

# Effect of a community-based primary healthcare program on adverse pregnancy outcomes in Northern Ghana

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## Abstract

**Background:** Pregnancy complications and adverse birth outcomes are among the major contributors to poor maternal and child health. Mothers in remote communities are at higher risk of adverse birth outcomes due to constraints in access to maternal healthcare services. In Ghana, a community-based primary healthcare program called the Ghana Essential Health Interventions Program (GEHIP) was implemented in a rural region to help strengthen primary healthcare delivery and improve maternal and child healthcare services delivery. This study assessed the effect of this program on adverse birth outcomes. **Methods:** Secondary household survey data from reproductive-aged women from the GEHIP project were used in this analysis. Difference-in-differences regression and logistic regression were used to examine the effect of GEHIP on adverse birth outcomes and equity in the distribution of adverse birth outcomes using household wealth index and maternal educational attainment as equity measures. The analysis involves the comparison of project baseline and end-line outcomes in intervention and non-intervention districts. **Results:** The intervention had a significant effect in the reduction of adverse pregnancy outcomes (DiD=−0.043; p-value=0.010). Although disadvantaged groups experience larger reductions in adverse pregnancy outcomes, controlling for covariates, there was no statistically significant equity effect of GEHIP on adverse pregnancy outcomes using either the household wealth index or maternal educational attainment as equity measures. **Conclusion:** GEHIP’s community-based healthcare program reduced adverse birth outcomes but no effect on relative equity was established. Factoring in approaches for targeting disadvantaged populations in the implementation of community-based health programs is crucial to ensuring equity in health outcomes.

## Effect of a community-based primary healthcare program on adverse pregnancy outcomes in Northern Ghana

**Short Title:** Effect of community-based healthcare program on pregnancy outcomes

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### Conflict of Interest Statement

The Authors declare that they have no competing interest.

### Ethics Statement

This study used secondary non-identifiable data from the GEHIP project. Ethical clearance was obtained from the Human Ethics and Research Office of the University of Queensland No: 2020000457. The GEHIP project was granted ethical approval by the Navrongo Health Research Centre Ethical review board under IRB number FWA00000250. Written informed consent was obtained from all study participants prior to interviews. The study team has endeavoured to ensure confidentiality, anonymity, respect for persons and beneficence in the conduct of this research.

### Data Availability Statement

Data used in this study are available from the authors and the GEHIP study team upon reasonable request

### Abstract

**Background:** Pregnancy complications and adverse birth outcomes are among the major contributors to poor maternal and child health. Mothers in remote communities are at higher risk of adverse birth outcomes due to constraints in access to maternal healthcare services. In Ghana, a community-based primary healthcare program called the Ghana Essential Health Interventions Program (GEHIP) was implemented in a rural region to help strengthen primary healthcare delivery and improve maternal and child healthcare services delivery. This study assessed the effect of this program on adverse birth outcomes.

**Methods:** Secondary household survey data from reproductive-aged women from the GEHIP project were used in this analysis. Difference-in-differences regression and logistic regression were used to examine the effect of GEHIP on adverse birth outcomes and equity in the distribution of adverse birth outcomes using

household wealth index and maternal educational attainment as equity measures. The analysis involves the comparison of project baseline and end-line outcomes in intervention and non-intervention districts.

**Results:** The intervention had a significant effect in the reduction of adverse pregnancy outcomes (DiD=-0.043; p-value=0.010). Although disadvantaged groups experience larger reductions in adverse pregnancy outcomes, controlling for covariates, there was no statistically significant equity effect of GEHIP on adverse pregnancy outcomes using either the household wealth index or maternal educational attainment as equity measures.

**Conclusion :** GEHIP's community-based healthcare program reduced adverse birth outcomes but no effect on relative equity was established. Factoring in approaches for targeting disadvantaged populations in the implementation of community-based health programs is crucial to ensuring equity in health outcomes.

**Keywords:** pregnancy outcome, community-based healthcare, maternal health, equity

## Highlights

- Community-based healthcare programs can reduce adverse pregnancy outcomes (miscarriage and still-birth) in rural poor settings
- Community-based health care programs have the potential to improve equity in adverse pregnancy outcomes in remote rural settings
- Community-based healthcare programs can play an important role in bringing socio-economic and cultural factors that impact on adverse pregnancy outcomes in rural poor settings
- Community-based healthcare program planners and implementers should factor in modalities for measuring and ensuring interventions do not widen equity gaps.

## Background

Globally, maternal mortality remains high at 216 per 100,000 live births . Current projections suggest the United Nations Sustainable Development Goals (SDGs) target to reduce maternal mortality to 70 per 100,000 live births by 2030 is unlikely to be achieved unless there is substantial additional investment in maternal and child survival, particularly in sub-Saharan Africa . If each country continues to reduce its maternal mortality ratio (MMR) at the current trend, an estimated 3.9 million women would die of maternal-related causes within the next 15 years . An acceleration of the pace of decline in maternal and child mortality, stillbirths and stunting of children will require a rapid scale-up of effective interventions . Thus, critical analyses of strategies are needed to inform countries striving to achieve the SDG mortality reduction targets

Pregnancy complications and adverse birth outcomes are among the key challenges confronting maternal and child health and pose significant public health concerns . Adverse pregnancy outcomes are known to be associated with infant and maternal mortality and physical and psychological disorders, contributing to ongoing healthcare costs. Therefore, improvement in pregnancy outcomes is key to the attainment of the sustainable development goals on maternal and child health.

Adverse pregnancy outcomes include a wide range of health challenges that happen to either the newborn or mother during pregnancy, delivery, or postpartum . They are among the most important indicators used to assess maternal and child health since they provide critical insights on the availability and use of quality maternal and child health services including antenatal and postnatal care, skilled delivery etc.

Globally, It is estimated that 810 mothers die each day from preventable pregnancy-related complications and over 90% of these deaths occur in developing countries such as Ghana . Sixty-six per cent (196,000) of all preventable maternal deaths occur in Sub-Saharan Africa . In Ghana, maternal mortality reduced from 484 per 100,000 live births in the year 2000 to 308 per 100,000 live births in 2017 falling short of the MDGs . Inequalities in access to and use of maternal and child health services expose millions of disadvantaged women and children to the risk of preventable diseases, ill health and deaths . The underlying causes of disparities in health between less and more advantaged groups of people are multifactorial and complex . Health and access to healthcare is a social commodity since it is influenced by social policies including the

policies and programs affecting the allocation and financing of healthcare and the quality of services delivered . Income, occupational status, economic assets, educational level, ethnicity/ race or religious affiliation, age, geography, sexual orientation and disability are among the major social determinants of health .This study aims to examine the effect of one of Ghana's flagship primary healthcare programs on pregnancy outcomes and equity improvement.

### **GEHIP's Community-based Primary Healthcare Program**

As part of efforts to improve access to healthcare in remote rural communities, Ghana's Ministry of Health supported the design and feasibility testing of community-based healthcare program in a rural district in northern Ghana between 1994-1996 , and a follow up plausibility trial from 1996 to 2003 . The results of these studies showed that community-based primary healthcare improves access to healthcare, leading to improvements in several maternal and child health indicators. In response to this evidence, the Ghana Health Service (GHS) launched the Community-based Health Planning and Services Program (CHPS) as a national policy in the year 1999 to scale up this successful initiative nationwide .

However, CHPS nationwide scale-up was constrained by challenges related to inadequate understanding of its service delivery modalities, communication deficits, low human resources capacity, lack of material logistics including funds and leadership bottlenecks . An in-depth review of the operational constraints to CHPS scale-up by the Ghana's Ministry of Health in 2009 provided a set of needs that was used to inform the design of a project known as the Ghana Essential Health Interventions Program (GEHIP) to demonstrate practical means of implementing and scaling up community-based primary healthcare .

The GEHIP project was implemented in a poor remote region of Ghana; the Upper East Region (UER). This region is located within the Sahelian savannah ecological belt in the north-eastern part of Ghana. It has a population of about 1.3 million . It has a poverty prevalence of 55% and almost 40% of its indigens have no formal education . GEHIP project was implemented in seven districts in this region with three serving as intervention districts while four others serving as non-intervention comparison districts. Both intervention and comparison districts were purposively selected based on their remote geographic isolation and socioeconomic deprivation.

GEHIP interventions included training and technical assistance provided to district-level health managers and frontline community health workers. These trainings aimed at building their capacity in both community and stakeholder engagement to support health service delivery and utilization. The project focused on addressing the challenges of effectively marshalling the system associated with the management of existing staff, equipment, pharmaceutical supplies, and leadership capacity for primary healthcare. Focus was directed to improving the implementation of the WHO's six health system building blocks . At the onset of the GEHIP, there was no shortage of nurses for expanding community-based healthcare operations in Ghana; but rather, a lack of health facilities in most communities/villages where trained nurses could be posted to render services . Also limited was district-level leadership understanding of strategies for obtaining resources for constructing and managing community health posts effectively .

To address these challenges, GEHIP developed a framework for strengthening community-based primary healthcare. The strategy was focused on improving district-level leadership capacity, use of information for decision-making, logistics, and budgeting, health worker training, and deployment for the provision of healthcare at the community locations. Specific maternal and child health interventions were included within GEHIP, including the integrated management of childhood illness regimen recommended by the WHO . GEHIP also developed a referral service program that enhanced health facility delivery using community engagement strategies to improve social support for referral operations . GEHIP was a plausibility trial in that the introduction of intervention was configured at the district level, preventing the imposition of randomized assignment of treatment observational units. Methods for statistical analysis of non-experimental conditions were therefore required . In the programmatic context of the Ghana Health Services (GHS), region-wide implementation of some interventions involving health worker training and deployment program focused on WHO recommendations for caring for the mother and newborn as well as the integrated management of

childhood illness . All such national program interventions were implemented equivalently in treatment and comparison districts.

The main objective of this current study is to assess the effect of GEHIP’s community-based health program on adverse birth outcomes. To achieve this, we examine; 1) the proportion of adverse birth outcomes for both intervention and non-intervention districts and the average treatment effect of GEHIP on birth outcome, 2) assess the distribution of adverse birth outcomes by wealth index and mother’s educational attainment for both intervention and non-intervention districts and 3) examine the equity effect of GEHIP’s community-based healthcare program on birth outcomes by household wealth index and maternal education.

## Theoretical Underpinnings

In rural remote settings, individual, household and community-level factors including socio-economic status, education, age, marital status, occupation, distance to health facility and how healthcare is delivered influence health-seeking behaviour . These factors also influence the ability to navigate the health systems as well as adherence to modern healthcare practices. This study hypothesized that the implementation of GEHIP has the potential to improve health equity in rural communities by attenuating the negative effect of adverse socio-economic status and other characteristics. The hypothesis here is that community-based primary healthcare brings services to the doorsteps of rural community members thus reducing the cost and time in accessing health care. In addition, through community engagement and health promotion activities, community-based programs can bridge socio-cultural barriers to healthcare seeking and practices in line with the Health Belief Model (HBM) which posit that good health behavior can be achieved through interventions that target perceived barriers to action, threats, risks susceptibility, risk severity, highlighting the benefits of action, as well as self-efficacy. To this end, GEHIP’s community-based primary healthcare program can mitigate the impact of social determinants of health between the poor and the rich, with potential equity improvement in both access to healthcare and health outcomes for mothers and children.

## Materials and Methods

### Source of Data

Data used in this study was collected through two rounds of household women surveys at baseline (2010) and end line (2015). A two-stage sampling approach was used in which 66 predominantly rural enumeration areas were first drawn and then followed by the sampling of households proportional to population size . In each sampled household, all resident women of reproductive age (15-49) were eligible to be interviewed. The surveys collected data on demographic and socio-economic characteristics of women including their birth histories, access to care, healthcare utilization, and contraceptive use among others. Both study rounds used the same enumeration areas to enhance the statistical efficiency of repeat observation, although no effort was made to reinterview the same women at the end line. A total of 5,604 women from 4,378 households were interviewed at baseline while 5,914 women from 4,421 households were interviewed at the end line. This study uses data from a subset of this sample of women who have had a recent pregnancy thus the baseline included 2,097 women of whom 1,020 were from intervention areas and 1,077 were from comparison districts. The end-line sub-sample includes 2,664 women of whom 1,357 were from intervention and 1,307 from comparison districts.

### Measurements

The main outcome variable in this study is adverse pregnancy outcomes for the most recent pregnancy. A binary variable was coded for adverse pregnancy/ birth outcomes in which all pregnancies that were either miscarriage or stillbirths were coded 1, while pregnancies that resulted in a live birth were coded 0. To estimate the effect of GEHIP’s community-based primary healthcare program on adverse birth outcomes, the Heckman difference-in-differences (DID) regression analysis is applied to estimate its average treatment effects . Equation 1 is a reduced form of the DID.

$$\text{logit}Y_{it} = \beta_0 + \beta_1T + \beta_2D + \beta_3T \times D + \beta_4X_{it} + \epsilon_{it} \quad (1)$$

Where  $Y$  represents the pregnancy outcome indicator.  $\alpha_0$  is the intercept.  $\alpha_t$  captures the period of time-invariant fixed effects.  $D$  is an area indicator for treatment ( $D = 1$ ) or comparison ( $D = 0$ ) districts.  $t$  is an indicator variable for baseline ( $t = 0$ ) or endline ( $t = 1$ ), the  $\beta$ s are the regression coefficients to be estimated,  $\beta_3$  captures the average treatment effect of GEHIP intervention on pregnancy outcome;  $U_{igt}$  captures individual-level factors that predict adverse pregnancy outcome. Predictor variables include mother's age, marital status, educational status, household wealth index, religion, ethnicity and parity.  $\epsilon_{ijt}$  is the error term.

To assess if GEHIP's intervention had an impact in the reduction of inequalities in adverse pregnancy outcomes, two variables; household wealth index and maternal educational attainment were used as equity stratifiers in line with the literature .

logistic regression models with interaction terms are used to examine the equity effect of GEHIP's community-based health program on adverse pregnancy outcomes stratified by household wealth index and maternal education. Equation (2) shows the specification of the logistic model for estimating the effect of wealth status:

$$\text{Logit}(Y_{ij}) = \alpha_0 + \alpha_t + \beta_1 D + \beta_2 t + \beta_3 D \cdot t + \gamma_1 W + \gamma_2 W \cdot t + \gamma_3 D \cdot W + \gamma_4 W \cdot D \cdot t + \epsilon_{ijt} + \epsilon_{ijt} \dots (2)$$

As equation (1) above,  $Y$  is the binary outcome indicator for adverse pregnancy outcome  $\alpha_0$  is the intercept.  $\alpha_t$  captures the period of time-invariant fixed effects.  $D$  is an area indicator for treatment ( $D = 1$ ) or comparison ( $D = 0$ ) districts.  $t$  is an indicator variable for baseline ( $t = 0$ ) or endline ( $t = 1$ ),  $\beta$ s are the regression coefficients to be estimated by maximum likelihood.  $W$  indicates the household wealth index. The parameters  $\gamma_1$ ,  $\gamma_2$ , and  $\gamma_3$  represent adjusted effects of wealth in comparison districts at baseline, the change in the effect of wealth in comparison districts between baseline and end-line, and the difference in the effect of wealth between intervention and comparison districts at baseline respectively. Thus,  $\gamma_4$  estimates the effect of GEHIP on health equity relative to comparison districts, that is the difference in change in equity between intervention and comparison districts. The vector  $U_{igt}$  refers to control variables in the model while  $\epsilon_{ijt}$  is the error term. STATA software was used in all the analyses.

## Results

Table 1 presents the descriptive statistics of the study sample. About 64% of respondents were between 20-34 years at baseline while 71% were within the same group at endline. Almost 92% of respondents were married at baseline as well as endline. On educational attainment, as high as 73% of respondents had no formal education at baseline while 63% had no formal education at endline. Only 3% and 9% had up to secondary or above at baseline and endline surveys respectively. The proportion of respondents affiliated to the Christian religion increase from 51% at baseline to 57% at endline while African traditional religion reduced from about 20% at baseline to 12% at endline. For each survey period, the distribution of most variables was similar between intervention and comparison districts.

[Insert Table 1 about here]

The proportion of pregnancy outcomes categorised as adverse pregnancy outcomes (either miscarriage or stillbirth) and born alive are presented in Table 2. The results show that 12% of the intervention group at baseline experienced adverse pregnancy outcomes as against 11.0% in the comparison group. At endline however, the intervention group has a lower proportion compared to the non-intervention group (7.2% verse 9.9%). It is worthy of note that both arms of the study experience a slight reduction in adverse pregnancy outcomes.

[Insert Table 2 about here]

Tables 3 and 4 present the results of Heckman's difference-in-differences estimation. The average treatment effect of the GEHIP's community-based healthcare program on adverse pregnancy outcome is shown by the interaction term. The results show GEHIP intervention has a statistically significant reduction effect on pregnancy outcome (DiD= -0.043; p-value= 0.010).

Covariates significantly associated with pregnancy outcomes are maternal age, marital status and parity. Teenage mothers were significantly less likely to have adverse pregnancy outcomes compared to older mothers (OR=1.13, p-value<0.001). Married women were significantly less likely to experience adverse pregnancy outcomes compared to single mothers (OR=0.94, p-value=0.003). Higher parity mothers were significantly less likely to have an adverse pregnancy outcome compared to lower parity mothers (OR 0.94, P-value<0.001).

[Insert Table 3 about here]

[Insert Table 4 about here]

Figure 1 is the proportion of adverse pregnancy outcomes among the poorest and least poor wealth index comparing baseline and endline. Results show that for the intervention group, adverse pregnancy outcomes reduced by about 2% among the poorest but remain almost the same among the least poor. The non-intervention group also experience similar reductions among the poorest while adverse pregnancy outcomes increase by about 1% for the least poor within the non-intervention group

[Insert Figure 1 about here]

Figure 2 shows the proportion of adverse pregnancy outcomes comparing mothers with no formal education to those with up to secondary or higher educational status. For the intervention group, adverse pregnancy outcomes among mothers with no formal education reduced from 10.4% at baseline to 9.2% at end line while those with up to Secondary or higher experienced an increase in adverse pregnancy outcomes from 6.9% to 10.9% at end-line.

[Insert Figure 2 about here]

For the non-intervention group, mothers with no formal educational attainment experienced a reduction of adverse pregnancy outcomes from 11.3% at baseline to 8.9% at endline while those with up to secondary education or higher reduced from 12.5% to 10.9%.

Overall, equity analysis indicates no significant treatment effect of household wealth index and education on adverse pregnancy outcomes (OR =0.99, p-value= 0.913, CI: 0.85-1.16) and (OR=0.68, p-value=0.093, CI:0.44-1.07) (see full regression in appendix). Table 5 presents the average marginal effect of household wealth index and educational attainment on adverse pregnancy outcomes from regression analysis based on the model specified in equation 2. While there was a slight negative effect of wealth and education at baseline of the intervention group, these diminished by endline.

[Insert Table 5 about here]

## Discussion

This study has aimed to contribute towards the growing evidence of community-based primary healthcare programs' effects on maternal and child health and survival in a rural poor context. Pregnancy-related complications are among the leading causes of maternal morbidity and mortality. Poor access to maternal services is a known contributor to adverse pregnancy outcomes. Previous studies have shown that community-based primary healthcare improves access to a wide range of maternal and child healthcare services. Therefore, this study commences with the hypothesis that GEHIP's community-based healthcare program would have a positive impact on the reduction of adverse pregnancy outcomes as well as improving equity in those outcomes.

Results indicate that adverse pregnancy outcome reduced from 12% to 7% within the intervention group while the non-intervention groups experience only a 1% reduction from 11% to 10%. Difference-in-difference regression analysis shows that GEHIP had a significant effect in the reduction of adverse pregnancy outcomes (DiD= -0.046; p-value= 0.010). It was found that older mothers, single mothers and lower parity mothers were more likely to have adverse pregnancy outcomes compared to their counterparts. Previous studies have consistently shown older mothers are more likely to have adverse pregnancy outcomes compared to younger mothers, it is therefore not surprising that the same trend was found in this study. Single mothers and

nulliparous mothers have also been documented to have poor birth outcomes . Interestingly, socio-economic-related variables like household wealth index and maternal educational status were not significantly associated with adverse pregnancy outcomes. A national cohort study in England found wide socioeconomic and ethnic inequalities in adverse pregnancy outcomes. Indeed, low socioeconomic status has long been associated with poor health-seeking behaviour and adverse health outcomes

It is noted that resource allocation to community-based healthcare programs is often backed by not only the assumption that mothers and children will benefit by the accessibility to healthcare, but also the potential equity effects of making services available at convenient locations in remote communities. General improvements in health outcomes may sometimes deepen health inequalities between the wealthy and the poor as better-off households often have improved access to new innovations and the economic means to get them . To this end, this study set off to further examine if changes in pregnancy outcomes as a result of GEHIP intervention have contributed to any changes in socio-economic inequalities.

Household wealth index and mothers' educational attainment were used as proxy socioeconomic indicators. Univariate analysis shows a reduction in adverse pregnancy outcomes for the disadvantaged groups (the poor and those with no formal educational attainment). However, further analysis controlling for confounders found that the average marginal effect of wealth and maternal education is not statistically significant. Thus, GEHIP neither improved nor widen socioeconomic inequalities in pregnancy outcomes.

The inverse equity hypothesis proposed by Victora et al postulates that public health interventions initially often reach those in higher socioeconomic status first thus increasing inequality and this later level up as the rich achieve new minimum levels of outcomes and the poor also gain greater levels of access to interventions . Going by this hypothesis, and noting that community-based primary healthcare program was made a national policy in Ghana in the year 2000 while GEHIP commences almost ten years later, then the inverse equity hypothesis is at play and the findings of this study is in line with the later stage of this process.

## Strengths and Limitations of the Study

Both intervention and comparison districts had some components of CHPS functioning before GEHIP was implemented (about 25% and 35% respectively). By the end of GEHIPs implementation, CHPS covered was about 85% and 55% of the population in intervention and comparison districts respectively. This means the effect of the community-based care may have been underestimated given that both arms of the study had CHPS running. The above notwithstanding, major strengths in this study include its used of data with both intervention and control groups. Also, the use of a rigorous statistical analysis to partial out the group's differences enhances the quality of evidence generated by this study.

## Conclusion

GEHIP's community-based healthcare program was found to significantly reduce adverse pregnancy outcomes but no effect on relative equity was established. There was however a general reduction in adverse pregnancy outcomes in both arms of the study owing to the expansion of access to community-based primary healthcare services across the region which mitigates the effects of household remoteness on basic preventive and curative public health care. The results of this study are challenged by limitations in the experimental designs but can be explained by the inverse equity hypothesis.

Globally, improving maternal and child health in line with the United Nations Sustainable Development Goal targets is constrained by socio-economic inequalities in access to and use of essential healthcare services. Community-based healthcare services as low-cost strategies have an important role to play in improving services to remote communities in culturally appropriate ways. However, program planners and implementers should keep an eye to ensure that interventions do not widen equity gaps.

## References

### Table 1: Descriptive statistics of the study sample



| Descriptive<br>Statis-<br>tics             | Descriptive<br>Statis-<br>tics | Baseline<br>Sur-<br>vey | Baseline<br>Sur-<br>vey | Baseline<br>Sur-<br>vey | Baseline<br>Sur-<br>vey | End<br>line<br>Sur-<br>vey | End<br>line<br>Sur-<br>vey | End<br>line<br>Sur-<br>vey |
|--|--------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|----------------------------|----------------------------|----------------------------|
|  |                                | Intervention<br>N       | Intervention<br>%       | Comparison<br>N         | Comparison<br>%         | Intervention<br>n          | Intervention<br>%          | Comparison<br>n            |
| <b>Age<br/>Group</b>                       | 15-19                          | 56                      | 5.6                     | 49                      | 4.6                     | 77                         | 5.7                        | 103                        |
|  | 20-34                          | 644                     | 63.9                    | 686                     | 65.0                    | 947                        | 69.8                       | 957                        |
|  | 35-49                          | 308                     | 30.6                    | 320                     | 30.3                    | 333                        | 24.5                       | 247                        |
| <b>Marital<br/>Status</b>                  | Single                         | 90                      | 8.8                     | 86                      | 8.0                     | 111                        | 8.2                        | 105                        |
|  | Married                        | 929                     | 91.2                    | 988                     | 92.0                    | 1,246                      | 91.8                       | 1,202                      |
| <b>Education</b>                           | No formal education            | 838                     | 77.8                    | 682                     | 66.9                    | 861                        | 65.9                       | 819                        |
|  | Prim/JHS/mid sch               | 211                     | 19.8                    | 293                     | 28.8                    | 348                        | 26.6                       | 405                        |
|  | Sec/tertiary                   | 26                      | 2.4                     | 44                      | 4.3                     | 98                         | 7.5                        | 133                        |
| <b>Religion</b>                            | Christianity                   | 554                     | 54.3                    | 509                     | 47.3                    | 792                        | 58.4                       | 730                        |
|  | Traditional Islam              | 214                     | 21.0                    | 208                     | 19.3                    | 158                        | 11.6                       | 165                        |
|  | Other                          | 252                     | 24.7                    | 359                     | 33.4                    | 407                        | 30.0                       | 412                        |
| <b>Location<br/>of<br/>Resi-<br/>dence</b> | Urban                          | 13                      | 1.3                     | 26                      | 2.4                     | 39                         | 3.0                        | 172                        |
|  | Semi-urban                     | 176                     | 17.3                    | 42                      | 3.9                     | 218                        | 16.7                       | 176                        |
|  | Rural                          | 831                     | 81.5                    | 1,007                   | 93.7                    | 1,050                      | 80.3                       | 1,009                      |
| <b>Wealth<br/>Index<br/>(5)</b>            | Poorest                        | 193                     | 18.9                    | 227                     | 21.2                    | 259                        | 19.1                       | 189                        |
|  | Poorer                         | 228                     | 22.4                    | 238                     | 22.2                    | 267                        | 19.7                       | 238                        |
|  | Better                         | 180                     | 17.7                    | 225                     | 21.0                    | 336                        | 24.8                       | 252                        |
|  | Less Poor                      | 208                     | 20.4                    | 195                     | 18.2                    | 255                        | 18.8                       | 274                        |
|  | Least Poor                     | 211                     | 20.7                    | 187                     | 17.4                    | 240                        | 17.7                       | 354                        |
| <b>Parity</b>                              | One birth                      | 322                     | 23.7                    | 340                     | 26.0                    | 322                        | 23.7                       | 340                        |
|  | 2-4 births                     | 665                     | 49.0                    | 636                     | 48.7                    | 665                        | 49.0                       | 636                        |
|  | 5 or more                      | 370                     | 27.3                    | 331                     | 25.3                    | 370                        | 27.3                       | 331                        |

**Table 2: Pregnancy outcome by intervention and non-intervention areas**

|                           |          | Adverse<br>Pregnancy<br>Outcome [A] | Born Alive [B] | Total [A+B] |
|---------------------------|----------|-------------------------------------|----------------|-------------|
| Intervention<br>group     | Baseline | 123(12.1%)                          | 897 (87.9%)    | 1020(100%)  |
|                           | End line | 97 (7.2%)                           | 1260 (92.8)    | 1357 (100%) |
| Non-intervention<br>group | Baseline | 118(11.0%)                          | 959(89.0%)     | 1077(100%)  |
|                           | End line | 129 (9.9%)                          | 1178(90.1)     | 1307(100%)  |

Table 3: Difference-in-difference estimation results

| Outcome var.  |
|---|
| Before  |
| After   |
| Diff-in-Diff  |
| <i>R-square: 0.03, * Means and Standard Errors are estimated by linear regression **Robust Std. Errors **Inference: *** p&lt;</i> |

Table 4: Difference-in-differences regression model for pregnancy outcome

| VARIABLES  | OR  |
|--|---|
| Treatment *Time  | 0.96*                                       |
| Treatment  | 0.99  |
| Time   | 1.00  |
| Age Group (Compared with 15-19yrs)                     | Age Group (Compared with 15-19yrs)          |
| 20-34  | 1.04  |
| 35-49  | 1.13***                                     |
| Marital Status (Compared with Single)                  | Marital Status (Compared with Single)       |
| Married  | 0.94**                                      |
| Educational Status (Compared with No formal education) | Educational Status (Compared with No formal |
| Prim/JHS/Middle Sch                                    | 1.00  |
| Sec/Tertiary   | 0.99  |
| Wealth Index (Compared with Poorest)                   | Wealth Index (Compared with Poorest)        |
| Poor   | 0.98  |
| Better   | 0.98  |
| Less poor  | 0.98  |
| Least poor   | 1.02  |
| Religion (Compared with Christianity)                  | Religion (Compared with Christianity)       |
| African Traditional Religion                           | 1.01  |
| Islam  | 1.01  |
| Location of Residence (Compared with Urban)            | Location of Residence (Compared with Urban) |
| Semi-urban   | 0.99  |

|   |   |
|---|---|
| Rural                                     | 1.00                                      |
| <b>Parity (Compared to one pregnancy)</b> | <b>Parity (Compared to one pregnancy)</b> |
| 2-4 pregnancies                           | 0.95***                                   |
| 5 or more pregnancies                     | 0.94***                                   |
| Constant                                  | 1.18***                                   |
| Observations                              | 4,715                                     |
| R-squared                                 | 0.02                                      |

\*\*\* p<0.001, \*\* p<0.01, \* p<0.05

Table 5: Average Marginal Effect of Wealth and Education on adverse pregnancy outcomes

#### Delta-method

|  | dy/dx  | std. err.  |
|--|--|--|
| <b>Average marginal effect of household wealth</b>   | <b>Average marginal effect of household wealth</b>   | <b>Average marginal effect of household wealth</b>   |
| Baseline Non-intervention group                      | -0.001   | 0.008  |
| Baseline Intervention group                          | -0.020   | 0.009  |
| End line Non-intervention group                      | 0.015  | 0.009  |
| End line Intervention group                          | 0.011  | 0.006  |
| <b>Average marginal effect of maternal education</b> | <b>Average marginal effect of maternal education</b> | <b>Average marginal effect of maternal education</b> |
| Baseline Non-intervention group                      | -0.036   | 0.022  |
| Baseline Intervention group                          | -0.047   | 0.019  |
| End line Non-intervention group                      | 0.023  | 0.025  |
| End line Intervention group                          | 0.010  | 0.011  |

#### Figure legends

Figure 1: Proportion of adverse pregnancy outcomes among the poorest and least poor wealth index

Figure 2: Pregnancy outcome by mother's educational status

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Figure 1.docx available at <https://authorea.com/users/585699/articles/624209-effect-of-a-community-based-primary-healthcare-program-on-adverse-pregnancy-outcomes-in-northern-ghana>

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