for this outcome limiting interpretability of this result. We used program monitoring data to record and narratively assess maternal, perinatal and infant deaths during the study period. Though we did not power our study to detect significant changes in birth outcomes, women in *Chamas* experienced a lower proportion of stillbirths (0.9% vs. 5.2%), miscarriages (5.2% vs. 7.8%), infant deaths (2.8% vs. 3.4%), and maternal deaths (0.9% vs. 1.7%) relative to controls.

### *Association between Chamas participation and health facility delivery*

Fully adjusted results from our multivariable analyses are presented in **Table 4**. 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 5**). We grouped women according to the health facility they attended for their first antenatal visit; among our cohort of women, they sought care at eight different health facilities (five dispensaries, two health centers, and one sub-county level hospital) (**Table 2**). 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).

### *Effect 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 association between *Chamas* participation and uptake of positive, evidence-based MNCH behaviors and 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 as compared to 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.

Though our findings demonstrate *Chamas*' potential to increase the practice of positive health behaviors, we acknowledge the potential effect of delivering in health facilities or receiving ANC is limited by the quality of services offered. For instance, delivering in a health facility alone may not equate to positive health outcomes if trained providers are in short-supply or inadequately prepared to deliver life-saving interventions. Participant-driven behaviors, such as exclusively breastfeeding, may conversely yield more consistent outcomes as these behaviors are less dependent on externally provided, high-quality services. By highlighting this distinction, we underscore the importance of not only promoting positive health behaviors but also bolstering the quality of services provided to those who seek them.

Moreover, we examined the combined effect 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 health outcomes.<sup>34,35</sup> 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.<sup>36,37</sup> It is possible participation in other microfinance schemes across cohorts may nullify the effect of GISHE participation; however, future investigations with larger sample sizes are needed to clarify this association. Furthermore, we plan to assess the use of savings and loans generated through GISHE participation in future studies to clarify whether funds are directed towards health-related expenditures (i.e. transportation to health facilities, emergency care) or other purposes (i.e. primary school-enrollment).

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 MNCH 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 effect 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.<sup>38</sup> 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.<sup>39-44</sup> Microfinance involvement is also associated with improving health outcomes.<sup>35</sup> *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 effect in combining MNCH education and microfinance participation on improving population-level outcomes in health, as well as financial inclusion.<sup>39-44</sup> Further, regional and national efforts to address MNCH are

increasing in Kenya as evidenced by initiatives such as the Linda Mama public funded health scheme and National Hospital Insurance Fund.<sup>45</sup> These services strive to ensure pregnant women and infants have access to quality and affordable health services by promoting universal health coverage. To clarify associations between *Chamas* participation and concurrent initiatives aimed at improving MNCH outcomes, we plan to assess and control for additional demographics such as health insurance enrollment and alternative program participation in future studies.

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 effect of *Chamas* participation on maternal and infant morbidity and mortality. We plan to examine these outcomes more thoughtfully in future studies with larger cohort sizes and more reliable measures to assess morbidity such as infant birthweight. 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 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. Further, from a logistical standpoint, retrospectively recruiting controls from clinic registers and enrolling them within the community proved exceedingly difficult, limited the size of our cohort, and increased susceptibility to missing baseline data. As many families move or change their addresses throughout the year, instituting a more reliable tracking method will be essential to increase cohort size and limit loss-to-follow-up in future studies. Fourth, though we sought to decrease the risk of response bias by collecting participant data privately, we speculate some women over-reported positive health behavior adherence due to pressure associated with social desirability. Fifth, 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. As locating, enrolling, and interviewing control participants at their homes often proved a time-intensive endeavor, we speculate research assistants conducted questionnaires as quickly as possible, increasing propensity for missing data. We intend to employ digital-based data collection methods to improve data quality, expedite collection, and decrease risk of missing data in future studies. Lastly, we did not record individual-level *Chamas* attendance, which limited our ability to evaluate whether there is an intervention dose-response effect, or in other words a threshold number of meetings participants must attend to yield a significant change in outcomes. We plan to further investigate this question in larger cohort studies by recording individual-level attendance data for all *Chamas* participants.

### *Implications for Practice*

Our findings demonstrate that participation in a group-based health education and microfinance program during the antenatal and postpartum period is associated with increased attendance at facility-based

MNCH services (ANC and delivery care) and uptake of key MNCH interventions. Local MOH representatives and policymakers may consider the *Chamas* program when seeking an effective strategy to increase facility-based deliveries and enhance uptake of other potentially life-saving interventions in western Kenya. Currently, the *Chamas* program is in the process of gradually transitioning leadership to the Busia County MOH, whose representatives have continued to support the growth and sustainability of *Chamas* in the years following the conclusion of this study. Now in the program's sixth year, the program has worked with over 1,100 mother-infant dyads to promote positive MNCH behaviors across the county.

Outstanding questions remain regarding the association between microfinance participation as well as contextual factors that lead to improved outcomes. Future studies will seek to evaluate cost-effectiveness of this strategy as well as logistical factors such as CHV compensation to ensure scalability and sustainability of the *Chamas* program at regional and national levels. Finally, to clarify the potential effect of our program on outcomes on a population-level scale, we plan to pursue a larger cluster randomized controlled trial with a larger sample population in the near future.

## 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

MOH – Ministry of Health

NMR – Neonatal Mortality Rate

OPV0 – Oral Polio Vaccine 0

SBA – Skilled Birth Attendant

## **Declarations**

### **Acknowledgements**

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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. Health and Social Topics for *Chamas for Change* Year 1 Curriculum\***

Lesson	Health Topic	Social Topic
1	Importance of antenatal and postnatal care	Personal constitution and Chama goals
2	Physical exercise during pregnancy	Table banking (Saving and Loans)
3	Anemia during pregnancy	National Hospital Insurance Fund (NHIF)
4	Danger signs during pregnancy and after delivery	Nutrition during pregnancy
5	Importance of facility delivery	Involving male partners during pregnancy and while raising children
6	Preventing maternal-child transmission of infections	Supporting the birth of a child in your Chama
7	Negative pregnancy outcomes (losing an infant)	Post-delivery welfare (up to 12 months of age)
8	Complications during pregnancy and delivery (i.e. obstructed labor)	Creating a budget
9	Postpartum depression	Setting Routines for the Infant: Sleeping and Eating
10	Newborn danger signs (4 hours to 2 weeks)	Promoting a good relationship with your Mother-in-law and Sister-in-law
11	Exclusively breastfeeding for 6 months	Home Hygiene
12	Infant growth monitoring and under-5 immunizations	Disclosing HIV status to your family
13	Kangaroo Care	Reducing stigma towards members in the community with HIV
14	Back to sleep/co-sleeping	Cooking in Clean Air
15	Family Planning: Coil/Uterine Copper Device	Farming and Rearing Livestock
16	Family Planning: Jadelle, Implanon, Nexplanon	Clean Water
17	Family Planning: Male and Female Condoms	Intimate Partner Violence
18	Infant growth and development	Adolescent Pregnancies
19	Complementary feeding for infants	Importance of female education
20	Basic first aid: choking and burns	Promoting a good relationship with your husband in the home
21	Pediatric diseases under surveillance: Measles, Polio, Pneumonia, and Scabies	Mutual sexual satisfaction between a man and a woman
22	Diarrheal Diseases	Preparing to take your child to school (preparing for pre-school)
23	Cervical Cancer Screening: Overcoming fears and misconceptions	Conflict resolution within a Chama
24	Malaria	Children with developmental delays

*\*The Year 1 Chamas curriculum is comprised of 12 months of bi-monthly lessons (24 lessons total). Each lesson covers one health and one social topic over the course of 60-90 minutes, facilitated by community health volunteers in a group-based setting.*

**Table 2.** Baseline sociodemographic and reproductive health characteristics by participant group for study population (n=326)

<b>Variable</b>	<b>Study Population (n=326)</b> M ± SD or % (n)	<b>Chamas (n=211)</b> M ± SD or % (n)	<b>Control (n=115)</b> M ± SD or % (n)
<b>Age</b>	25.2 ± 4.8	25.2 ± 5.0	25.1 ± 4.5
<b>Education level</b>			
None-some primary	14.7 (48)	11.8 (25)	20.0 (23)
Completed Primary	73.6 (240)	73.9 (156)	73.0 (84)
Some secondary	6.1 (20)	8.1 (17)	2.6 (3)
Completed secondary	5.6 (18)	6.2 (13)	4.4 (5)
<b>Employment*</b>			
Housewife (unemployed)	46.0 (150)	40.3 (85)	56.5 (65)
Self-employed	30.3 (99)	36.0 (76)	20.0 (23)
Agricultural worker	16.3 (53)	18.0 (38)	13.0 (15)
Other	7.4 (24)	5.7 (12)	10.5 (12)
<b>Marital Status</b>			
Married	86.8 (283)	85.3 (180)	89.6 (103)
Single/Separated/Divorced	13.2 (43)	14.7 (31)	10.4 (12)
<b>Parity*</b>			
Mean (SD)	2.8 ± 1.8	2.5 ± 1.8	3.0 ± 1.7
Parous	92.0 (300)	87.7 (185)	100.0 (115)
Nulliparous	8.0 (26)	12.3 (26)	0.0 (0)
<b>Prior facility delivery*<sup>l,m</sup></b>			
Yes	58.7 (176)	65.3 (121)	47.8 (55)
No	27.7 (83)	25.0 (46)	32.2 (37)
<b>Gestational age at first ANC visit (weeks)</b>	22.1 ± 8.5	22.4 ± 8.9	21.8 ± 8.0
<b>First ANC visit location<sup>m</sup></b>			
Port Victoria	27.6 (90)	25.6 (54)	31.3 (36)
Budalangi	8.3 (27)	7.6 (16)	9.6 (11)
Sirimba	11.3 (37)	12.8 (27)	8.7 (10)
Sisenya	12.9 (42)	12.8 (27)	13.0 (15)
Mukhobola	13.2 (43)	11.9 (25)	15.7 (18)
Rukala	15.6 (51)	16.1 (34)	14.8 (17)
Bulwani	4.9 (16)	5.2 (11)	4.4 (5)
Osieko	3.1 (10)	3.3 (7)	2.6 (3)
Other	2.1 (7)	3.3 (7)	0.0 (0)

\*Significant  $p < 0.05$ .

□ Among those with previous delivery (*Chamas* group = 185; control group = 115).

<sup>m</sup>Missing data: prior facility delivery  $n=18$  (*Chamas*),  $n=23$  (Control); first ANC location  $n=3$  (*Chamas*).

**Table 3.** Uptake of maternal, newborn and child health interventions by participant group for study population ( $n=326$ )

<b>Health Intervention</b>	<b>Study Population (n=326)</b> M ± SD or % (n)	<b>Chamas (n=211)</b> M ± SD or % (n)	<b>Control (n=115)</b> M ± SD or % (n)
<b>Delivered in a facility with skilled birth attendant<sup>*,m</sup></b> Yes No	72.4 (236) 22.7 (74)	84.4 (178) 12.8 (27)	50.4 (58) 40.9 (47)
<b>Attended ≥ 4 ANC visits<sup>*,m</sup></b> Yes No	54.6 (178) 43.9 (143)	64.0 (135) 33.7 (71)	37.4 (43) 62.6 (72)
<b>Received CHV 48-hour postpartum home visit<sup>*,m</sup></b> Yes No	62.6 (204) 32.5 (106)	75.8 (160) 19.9 (42)	38.3 (44) 55.7 (64)
<b>Exclusively breastfed ≥ 6 months<sup>*,m</sup></b> Yes No	69.6 (227) 22.7 (74)	82.0 (173) 11.9 (25)	47.0 (54) 42.6 (49)
<b>Adopted any modern family planning method or permanent method (oral contraceptives, injections, IUD, implant, tubal ligation)<sup>m</sup></b> Yes No	57.4 (187) 41.7 (136)	58.2 (123) 40.7 (86)	55.6 (64) 44.3 (51)
<b>Adopted a long-term or permanent method of family planning (IUD, implant, tubal ligation)<sup>□</sup></b> Yes No	65.0 (122) 34.8 (65)	66.7 (82) 33.3 (41)	62.5 (40) 47.1 (24)
<b>Infant received OPV0 immunization<sup>m</sup></b> Yes No	89.5 (292) 3.4 (11)	91.9 (194) 2.8 (6)	85.2 (98) 4.4 (5)

\*Significant p<0.001.

□ Among women who answered “yes” to adopting any modern family planning method (n=187).

<sup>m</sup>Missing 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); Any family planning n=2 (*Chamas*); OPV0 immunization n=11 (*Chamas*), n=12 (Control).

**Table 4.** 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)	p-value
<b><i>Chamas</i> participation</b>			
Did not participate in <i>Chamas</i>	-	-	-
Participated (unadjusted)	5.49	(3.12, 9.64)	<0.001
Participated (adjusted)	5.07	(2.74, 9.36)	<0.001
<b>Age (years)</b>	1.00	(0.93, 1.08)	0.92
<b>Education level</b>			
None-some primary	-	-	-
Completed primary	1.22	(0.56, 2.66)	0.63
Some-completed secondary	3.24	(0.74, 14.17)	0.12
<b>Employment</b>			
Housewife (unemployed)	-	-	-
Self-employed/Agricultural Worker/Other	1.38	(0.74, 2.55)	0.31
<b>Marital Status</b>			
Single/Separated/Divorced	-	-	-
Married	1.56	(0.52, 4.63)	0.43
<b>Parity</b>			
Multiparous	-	-	-
Primiparous	1.10	(0.18, 6.89)	0.92
<b>Prior facility delivery</b>			
No	-	-	-
Yes	4.31	(2.25, 8.25)	<0.001

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

**Table 5.** Nested random effects models of association between *Chamas* participation and facility delivery controlling for prenatal care location (n=307)\*

Model variance estimates	<i>Random Effects Model</i>		
	Null	Unadjusted	Adjusted
$\sigma_u^2$ (SE)	0.30 (0.24)	0.51 (0.40)	0.44 (0.39)
$\rho$ (SE)	0.08 (0.06)	0.14 (0.09)	0.12 (0.09)
p-value <sup>□</sup>	0.01	<0.01	0.01
-2 log likelihood	330.23	291.10	267.40
<b>Covariates</b>	<b>OR (95% CI)</b>	<b>OR (95% CI)</b>	<b>OR (95% CI)</b>
<b><i>Chamas</i> participation</b>			
Did not participate in <i>Chamas</i>		-	-
Participated		6.40 (3.44, 11.76) <sup>□</sup>	5.60 (2.91, 10.80) <sup>□</sup>
<b>Age (years)</b>			1.00 (0.92, 1.08)
<b>Education level</b>			
None-some primary			-
Completed primary			1.22 (0.54, 2.74)
Some-completed secondary			3.28 (0.73, 14.75)
<b>Employment</b>			
Housewife (unemployed)			-
Self-employed/Agricultural Worker/Other			1.47 (0.76, 2.85)
<b>Marital Status</b>			
Single/Separated/Divorced			-
Married			1.35 (0.44, 4.15)
<b>Parity</b>			
Multiparous			-
Primiparous			1.03 (0.15, 6.95)
<b>Prior facility delivery<sup>□</sup></b>			
No			-
Yes			4.16 (2.09, 8.27) <sup>□</sup>

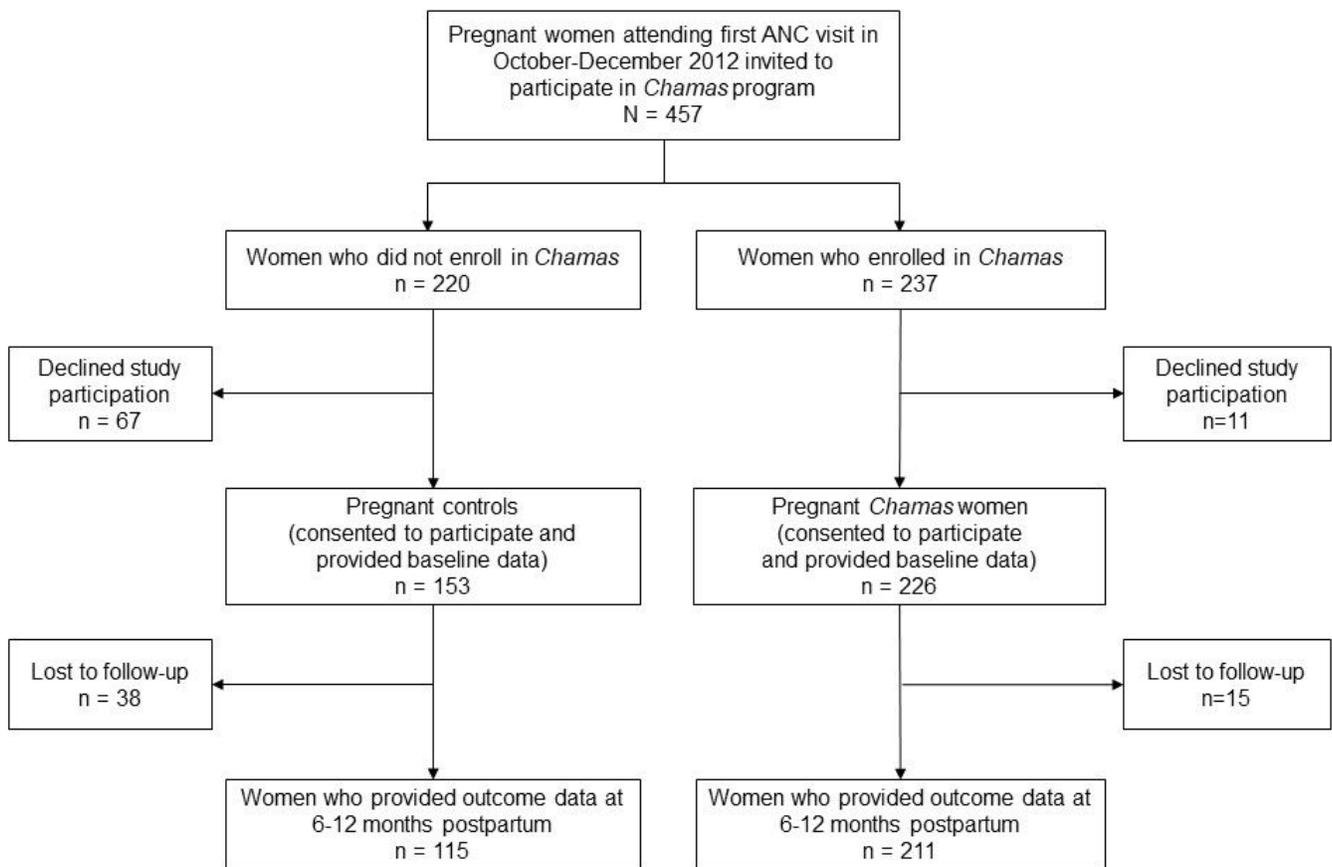
\* Complete cases only; n=19 participants missing data on primary outcome or covariate.

□ Likelihood ratio test,  $\rho=0$ .

□ Significant  $p<0.001$ .

## Figures

**Figure 1.** Study flow diagram



**Figure 1**

Study flow diagram