RETURNS ON HEALTH INVESTMENT

By

BIGOOL MARK

DISSERTATION

Submitted to

KDI School of Public Policy and Management

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

IN PUBLIC POLICY

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ABSTRACT

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Chapter 1: Effect of the Free Delivery Healthcare Policy on Under-five Deaths in Ghana. User fee elimination policies have been implemented by developing countries to eliminate financial obstacles that limit health care service utilization by pregnant women. Numerous studies reveal positive association between the delivery fee elimination policy on maternal health service uptake, however there are rare studies that investigate its long-term effect on child mortality especially its impact on both neonatal and infant deaths and the benefit incidence of the policy. This study investigates the effect of the free delivery care policy in Ghana and its effect on child death using the 2003 and 2008 Ghana demographic and health survey (GDHS) data set. Using the difference-in-difference estimation approach, we find the free delivery care policy significantly lowers the probability of neonatal, and infant deaths by 3.3, and 3.6 percentage points respectively in the treated regions. Thus, the likelihood of infant death in the treatment regions is lower compared to the control regions during the pilot period. We find the free maternal delivery care policy to be cost-effective, with an estimated $820.7 cost per infant death averted.

Chapter 2: Effect of Healthcare Quality Initiative on Maternal Healthcare Service Utilization and Pregnancy Outcome: A Case Study of Spring-Ghana Project.

We study the effect of the Spring-Ghana project on maternal healthcare service utilization and pregnancy outcome. The aim of the spring Ghana project was to improve the health of households with pregnant women and children within thousand days of life. As a result, spring introduced several strategies including quality improvement (QI) initiative, where QI teams used PDSA cycle to identify nutrition gaps, brainstorm for change ideas and then test the change ideas. Low antenatal attendance was one of the major gaps identified by the facility teams and changed ideas generated and tested. This study examines the effect of the project on maternal healthcare service utilization and pregnancy outcome. Using the 2017 GMHS dataset and the difference-in-difference approach, we find strong positive association of the project impact on the probability of antenatal care attendance at least one visit and four and more visits by 23 and 11 percentage points respectively and facility delivery by 24 percentage points. We also find that the project reduces the probability of miscarriage by 10 percentage points, and a reduction in the expected number of stillbirths by 27 percent. The findings indicate that pregnant women in the intervention regions were more likely to utilize maternal health service, which translated into improved live births than in the non-intervention regions.

Chapter 3: Effect of the Community-Based Health Planning and Services on Anemia and Acute Malnutrition among the Vulnerable in Ghana.

We study the impact of the community-based health planning and services (CHPS) model implemented by JICA in the upper west region of Ghana on anemia prevalence in children less than five years and women of 15 to 49 years of age. Using the Ghana demographic and health survey dataset and the difference-in-difference approach, we find a reduction in the likelihood of anemia prevalence among children less than five years and women of 15 to 49 years of age

by 15 and 19 percentage points respectively. We also find a reduction in the probability of acute malnutrition in children less than five years by 7 percentage points. The results indicate that the JICA model of CHPS implementation is effective in the reduction of anemia and acute malnutrition prevalence as compared to the traditional model. We find the JICA CHPS project to be very cost-effective in averting anemia prevalence, with an estimated cost of $8 and $6 per year among children less than five years and women of reproductive age respectively.

Keywords: Child death, Healthcare service utilization, pregnancy outcome, Anemia, Acute Malnutrition, Free delivery care policy, Spring, Community-based health planning and services Difference-in-difference, Ghana.

DEDICATION

This work is dedicated to my Prophet, Senior Prophet TB Joshua and the SCOAN prayer warriors for their continual prayer support throughout my entire study period. And to my friend, Karim John Mahmud, my parents and siblings, and the entire Bigool's family for their prayer support.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

EFFECT OF THE FREE DELIVERY HEALTHCARE POLICY ON UNDER-FIVE DEATHS IN GHANA

1.1 Introduction

Under-five mortality reduction is a long-standing global priority and the efforts shown for the past years have yielded a tremendous progress in global under-five deaths reduction and variations in under-five deaths across countries (Wang et al., 2017; Liu et al., 2016). Despite the progress made, only 57 out of 195 nations were able to attain the target 4 of the millennium development goals (MDGs) by the end of 2015 (Wang et al., 2017). In order for countries especially low-income countries to realize the Sustainable Development Goals target on child death reduction to 25 per 1,000 live births by 2030 (Battersby, 2017), an aspiration that demands a much better understanding of precisely where the major gaps remain in child mortality reduction, will require effective maternal and child health policy formulation and implementation.

A number of strategies and structures have been established and executed by the Ministries of Health in developing countries to tackle maternal and child health issues. One among the frameworks is the user fee exemption policy put in place to eliminate financial barriers that limits uptake of maternal healthcare services. A growing body of research reveal a positive relationship between the user fee exemption policies and maternal healthcare service uptake (Edu et al., 2017; Manthalu, 2019; Manthalu et al., 2016a; S. Witter et al., 2011; Powell-Jackson & Hanson, 2012). Also, an assessment of ten countries in Sub-Saharan Africa by McKinnon et al., (2015) show a positive association of the fee exemption policy on institutional births and neonatal survival. However, there are rare studies on the impact of the policy on post-neonatal and infant deaths.

The free delivery healthcare policy was piloted in four regions of Ghana in 2003 and afterwards extended to the other six regions nationwide in July 2005 (Ofori-Adjei, 2007). Previous studies show a positive association between the delivery care policy and maternal healthcare utilization in Ghana (Hatt et al., 2013; Sofo and Thompson, 2015). However, there are rare studies that examine the effects of the free delivery care policy on child death, since maternal healthcare is positively associated with child health outcomes (HIGH, 2014). For instance, studies have indicated the efficacy of prenatal care in reducing child mortality (Amuedo-Dorantes and Mundra, 2003; Currie and Grogger, 2002; Fung and Robles, 2016; Jewell, 2007). Hong and Ruiz-Beltran (2007) indicate that a child whose mother did not attend antenatal, had higher chances of death within five years of birth compared to their counterparts whose mothers received antenatal care. The paper also shows that antenatal care and birth attendance from health experts lessens the likelihood of child death.

We realize the free delivery care policy implementation in Ghana is a quasi-experimental research design that can enable us to examine the policy effect on child health using the difference in difference approach. This paper examines the effect of the delivery care policy on neonatal, post-neonatal and infant since maternal health is associated with child health outcomes. We expect the free delivery care policy will reduce child death since the care rendered during pregnancy is geared towards the health of the pregnant woman and her unborn child as well as the safe delivery of the woman. That is the experimental, the maternal free delivery care policy in the pilot years 2003 and 2004 positively impacts on child health outcomes. We investigate this hypothesis using the Ghana demographic and health survey data set which is representative of the entire population of Ghana. Our results reveal that the free delivery care policy strongly reduces the likelihood of neonatal and infant deaths in the treatment regions. However, we did not find its effect on post-neonatal deaths. The findings suggest that policies and projects/programs that improve the healthcare of pregnant women yields desired benefits on the health of a fetus that extend throughout the lives of children from birth up to one year. Thus, this paper supports the fetal origin hypothesis. To the best of our knowledge, this is the first paper that examines the effect of the user fee elimination policy on long-term child health outcome. This study contributes to literature on the effect of the user fee exemption policy on under-five death. The paper also contributes to previous works on the effect of maternal health investment on child health.

We structure the rest of the paper as follows: Section 2 gives a brief background of the free delivery care policy and section; Section 3 discusses the literature review, and in Section 4 describes the data used for the study. Section 5 describes the empirical strategy. We present the results of the study and discussions and conclusions in Section 6 and 7 respectively.

1.2 Background

1.2.1 Delivery Care Policy in Ghana

The Free maternal delivery care policy was piloted by the Government of Ghana in September 2003 in four regions of the country (see Figure A.1), and later expanded nationwide in April 2005 (Ofori-Adjei, 2007). The objective of the policy is to eliminate financial challenges that limit access to maternal healthcare services in the country (Asante et al., 2007). Both private and public health institutions were covered under the policy (Sophie Witter et al., 2007). The private institutions that were not covered either did not meet criteria for the accreditation or they were not interested in the policy. Under the policy, health facilities were paid per number of deliveries and normal deliveries had different fixed rates from caesarean deliveries. Both public and private health institutions had different reimbursement rates per-deliveries. The Highly Indebted Poor Country (HIPC) fund was used to finance the policy and in 2007 the policy ended owing to lack of funds (Ghana Statistical Service et al., 2007).

Pregnant women had to pay for health insurance premium to access healthcare services when the policy ended, while others not enrolled had to pay for healthcare services with some resorting to home deliveries. These lead to low uptake of maternal healthcare services with resultant surge in maternal and child mortality in 2007 (Ministry of Health, 2008a). To reverse the trend, the government abolished maternal healthcare user fees in 2008. Pregnant women no longer pay for national health insurance premium (NHIS) premium and are automatically enrolled into the NHIS as soon as they are confirmed pregnant. The policy covers medical care during pregnancy, delivery by health professional, Caesarean section, normal vaginal deliveries and management and treatment of pregnancy complications and complications during deliveries (GSS, 2009; Sophie Witter, Armar-Klemesu, & Dieng, 2008).

An evaluation study of the policy by Penfold et al., (2007) show an increase in skilled deliveries by 12 percentage points. Other studies also show significant increase in maternal healthcare utilization and facility deliveries (Dzakpasu et al., 2012). The main evaluation report conducted by Hera and Health Partners Ghana in 2013, only assesses the national roll out in 2008, starting from 2007 to 2013 and reports an increase in facility-based deliveries and reduction in maternal mortality ratio. This evaluation reviewed available maternal documents and databases, maternity registers and records and conducted key informant interviews. However, the studies and evaluation fail to examine the policy effect on under-five health since maternal healthcare is connected with child health especially during the neonatal and infant period.

Our study examines the short and long-term impact of the policy on child death since maternal health care is linked with child health by exploiting the natural experimentation of the policy intervention using data from the demographic and health survey, which quite represents the entire Ghanaian population. We use the piloted regions (see Figure A.1 in appendix A) as the treatment regions to investigate the policy effect on child death.

1.2.2 User Fee Exemption Policies and Health Outcomes

The question as to whether healthcare service user fees should continue or be eliminated is still a challenge and a debate for policy makers, and thus health facility utilization still poses a challenge to many especially the underprivileged. Financial obstacles have been shown to have adverse impact on health services utilization in both advanced and developing nations as reflected in several published researches (Peters et al., 2008; Waddington & Enyimayew, 1990; Wagstaff, 2002). Lately, some international organizations are promoting the elimination of user fees particularly for the vulnerable group and the underprivileged in the society (Adeola et al. 2005.), and as such developing nations have taken the initiatives to abolish healthcare service user fees for pregnant women.

User fee exemptions are found to be associated with increase in health service uptake. In Uganda, elimination of user fees resulted in a surge for demand for curative healthcare and a marginal increase in promotive care and preventive healthcare services among the underprivileged (Nabyonga et al., 2005; Pariyo et al., 2003). Similar studies on the elimination of healthcare service user fees for children and pregnant mothers in South Africa by Wilkinson et al, (2001) revealed a significant increase in uptake of curative care service, but no evidence of its effect on preventive health services. Evidence by Shinsuke Tanaka (2014) on user fee elimination in Post-Apartheid South African health facilities for pregnant women and children show improved child health status.

After five years of implementation of the maternal subsidy program in Burkina Faso, Ganaba et al., (2016) established that the usual 1 percent increase in health facility delivery rate from 1988 to 2010 was replaced by an annual increase of 4 percent from 2007 onwards. In a randomized trial to encourage maternal healthcare utilization in Kenya, Grépin et al., (2019) examined the effectiveness of cash transfers, vouchers, and SMS messages in the utilization of institutional delivery among the underprivileged. The paper shows that 48 percent of pregnant women with access to both conditional cash transfers and vouchers gave birth at the health facility, whilst 36 percent delivered elsewhere.

A study in Bangladesh by Ahmed and Khan, (2011) evaluating the effects of demand side financing on maternal healthcare service utilization revealed that women who received maternal healthcare vouchers had higher probability of attending antenatal care, seek for health professional care during labor, attend postnatal care and also likely to seek healthcare for complications arising out of pregnancy than pregnant women who were not in the program. Examining the effect of the user fee exemption policy in Malawi at mission health facilities, Manthalu et al., (2016) found an increase of 15 percent antenatal care attendance and an increase of 12 percent for institutional deliveries.

A systematic assessment of researches on health service utilization by Lagarde & Palmera, (2008) posits that the researchers did not clearly show whether the surge or decline in health service uptake was maintained over time. They suggested the need for a more robust research to examine the impact of the user fee exemptions on health facility utilization. Also, a review of empirical studies on user fee elimination and maternal healthcare service utilization by Dzakpasu et al., (2014) revealed poor quality studies, as few of the studies addressed potential biases and as such, they recommended an improved method of evaluation and a robust research technique that permits comparison of groups and as well reporting immediate and long-term effects.

Owing to the above recommendations, our research focuses on the policy effect on the child health indices (neonatal, post-neonatal and infant deaths). We investigate the policy effect for both immediate and long-term perspective. We exploit the variation in the intervention of the policy throughout the regions using the Ghana demographic and health survey data set, which provides detailed information on the birth status of women of the reproductive years.

1.2.3 Under-five Mortality Situation Globally and in Ghana

Although the global mortality rates for under-five has reduced by 59 per 1000 live births, from 93 per 1000 live births to 39 per 1000 live births in 1990 and 2018 respectively, there are still widespread disparities in under-five rates globally. The rate of children less than five mortality in developed countries is 5 per 1000 live births compared to 42 per 1000 live births in least developed nations. Sub-Saharan Africa has the highest under-five mortality rate, that is 78 deaths per 1000 live births in 2018. One out of 13 children in Sub-Saharan African die before their five birthdays. Current mortality estimates predict that close to 52 million children less than five years will die between 2019 and 2030 and half of these deaths will be from Sub-Saharan Africa (UNICEF et al., 2019). It is imperative to fast-track progress in averting child mortality. To avert these deaths, effective policies are needed which will demand evidence from researchers thus making this study relevant.

Ghana has made remarkable progress in child mortality reduction; however, the current rates are still unacceptably high. Neonatal and infant mortality rates in Ghana are 24 and 35 per 1,000 live births respectively. Less than five mortality rates decreased from 101 per 1,000 live births in 2000 to 48 per 1,000 live births in 2018 (UNICEF et al., 2019). Despite the decline, one out of 27 Ghanaian children still die before attaining age one and one out of 19 children dies before attaining age five (Ghana statistical service et al., 2018). This paper studies the free maternal delivery care policy and its contribution to child mortality reduction to aid in policy decision making.

1.3 Data and Summary Statistics

We use the Ghana demographic and health survey to estimate the project effect on maternal free delivery care policy on child health. The Survey (DHS) program is intended to provide data to assess the health situation of Ghanaians. There are about 6 waves of the dataset. We use the 2003 and 2008 waves to estimate the policy impact and the 1998 dataset for the falsification test. In total, a sample of over 12,831 households were identified for the interview and 11,778 households were fully interviewed, making a response rate of 99 percent. Women of reproductive age were identified in the selected households from the clusters for the interview. The survey collects comprehensive information on maternal health and service utilization including fertility, family planning methods, nutritional status of women and children, breastfeeding practices, and maternal and child health. The dataset covers a reference period of 5years and contains information on birth records, couple records, individual records, men's records, household records and children records. We use the children records in this study. Children records are obtained from the mother and it contains information on the year of birth of child, whether child is alive or not, age of child at time of the survey and age at death in years if any and in months. The variables: imputed age of death in months and the child is still alive is used to create our outcome variables of interest (neonatal, post-neonatal, and infant mortality). We only consider deaths up to the infant period because care during pregnancy will resolve pregnancy complications reducing the likelihood of preterm and low birth weight which easily results in death during the infant period.

Table 1.1 presents a summary of the main variables used in this study. The total observation used for this study is 8,271 (3,283 for treatment regions and 4,988 for control regions). The main dependent variable, child mortality is measured as neonatal, post-neonatal and infant death. The treatment regions experienced 3.9 percent neonatal death compared to 4.3 percent for the control regions. Post-neonatal deaths for the treatment region are higher (3.2 percent) compared to 2.2 for the control region. The treatment regions also recorded higher infant deaths (7.1 percent) compared to 6.5 percent in the control regions. Majority of the mothers in the treatment regions had no education, 76 percent compared to 28 percent in the control regions and mostly from the Christian religion, 40 percent in the treatment regions compared to 82 percent Christians in the control regions. The results of the summary indicate that Christians are more in the control region than the treatment regions. Poverty incidence is also higher in the treatment regions than the control regions, with 59 percent of the households among the poorest households in Ghana compared to 17 percent poorest in the control regions. Most of the women in both treatment and control regions are from the rural areas. We also present definitions of variables in appendix A, Table A.1.

Table 1. 1: Summary Statistics

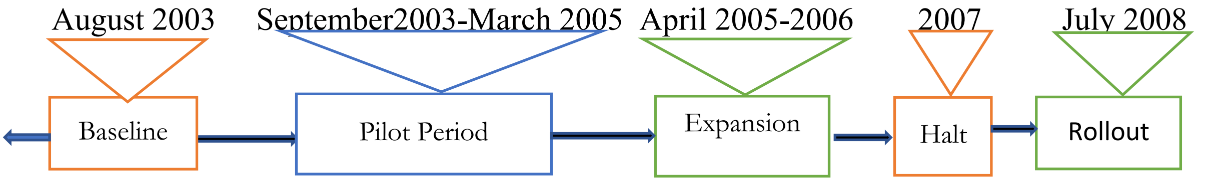
Variable	Treatment		Control	
	Mean	Std. Dev.	Mean	Std. Dev.
Neonatal death	0.039	0.194	0.043	0.204
Post-neonatal death	0.032	0.177	0.022	0.147
Infant death	0.071	0.257	0.065	0.247
Post	0.235	0.424	0.216	0.412
Child gender:				
Male	0.520	0.500	0.498	0.500
Female	0.480	0.500	0.502	0.500
Mother age	31.068	7.242	30.272	7.001
Mother place of residence:				
Urban (excluded category)	0.137	0.344	0.362	0.481
Rural	0.863	0.344	0.638	0.481
Mother Ethinicity	12.217	25.498	7.932	22.699
Mother education:				
No education (excluded category)	0.759	0.428	0.276	0.447
Primary	0.133	0.339	0.271	0.445
Secondary	0.103	0.304	0.436	0.496
Higher educ	0.005	0.072	0.016	0.127
Wealth index:				
Pooer	0.180	0.385	0.252	0.434
Poorest	0.591	0.492	0.166	0.372
Middle (excluded category)	0.124	0.330	0.211	0.408
Richer	0.075	0.263	0.182	0.386
Richest	0.029	0.169	0.188	0.391
Twins	0.035	0.183	0.044	0.206
Mother religion:				
Christian	0.398	0.490	0.817	0.387
Islam	0.330	0.470	0.108	0.311
Traditionalist	0.143	0.351	0.020	0.140
Other religion	0.018	0.134	0.003	0.051
No religion (excluded category)	0.107	0.309	0.047	0.212
Literacy	0.138	0.593	0.540	0.910
Child birth order	3.838	2.391	3.434	2.285
Mother Age-squared	1017.6	471.9	965.4	445.4
Observations	3,283		4,988	

Note: Variables with excluded categories are not used in the main regression. We exclude 4 missing values from mother ethnicity making our summary statistics not comparable with the observation for the analysis.

1.4 Estimation Strategy

In our setting, the free delivery healthcare policy was first implemented in four regions (Central, northern, upper east and upper west) of the country in September 2003 and the whole pilot program existed until April 2005 when it was expanded to the remaining six regions nationwide. Below figure shows the implementation phases of the policy:

Figure 1. 1: Free Delivery Healthcare Policy in Ghana – Implementation phases



We employ the difference in difference (DID) estimation approach because of the nature of the policy implementation. The DID estimator is most often used to estimate a causal impact of a program when there exists a policy or program intervention and control group before and after the implementation. We use the 2003 and 2008 DHS dataset which has information on children records of mothers who were interviewed during the survey to estimate the project impact on child death. We estimate the policy effect using the variable 'child-birth year' to create our post year variable. We use birth cohorts of 2004 and 2003 as our post year and birth cohorts of 2002 and before as the baseline years. A potential threat to the validity of our identification strategy is the National health insurance scheme implemented nationwide in 2003, which exempt children under 18 years from paying premium fees which could affect the outcome variable of interest. However, its services were not accessible until 2005, and thus we omitted birth cohorts for 2005 in our analysis to eliminate confounding effects. The DID model is:

$$\mathrm{CDEAD}_{\mathrm{ijt}} = \beta_1 \mathrm{Treatment}_{\mathrm{j}} + \beta_2 \mathrm{Post}_{\mathrm{t}} + \delta \mathrm{Treatment}_{j} * \mathrm{Post}_{\mathrm{t}} + \beta_3 \mathrm{X'}_{\mathrm{ijt}} + \gamma_{\mathrm{j}} + \tau_t + \mu_{\mathrm{ijt}}$$

$\mathrm{CDEAD}_{\mathrm{ijt}}$ represents the child death (neonatal, post-neonatal, and infant death). Neonatal death is a binary variable indicating whether a neonate *i* died within the first month of birth in region *j* at time *t.* Post neonatal death is an indicator variable whether a child *i* in region *j* dies after a month to one year of life. Infant mortality is also an indicator variable whether child *i* died within a year of birth in region *j* at time *t*. $\mathrm{Treatment}_{\mathrm{j}}$ represents the regions (Upper East, Northern, Central, Upper West) that were treated (see Figure A.1. in appendix A). It takes the value of 1 if region j benefited from the pilot study and 0 otherwise. Post_t represents 1 if birth year is 2004 and 2003 and 0 if birth year is 2002 and earlier birth years. δ is the difference in difference estimator which is the coefficient of interest. $\text{Treatment}_j * \text{Post}_t$ is the interaction of treatment and the post year. X'_{ijt} is a vector of child, mother and household related covariates. γ_j refers to region fixed effects to control for time-constant, unobserved heterogeneity across regions which may have influenced child death. τ_t refers birth year fixed effects to control for national events which may have affected childbirth or death in a given year. Such as national immunization programs, malaria control program and child health promotion week. μ_{ijt} is the error term clustered at the primary sampling unit level[1].

1.5 Empirical Results

1.5.1 Average Deaths before and after the Free Delivery Care Policy

In Table 2.1 we present the average neonatal and infant death before and after the free delivery care policy in Ghana. We also show the mean child death distinctively for control and treatment regions before and after the policy introduction. The mean neonatal deaths for the treatment regions before the policy are higher (3.9 percent) than the control regions (3.7 percent). After the policy introduction the neonatal death in the treatment regions slightly declined to 3.8 percent, a decrease by 0.1 percent. However, we see a rise in neonatal death in the control regions after the policy (An average of 6.7 percent). We expect similar trends in the treatment regions if the policy was non-existent. The overall average of the policy effect is 3.2 percentage points reduction in neonatal death. Similar pattern is observed in infant death. The mean infant

[1] Primary sampling units contain 412 clusters. 12,360 households were selected from the 10 regions of the country in the first phase of the survey for verbal autopsy of under-five deaths. During the fieldwork involving the phase two of the survey, 6180 households were chosen from the identified clusters in phase one and stratified on region bases in urban-rural residence and households with women (15-49) were chosen and interviewed. We cluster the error term at this level.

death in the treatment regions is higher 7.6 percent compared to 6.2 in the control regions before the policy introduction. Infant death in the treatment regions after the policy reduced to 5.6, a decline by 2 percentage points but increased by 1.6 from 6.2 in the control regions before the policy to 7.8 percent after the policy introduction. We find a significant average reduction of infant death by 3.6 percentage points.

Table 1. 2: Average Deaths before and after the Free Delivery Care Policy

Outcome variables	**Neonatal death**			**Infant death**		
	Control	Treatment	Diff (T-C)	Control	Treatment	Diff (T-C)
Mean child death before policy	0.037	0.039	0.003 (0.005)	0.062	0.076	0.014** (0.006)
Mean child death after policy	0.067	0.038	-0.029*** (0.009)	0.078	0.056	-0.022* (0.012)
Diff-in-Diff			-0.032*** (0.011)			-0.036*** (0.013)

Note: Standard errors are in the parentheses. Treatment is the policy regions (Northern, central, upper east and upper west region) and Control is the remaining six regions of Ghana. The diff-in-diff is average difference-in-difference estimator of the policy effect on both neonatal and infant deaths. We did not control for other covariates in this regression.

1.5.2 Effect of the Free Delivery Care Policy on Child Death

Table 1.3 presents the main result of the free delivery care policy. Since the policy is a social program aimed at reducing barriers to accessing health services and most rural dwellers in Ghana are poorer, we controlled for place residence, we also control mother age since it is associated with child health outcomes (Chari et al., 2017). We include a wealth index owing to the research findings that the probability of child death is higher among the lower wealth quintiles (Currie & Stabile, 2003; Lartey et al., 2016; Cameron & Williams, 2009). For better understanding of how wealth index was constructed, see footnote[2]. We include region fixed effects to control for region shocks that might influence child death. Previous studies show that parental education reduces the probability of child mortality (Chou et al., 2010; Desai & Alva, 1998; Grépin & Bharadwaj, 2015; Currie & Moretti, 2003). Also estimating the effect of parents' education on sons using the mandatory educational reform in Sweden, Lundborg et al., (2014) discover maternal education to have positive effects on sons' abilities and health outcomes but no evidence of father education on child health and skills. Based on these findings we include mothers' education in our analysis.

Controlling for covariates in all the columns of Table 1.3, the result shows a positive association of the delivery care policy and child mortality reduction. The interaction term (Treatment*post) which is the difference in difference estimator shows a reduction on child mortality. Holding other covariates constant in column 1, the policy reduces the probability of neonatal mortality in the treated regions by 3.3 percentage points, at 5 percent significance level. In column 2 the policy reduces post-neonatal death – holding other covariates constant, the free delivery care policy reduces the probability of post-neonatal death in the treatment regions by 0.3 percentage points albeit statistically insignificant. In column 3 the policy shows a significant effect on infant mortality reduction; that is holding other covariates constant, the free delivery care policy strongly reduces the probability of infant death in the treatment regions by 3.6 percentage points. Thus, our study indicates the effectiveness of policy in the long-term and this lays emphasis on the importance of free maternal health care and institutional delivery. This paper is consistent with the study by Lusaka, (2018), who explored

[2] The wealth index is created using data based on the assets the households possess, such as ownership of car, television, bicycle as well as others like sanitation facilities types, drinking water source and flooring material. Weights are created through principal components assessment and assigned to each asset and the score of each asset standardized to a normal distribution. Each household is then allocated a score for each asset, the scores added up by household and individuals ranked based on the total score of the household they live in. The sample was then ranked (poorest, poor, middle, rich and richest) in quintiles (Ghana Statistical Service et al., 2008).

the long-term effect of receiving treatment at birth from trained midwives and revealed that treatment at birth by trained midwives lowered neonatal death. Fung & Robles, (2016) study the effect of antenatal testing law implemented in the US mandating pregnant women to test for syphilis during antenatal care and find a neonatal reduction of 8.6 percentage points, which is also in line with our findings.

1.5.3 Mechanisms

The maternal free delivery care policy may affect child health/death through three classes of mechanisms. First, antenatal care attendance; pregnant women have been recommended for at least four antenatal care visits before delivery and four and more for pregnant women with pre-existing conditions and delivery by qualified health professionals. During this period several kinds of interventions are carried out including fetal growth monitoring, urine and blood sample analysis to uncover infections that might interfere with the pregnancy. Other measures include intermittent preventive treatment, deworming, iron and folic acid supplementation. Several studies have investigated the effects of antenatal care and delivery care on child health. For instance, in a study in Azerbaijan on the effect of maternal healthcare on the likelihood of child survival, Habibov and Fan (2014) show an increase in child survival by 18 percent for women who gave birth at the health institutions. Second, delivery by a qualified health professional and thirdly, postnatal care of a child by a qualified health professional.

The results of this study indicate that the free delivery care policy significantly reduces the probability of neonatal and infant mortality in the treatment regions. We further examine the mechanisms stated above and how they impact on child's death. We investigate the impact of free delivery care policy on skilled antenatal care attendance, skilled birth and skilled postnatal care of a child. We present the results in Table 1.4. We find no significant impact of the policy on skilled antenatal care (ANC), skilled delivery and skilled postnatal care (PNC). What then could be translating to the gains in child survival? We further investigate the policy impact on antenatal attendance at the hospitals. Since hospitals are better equipped in terms of human resources(specialist) and diagnostic equipment, we anticipate an expert care which will result in less mortalities compared to health Centers. In column 2 of Table 1.4, we find an increase in antenatal care uptake at the hospitals by 11 percentage points.

1.5.4 Robustness Checks

The main assumption required for the difference in difference strategy is the common trend assumption, that is the outcome variables in both treatment and control regions will have experienced the same trend in the absence of the policy. To ensure this hold, we estimate a falsification test using the 1998 GDHS data set and present the results in Table 1.5. We consider the unaffected birth cohorts of 1999 and 1998 as the pseudo-post and birth cohorts of 1997 and less as the baseline years and then interact with the treatment. The coefficients of the interaction term (Treatment*Pseudo-post) are statistically insignificant even after controlling for child's gender, twin, mothers age, education dummies, religion dummies, ethnicity dummies, wealth index, region and birth year fixed effect. This shows that there existed a common trend in neonatal, post-neonatal and infant death in the treated and control regions before the implementation of the free delivery healthcare policy in Ghana.

We also present marginal effects after probit estimates of the policy effect on the child death in Table A.2. In column 2 and 6, holding all other covariates constant, the free delivery care policy significantly lowers neonatal and infant death by 2.9 and 3.4 percentage points respectively. The magnitude of probit estimates is slightly lower than OLS results, however, the significance and sign of effect are the same confirming the robustness of our results.

Table 1. 3: Effects of the Free Delivery Policy on Child Death

Variables	(1) Neonatal death	(2) Post-neonatal death	(3) Infant death
Treatment	0.015	-0.021*	-0.006
	(0.016)	(0.012)	(0.018)
Post	0.029**	-0.015***	0.013
	(0.011)	(0.005)	(0.012)
Treatment*post	**-0.033****	**-0.003**	**-0.036****
	(0.015)	**(0.010)**	**(0.018)**
Constant	-0.069	0.043	0.131
	(0.068)	(0.046)	(0.080)
Observations	8267	8267	8267
R-squared	0.025	0.011	0.024
Individual variables	Yes	Yes	Yes
Mother variables	Yes	Yes	Yes
Household level var.	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes

Note: this table reports the main results of the study. The variable 'Treatment*post' is the difference in difference estimator. Is the interaction of post (birth year-2004&2003) with treatment (Northern, central, upper east, upper west). Individual variables are; child gender, twin and birth order. Mother variables are; mother's age and age-squared, education dummies, religion dummies, ethnicity and literacy. Household level variables are; wealth index, place of residence(rural). We also control for region and birth year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in parentheses and are clustered as the primary sampling level.

Table 1. 4: Skilled Maternal Healthcare Service uptake

Variables	(1) Skilled ANC	(2) ANC at hospitals	(3) Skilled delivery	(4) Skilled PNC
Treatment	-0.003	0.007	0.026	-0.361***
	(0.012)	(0.063)	(0.019)	(0.079)
Post	0.012	-0.037	0.123***	0.026
	(0.009)	(0.083)	(0.030)	(0.066)
Treatment*post	**0.007**	**0.108****	**0.027**	**0.044**
	(0.006)	**(0.047)**	**(0.018)**	**(0.051)**
Constant	-0.011	0.527**	0.058	0.485*
	(0.021)	(0.248)	(0.060)	(0.275)
Observation	5679	5268	8219	4403
R-squared	0.021	0.070	0.071	0.115
Individual variables	Yes	Yes	Yes	Yes
Mother variables	Yes	Yes	Yes	Yes
Household level var.	Yes	Yes	Yes	Yes
Birth year FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes

Note: this table reports the mechanisms of the policy effect on child health. The variable 'Treatment*post' is the difference in difference estimator. Is the interaction of post (child birthyear-2004 &2003) with treatment (Northern, central, upper east, upper west). **Skilled** refers services rendered by doctors, nurses, midwives and community health nurses/officers. Mother variables are; mother's age and age-squared and age-squared, education dummies, religion dummies, ethnicity and literacy, twin pregnancy, birth order (parity). Household level variables are; wealth index, place of residence(rural). We also control for region and birth year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5% and 10% respectively. Standard errors are in parentheses and are cluster as the primary sampling unit level.

Table 1. 5: Falsification Test-Free Delivery Care Policy on Child Death

Variables	(1) Neonatal death	(2) Post-neonatal death	(3) Infant death
Treatment	0.015	0.018	0.003
	(0.016)	(0.023)	(0.017)
Pseudo-post	0.007	-0.164	-0.171
	(0.015)	(0.187)	(0.182)
Treatment*pseudo-post	**0.012**	**-0.006**	**-0.018**
	(0.016)	**(0.022)**	**(0.015)**
Constant	-0.039	0.172	0.211
	(0.031)	(0.192)	(0.185)
Observation	2921	2921	2921
R-squared	0.017	0.026	0.026
Individual variables	Yes	Yes	Yes
Mother variables	Yes	Yes	Yes
Household level var.	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes

Note: this table reports the falsification test of the main results. The variable "Treatment*Pseudo-post**"** is the DID estimator for Policy implementation. We use the 1998 DHS data set to estimate the falsification test. Pseudo-Post represents childbirth year 1999 and 1998 and baseline years being 1997 and earlier birth years. Teatment regions are; northern, central, upper east, upper west regions. Individual variables include; child gender and twin. Mother variables are; mother's age, education, religion, ethnicity. Household level variables are; wealth index, and place of residence(rural). We also control for region and birth year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5% and 10% respectively. Standard errors are in parentheses and are clustered as the primary sampling level.

1.5.5 Simple Cost-effectiveness Analysis

We use our regression estimates of column 3 of Table 1.3 for the cost-effective analysis. The result of the cost-effectiveness analysis is in Table 1.6. The total cost (column 1) for the ongoing intervention is obtained by multiplying total live births[3] by the cost per interventions[4].

[3] Total live births are obtained from Ghana birth and death registry, (2020). It represents only registered births in 2004 and 2002, for the entire country. We obtain live birth births for the implementing region by calculating 14 percent of the total live births in Ghana for the implementing regions. The reason for this is because, under-five total population of the implementing regions is 14 percent of the total is under-five population in Ghana. In 2002, only 17 percent of births were registered, and we adjusted the total live births for 2002 by doubling it, making it comparable with the 50 percent registrants in 2004.

[4]The Total cost of ongoing interventions is obtained as follows: The cost per normal vaginal delivery, cost per caesarean and cost per antenatal care (ANC) and post-natal care (PNC) is obtained from Levin et al. (2003). The average cost per normal vaginal delivery 11.15 is multiplied by 99 percent of the total live births in 2002 while the average cost per caesarean section is 72.22 multiplied by 1 percent of the total live births. We then sum the two to obtain the total amount spent on delivery. The reason for this is because 1 percent of deliveries in 2002 were by caesarean section. The average unit cost per ANC is $4.21, we multiply this figure by 4 since pregnant women are mandated to visit ANC at least four times. We also use the same figure of ANC as the cost for post-natal care ($4.21), we also multiply it by 3 times, a recommended number of PNC visits. We then multiplied the total average unit cost per ANC and PNC (29.17) by the total live births to obtain the total amount spent on ANC

The total cost for the free maternal delivery care policy is obtained from the Ghana health sector annual program of work (Ministry of health, 2004)[5]. Health benefit (column 4) for the free delivery care policy is 3.6 percent of our estimates from column 3 of Table 1.3 multiplied by the total live births. Whilst the Health benefits for the ongoing intervention is obtained by multiplying 2.9 percent[6] with the total live births for the ongoing intervention. Our results show that 2,268 infant deaths were averted by the policy. Incremental cost-effectiveness ratio (ICER)[7] is calculated by taking the differences between the cost of maternal free delivery care policy and the cost of the ongoing interventions divided by the difference between the health benefits of the maternal free delivery care policy and the health benefit of ongoing interventions. Our analysis indicates that it cost US$820.7 to avert infant death or save an infant's life. Our ICER is within the national cost-effectiveness threshold (opportunity cost of other interventions) range for Ghana (US$ 104 – 951) estimated by Woods et al. (2016). Thus, the maternal free delivery care policy is cost cost-effective. Thus, the policy gives value for money, and allocating resources to the policy will yield desired benefit.

and PNC. The total cost spent on delivery is summed with the total cost spent on ANC and PNC to obtain the total cost spent for the ongoing intervention in 2002.

[5] Total cost of the project in 2004 is $$3,056,027. It is GHS 2,700,000, we converted it to dollars using the Bank of Ghana, (2018b) exchange rate for 2004. Since the amount was spent on all pregnant women, and not all the pregnancies led to live births, we subtracted 12 percent from the total cost to obtain the amount spent on live births. The reason for this is because 12 percent of the pregnancies in 2004 did not result in live birth (resulted in miscarriages, abortions and still births based on our micro data).

[6] Is the average annual rate of child mortality reduction and is obtained from UNICEF (2015)

[7] Cost-effectiveness ratio refers to the amount of money an intervention needs in order to avert 1 DALY. Is the measure for cost-effectiveness. It shows 'value for money.

Table 1. 6: Cost-effectiveness Analysis of the Free Delivery Care Policy

Intervention (1)	*Total live births* (2)	*Cost (US$)* (3)	*Health benefit (deaths averted)* (4)	*ICER calculation* (5)	*ICER (US$ per death averted)* (6)
Ongoing interventions in 2002	52,220	$2,168,957.7	1,514.4	–	–
Maternal free delivery care policy in 2004	60,217	$2,689,303.9	2,267.8	$536,239.36/ 653.4	$820.7

Cost per ANC and PNC interventions in 2002 =$29.47, Cost per normal delivery 2002 is $11.15
Cost per Caesarean section in 2002=72.22 Total cost of project 2004=$$3,056,027.16

Note: if the ICER is less than the national cost-effectiveness threshold then the intervention is deemed cost-effective. We use this equation: $ICER = {}^{\Delta Cost}/_{\Delta\ death\ averted}$ for the analysis.

1.5.6 Heterogeneous Effect

1.5.6.1 Effect by Gender

We also conduct heterogeneity tests to determine whether there was a gender difference in mortality reduction. We present the results in Table 1.7. In Panel A of column 1 and 3 the policy significantly reduces the probability of neonatal and infant death among males by 3.8 and 4.7 percentage points. Panel B of Table 1.7 shows the policy effects on females. The results are statistically insignificant, indicating no significant effect of the policy on neonatal, post-neonatal, infant and under-five deaths among females. The reason for the gender differences in mortality reduction could be due to mortality rates of male and females before, during and after the policy introduction. Figure A.2 shows that females were more likely to survive before, during and after the policy introduction than males. This could be one reason why under-five males benefited more of the policy compared to females.

1.5.6.2 Effect among Urban and Rural Dwellers

We also estimate the policy effect among the rural and urban dwellers to determine the place of residence that benefited most from the policy. Table 1.8 shows the results among urban and rural children. Panel A shows the policy among the rural residents. In column 1 of Panel A, the interaction term Treatment*post is statistically significant, showing a reduction in the probability of neonatal death among rural residents by 4.1 percentage points. In column 2, and 3 we see no significant impact of the post-neonatal, and infant's policy among rural dwellers. Panel B presents the effect of the policy among urban residents, we find a significant reduction on post-neonatal deaths among urban dwellers by 3.5 percentage points. However, there is no evidence of its effect on neonatal and infant deaths among the rural dwellers.

1.5.6.3 Effect by Education

A growing body of research has documented a positive association between education and child health. The benefit of the free delivery care policy on child death may differ by education of the mother. In Table 1.9 we estimate the heterogeneous effect of the policy by educational status of women. In column 1 of Panel A, we see a reduction in neonatal mortality by 5.4 percentage points among women with primary education albeit insignificant. In column 1 and 3, the policy significantly reduces neonatal and infant deaths by 6.5 and 11.6 percentage points respectively among women with primary education. In Panel B of Table 1.9, we find no evidence of the policy effect on child death among women with higher educations. The findings suggest that children of mothers with primary were more likely to survive compared to those with higher education. Most women with primary education do not have formal employment and can at any time access maternal healthcare services since it is free. Women with higher education do have formal employment and their frequency of access to maternal healthcare service may be limited compared to those with lower education.

Table 1. 7: Policy Effect on Child Death by Gender

Variables	(1) Neonatal death	(2) Post-neonatal death	(3) Infant death
Panel A: Effect among males			
Treatment	0.011	-0.012	-0.001
	(0.024)	(0.015)	(0.028)
Post	0.015	0.030***	0.045
	(0.030)	(0.011)	(0.032)
Treatment*post	-0.038*	-0.009	-0.047**
	(0.021)	(0.012)	(0.024)
Constant	0.143	0.012	0.155
	(0.105)	(0.055)	(0.115)
Observations	4190	4190	4190
R-squared	0.043	0.032	0.047
Panel B: Effect among females			
Treatment	0.024	-0.023	0.000
	(0.018)	(0.019)	(0.026)
Post	0.020	0.019	0.039
	(0.023)	(0.018)	(0.029)
Treatment*post	-0.028	0.002	-0.026
	(0.019)	(0.015)	(0.024)
Constant	0.011	0.053	0.063
	(0.084)	(0.075)	(0.109)
Observations	4077	4077	4077
R-squared	0.028	0.015	0.024

Note: this table show the heterogenous effect policy gender. Panel A is effect among males and Panel B shows the effect among females. The variable 'treatment*post' is the difference in difference estimator. Is the interaction of post – child's birth year 2004 and 2003 with treatment (Northern, central, upper east, upper west). Individual variables include; child gender and twin. Mother variables are; mother's age and age-squared, education dummies, religion dummies, ethnicity and literacy. Household level variables are; wealth index, place of residence(rural). We also control for region and birth year fixed effect in all models. Statistical significance is indicated by ***, **, and * at 1%, 5% and 10% respectively. Standard errors are in parentheses and are cluster as the primary sampling unit level.

Table 1. 8: Policy Effect on Child Mortality among Urban and Rural Dwellers

Variables	(1) Neonatal death	(2) Post-neonatal death	(3) Infant death
Panel A: Effect on Rural			
Treatment	0.028	-0.026*	0.002
	(0.017)	(0.014)	(0.021)
Post	0.034	0.017	0.051*
	(0.022)	(0.014)	(0.026)
Treatment*post	-0.041**	0.008	-0.033
	(0.019)	(0.011)	(0.022)
Constant	0.130	0.018	0.148
	(0.091)	(0.054)	(0.108)
Observations	6014	6014	6014
R-squared	0.038	0.015	0.034
Panel B: Effect on Urban			
Treatment	-0.022	0.010	-0.011
	(0.036)	(0.035)	(0.051)
Post	-0.019	0.029**	0.010
	(0.037)	(0.014)	(0.040)
Treatment*post	-0.002	-0.035*	-0.037
	(0.026)	(0.019)	(0.032)
Constant	-0.039	0.154*	0.115
	(0.103)	(0.090)	(0.141)
Observations	2253	2253	2253
R-squared	0.040	0.043	0.040

Note: this table reports the heterogenous effect among the rural and urban residents. Panel A is effect among children in rural areas and Panel B shows the effect among urbanl children. The variable 'treatment*post' is the difference in difference estimator. Is the interaction of post –child's birth year 2004 and 2003 with treatment (Northern, central, upper east, upper west). We control for child's gender, twin and birth order in all the models. Individual variables include; child gender and twin. Mother variables are; mother's age and age-square, education dummies, religion dummies, ethnicity and literacy. Household level variables are; wealth index, place of residence (rural). We also control for region and birth year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5% and 10% respectively. Standard errors are in parentheses and are clustered as the primary sampling level.

Table 1. 9: Effect of the Free Delivery Care Policy by Education

Variables	(1) Neonatal death	(2) Post-neonatal death	(3) Infant death
Panel A: Effect by Primary education			
Treatment	0.010	-0.003	0.007
	(0.026)	(0.019)	(0.031)
Post	0.063**	0.049**	0.111***
	(0.026)	(0.022)	(0.037)
Treatment*post	-0.040	-0.065**	-0.105**
	(0.035)	(0.025)	(0.041)
Constant	0.009	0.068	0.077
	(0.163)	(0.115)	(0.184)
Observations	1790	1790	1790
R-squared	0.065	0.059	0.080
Panel B: Effect by Higher education			
Treatment	0.034	-0.036**	-0.002
	(0.064)	(0.015)	(0.063)
Post	-0.046	0.028**	-0.019
	(0.042)	(0.011)	(0.043)
Treatment*post	0.001	0.020	0.020
	(0.037)	(0.022)	(0.043)
Constant	0.299**	0.000	0.300**
	(0.137)	(0.057)	(0.143)
Observations	2610	2610	2610
R-squared	0.042	0.019	0.035

Note: this table reports the heterogenous effect by education. Panel A is effect among children of mothers with primary education. Panel B shows the effect among children of mother with higher education (secondary and higher). The variable 'treatment*post' is the difference in difference estimator. Is the interaction of post – child's birth year 2004 and 2003 with treatment (Northern, central, upper east, upper west). We control for child's age and gender in all the models. Individual variables include; child gender, twin and birth order. Mother variables are; mother's age and age-squared, education dummies, religion dummies, ethnicity and literacy. Household level variables are; wealth index, place of residence(rural). We also control for region and birth year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5% and 10% respectively. Standard errors are in parentheses and are clustered as the primary sampling level.

1.6 Discussions and Conclusions

User fee exemption policies are widely implemented in less developed nations especially in most countries of Sub-Saharan Africa. Although there are numerous studies that investigates the policy effect on maternal health services utilization, there exist rare studies that examine both the immediate and long-term impact of the policy on child death since maternal mortality is associated with child health outcomes. This study used the GDHS dataset which is a nationally representative data set and the difference-in-difference approach to estimate the effect of the free delivery care policy on child death in Ghana. The falsification test using unaffected birth cohorts presented in Table 1.5 proves that our estimates are consistent.

Based on available literature, our paper is the first study that estimates both the immediate and long-term effect of the user fee exemption policy on child mortality as proposed by Dzakpasu et al., (2014). Our analysis supports the 2008 nationwide expansion of the free delivery policy in Ghana. The results show that the free delivery healthcare policy significantly reduced neonatal mortality, which is in line with the studies by McKinnon et al., (2015). We find that the policy is also effective in reducing infant mortality in the treatment regions by 3.6 percentage points. Our result is also in line with the findings by Daysal et al., (2015) that health facility birth leads to significant reduction in infant mortality. This is the first paper that examines the policy impact on both infant and child mortality, a major contribution to research and maternal and child health policy decision-making. This finding supports our hypothesis that the fee exemption policy significantly impacts on child survival.

We explore the mechanisms through which the free delivery care policy led to a reduction in child death as indicated in our findings (see Table 1.3). We find an increase in antenatal care uptake at the hospitals by 11 percentage points. Since hospitals are better equipped in terms of human resources(specialist) and diagnostic equipment, we anticipate an expert care which will result in less mortalities compared to health Centers. We are convinced that the increase in hospital antenatal attendance translated into significant reduction in neonatal and infant deaths.

We also examine the heterogeneous effect of the policy on a child's place of residence and our results show that the policy significantly reduces the probability of neonatal death among children in rural areas. However, we did not find the policy effect among infants' rural dwellers. Literature indicates high male's under-five mortality in Ghana before, during and immediately after the policy introduction (see figure 1.2) compared to females. Owing to this, we investigate heterogeneous effect of the policy on gender and our findings reveal the under-five death reduction benefited males more. Our heterogeneous analysis also shows that the policy benefited women with lower education. Our results indicate that the policy yielded the desired benefits since its main objective is for the deprived in the communities.

Research has shown that devoting resources to early childhood promotes adult health and well-being throughout adulthood (Case & Paxson, 2010). This finding is consistent with our result as we have shown that investing in maternal healthcare services has a positive effect on child health outcomes which will necessarily translate into economic impact in both the short and long-run since our results reveal a short and long-run reduction of child death. Although most developing countries have implemented the maternal fee exemption policy nationwide, others are still piloting, and some developing countries do not have such policy.

We recommend based on our findings that countries that do not have no such policies adopt the user fee exemption policy in order to aid in the reduction of neonatal and infant mortality. This study will serve as an important document of reference in maternal and child health policy decision making in developing countries especially countries intending to abolish maternal and child healthcare user fees. Child health policies should incorporate maternal health components since most under-five deaths occur in the neonatal period to ensure maximum benefit of the child from conception to less than years. We employ government and other policymakers to provide and identify other funding sources to ensure the smooth operations of the policy to enable the less privileged to continue to benefit. Governments should sustain and strengthen improved social programs such as the free delivery exemption policy which aims to benefit the less privileged. The incremental cost-effectiveness analysis shows that the free maternal delivery care policy is cost-effective. Our estimates provide strong support for the national scale of the policy in 2008 and also encourage countries intending to increase maternal healthcare service uptake and reduce child mortality to implement the free maternal delivery care policy.

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APPENDIX A

Figure A. 1: Map of Ghana

The above is a Ghana map with regional demarcations, the gray parts are the treated regions (Upper East, Northern, Central and Upper West), while the pink are the control regions.

Table A. 1: Description of Variables

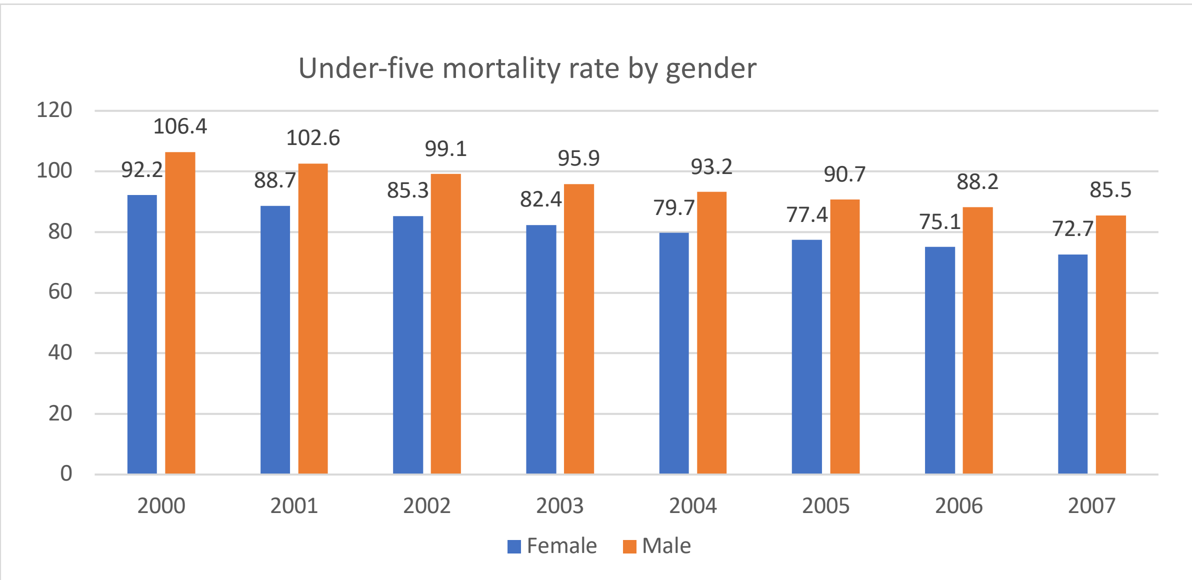
Variables	Definitions
Dependent variables	
Neonatal Mortality	=1 if child dies within 1 month of birth, and 0 otherwise
Post-Neonatal Mortality.	=1 if child dies after 1 month to one year of life, 0 otherwise
Infant Mortality	=1 if child dies within one year of birth, and 0 otherwise
Independent variables:	
Treatment	=1 if region is upper west, northern, central, and upper east, and 0 otherwise
Post	=1 if child year of birth is 2004 and 2003, and 0 if 2002 and less
Mother's education	
No education	= 1 if mother had no education and 0 otherwise
Primary	=1 if mother attains primary, and 0 otherwise
Secondary	=1 if mother had Secondary education, and 0 otherwise
Higher education	=1 if mother had tertiary education, and 0 otherwise
Place of residence	
Urban (excluded category)	=1 if mother reside in urban, and 0 otherwise
Rural	=1 if mother reside in rural, and 0 otherwise
Wealth Index	
Poorest	=1 if household is in poorest wealth index, and 0 otherwise
Poorer	=1 if household is in poorer wealth index, and 0 otherwise
Middle (excluded	=1 if household is in middle wealth index, and 0 otherwise
category)	=1 if household is in Rich wealth index, and 0 otherwise
Rich	=1 if household is in Richest wealth index and 0 otherwise
Richest	
Sex of a child/gender	
Male	=1 if child is boy, and 0 otherwise
Female (excluded	=1 if is girl, and 0 otherwise
category)	= if child is twin, 0 if single
Twin	
Mother age	=Respondent age
Partner/husband educ:	
No education	= 1 if partner had no education and 0 otherwise
Primary	= 1 if partner had primary education and 0 otherwise
Secondary	= 1 if partner had secondary education 0 otherwise
Higher education	= 1 if partner had higher education and 0 otherwise
Partner/husband age	

Table A. 2: Effect of the Free Delivery Policy on Child Death

Variables	(OLS) Neonatal death	(Probit) Neonatal death	(OLS) Post-neonatal death	(Probit) Post-neonatal death	(OLS) Infant death	(OLS) Infant death
Treatment	0.015	0.016	-0.021*	-0.032**	-0.006	-0.009
	(0.016)	(0.016)	(0.012)	(0.015)	(0.018)	(0.020)
Post	0.029**	0.023***	-0.015***	-0.021***	0.013	0.011
	(0.011)	(0.009)	(0.005)	(0.008)	(0.012)	(0.011)
Treatment*post	**-0.033****	**-0.027****	**-0.003**	**0.003**	**-0.036****	**-0.034***
	(0.015)	**(0.014)**	**(0.010)**	**(0.012)**	**(0.018)**	**(0.018)**
Constant	-0.069	–	0.043	–	0.131	–
	(0.068)	–	(0.046)	–	(0.080)	–
Observations	8267	8267	8267	8267	8267	8267
R-squared	0.025	–	0.011	–	0.024	–
Individual var.	Yes	Yes	Yes	Yes	Yes	Yes
Mother variables	Yes	Yes	Yes	Yes	Yes	Yes
Household var.	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: this table reports both the OLS estimates and marginal effect after probit of the policy effect. The variable 'Treatment*post' is the difference in difference estimator. Is the interaction of post (birth year-2004&2003) with treatment (Northern, central, upper east, upper west). Individual variables include child gender, twin and birth order. Mother variables are mother's age and age-squared, education dummies, religion dummies, ethnicity and literacy. Household level variables are wealth index, place of residence(rural). We also control for region and birth year fixed effects in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in parentheses and are clustered as the primary sampling level.

Figure A. 2: Under-five Mortality Rate by Gender



CHAPTER 2

EFFECT OF HEALTHCARE QUALITY INITIATIVE ON MATERNAL HEALTHCARE SERVICE UTILIZATION AND PREGNANCY OUTCOME: A CASE STUDY OF SPRING-GHANA PROJECT

2.1 Introduction

Maternal and child mortality is still a major public health challenge in low resource countries. Despite the global efforts made over the years to reduce maternal and child mortality, the rates are still unacceptably high. It is particularly unacceptable that pregnant women and children still die mainly of preventable or treatable diseases and during childbirth when there are means to prevent these deaths. The continued burden of maternal and child deaths calls for countries especially developing countries to redouble efforts to realize the sustainable development goal three targets of reducing maternal mortality ratio and ending preventable child deaths by 2030. Lack or inadequate uptake of maternal healthcare services especially antenatal and delivery care services is the principal contributing factor increasing maternal, neonatal and infant mortality rates.

Studies have shown a positive association between antenatal care (ANC) and child health and pregnancy outcome (Figlio et al., 2009; Guilkey et al., 1989; Jewell, 2007; Neelsen & Stratmann, 2011; Rous et al., 2004). Joyce, (1999) studied the impact of augmented prenatal care and show a positive relationship on the utilization of prenatal services and birth outcomes. Reichman and Florio (1996) also studied the impact of HealthStart program, an augmented prenatal care on birth outcomes and confirms a positive effect for blacks but no evidence of its effect for whites. Despite the evidence of the effectiveness of prenatal care, not all pregnant women still access prenatal and health care services.

Pregnant women in Ghana have been exempted from paying for healthcare services since July 2008. However, not all women still meet the recommended minimum of four antenatal care visits in Ghana (Ghana statistical service et al., 2018) despite the services being free. Although the percentage of pregnant women who visited ANC four or more times improved by 12 percentage points from 77 percent to 89 percent in 2007 to 2017 respectively, with resultant increase in health facility delivery from 54 percent in 2007 to 79 percent in 2017 (Ghana statistical service et al., 2018) much still needs to be done to achieve ANC attendance in order to maintain and further improve ANC visit during the first trimester and four plus visit.

Spring Ghana introduced a "1,000-day household approach" in 2014, a nutrition project in the northern and the upper east regions of the country, which ended in 2017. The focus of the project is on specific nutrition sensitive areas in households targeting the determinants of malnutrition. The aim of Spring Ghana was to improve the health of pregnant women and children within a thousand days. The project objective was to reduce stunting in the thousand days of the child's life from the onset of pregnancy to the second year of birth by 20 percent. Spring Ghana also introduced quality improvement (QI) methods at the health facilities and community levels to ensure team identification of problems and brainstorming for change ideas to proffer solutions for the identified challenges. Most facility QI teams realized that low ANC attendance was one of the primary reasons for poor nutrition during pregnancy since messages of nutrition in pregnancy are given during ANC sessions. As such the facility QI teams identified a number of change ideas including community *durbars (*meetings*),* household meetings, and counseling of husbands and couples to improve ANC attendance and facility delivery (SPRING, 2018a).

Health quality improvement approach is one of the main drivers of enhanced health outcomes. Despite the vital role of healthcare quality in strengthening healthcare systems, there exist few studies on quality initiatives and its impact in developing countries. Although modern methods of improving healthcare quality are increasingly used worldwide, their suitability for low or poor resource settings have received little attention and its acceptance remains erratic. The nature of the project introduction is a natural experiment, however, there are rare empirical studies that investigate the causal effect of the project. This study assesses the effect of the quality improvement initiative on maternal health facility utilization and pregnancy outcome. To the best of our knowledge, this is the first paper that studies the project effect on facility utilization and pregnancy outcome using the difference-in-difference approach.

We find that the Spring Ghana project which incorporates quality improvement methods increases ANC at least one visit and four plus visits and as well as facility-based deliveries. The results indicate that pregnant women in the intervention regions were more likely to make at least one ANC visit and four and more visits and to deliver at the health facilities in the treatment region compared to the non-intervention regions. We find no evidence of the project effect on antenatal attendance first trimester visits. We also examine the project impact on pregnancy outcome and find a reduction in the probability of miscarriage and still births by 10 and 23 percentage points respectively, indicating that pregnant women in the treatment region were more likely to deliver live births than those in non-treatment regions. This paper contributes to the available literature on quality improvement initiatives and maternal health service utilization. The study also contributes to the strand of literature on the effect of nutrition and nutrition projects on pregnancy outcome. The findings suggest free maternal health care services alone is not enough to increase maternal health care service uptake but with incorporation of quality improvement tools – a key contribution to policy.

We organized the remaining paper as: in Section 2 we discuss the background of the project, we present the literature review in Section 3, Section 4 describes the data source. Section 5 discusses empirical strategy, and the results are presented in Section 6. Discussions and conclusions are in section 7.

2.2 The Spring Ghana Project

Spring Ghana project was introduced in Ghana in 2014 in two regions of the country, the northern and upper east regions of the country with the main aim of reducing the high rate of stunting (33 percent) in children under-five in spring project implementing regions. The project operated for four years, from January 2014 to December 2017.

The project introduced a "1,000-day household approach" strategy in the implementing regions where households with children under two years and pregnant women were earmarked for its activities. Mainly, the project was to improve the health of households with pregnant women and children within a thousand days of life. Spring relied on evidence-based practices to develop a multi-sectoral strategy to reduce stunting in the upper east and the northern regions of the country by 20 percent. The project connected itself with the sectors of nutrition, WASH (water, sanitation, and hygiene), agriculture, and employed social and behavior change communication approaches at household, community, and facility levels (SPRING, 2018a).

Spring implemented a quality improvement[8] (QI) initiative at the health facilities and community levels. The health facilities QI teams centered on forming a team of health workers and equipping their skills to solve nutrition service delivery challenges, while the community QI teams used existing community groups; the village health committees, village savings and loans associations and women's and farmers' groups to tackle nutrition issues. The IQ teams used an improvement process approach to implement change ideas to solve nutrition issues. The approach uses the PDSA cycle; that is plan, do, study, and act: *Plan:* The planning stage is when teams meet to identify nutrition related gaps. Analysis is conducted to ascertain the root cause of the problem. An indicator is selected to be used to measure progress, and a

[8] **Quality Improvement** is a systematic method that uses specific approaches to improve quality in the health care setting and the health status of targeted groups of patients (USDHRS & HHRA, 2011). It talks about what can be done to improve the situation; it avoids blames and foster system change focusing on the entire system. The principles are why the need for improvement, knowing if there is improvement by getting feedback, developing a change that will lead to an improvement and then making a trial of a change before attempting to implement it.

baseline data on the indicator collected. *Do:* This is when brainstorming is done for interventions (change ideas) that can lead to an improvement of the situation. One change idea is selected and tested at time. *Study:* Teams meet at least once monthly for a plenary session of progress made on change ideas. *Act:* A change idea may be tested for a period of three months for Facility QI and one month for Community QI teams. A change idea is dropped if it does not yield the needed results, and a different change idea chosen. For an effective change idea, the team works to sustain performance by monitoring the indicator while testing another change idea. There are quarterly meetings of teams with district supervisors. Where they highlight chosen indicator(s), discuss gaps, change ideas, and the selected indicators, action plans, and show pictorial progress of change ideas implementation. There are separate sessions for Facility QI and Community QI teams.

Facility QI teams focused mainly on three objectives to improve nutrition for 1,000-day households; to improve growth chart plotting, to improve antenatal care (ANC) attendance, and improve child welfare clinic (CWC) attendance. Most facility QI teams realized that low ANC attendance was one of the primary reasons for poor nutrition during pregnancy since messages in nutrition in pregnancy are given during ANC sessions. As such the facility QI teams identified a number of change ideas, including community *durbars* (meetings), household meetings, and counseling of husbands and couples, to improve ANC attendance and facility delivery (SPRING, 2018b). Specific activities to increase ANC include:

- Regular health education sessions to increase postnatal attendance
- Engaging community health volunteers to increase coverage of antenatal care attendance
- Increasing the number of ANC counseling sessions and improving record-keeping to increase coverage and quality of ANC services
- Communities sensitization on child immunization to increase coverage

- Homes visiting to increase ANC visits four or more times.

The final report provides information on the evaluation of the project on stunting but not on maternal healthcare service uptake and pregnancy outcome (SPRING Ghana, 2018). This paper examines the quality improvement approach on maternal service uptake and pregnancy outcome, since antenatal attendance was one of the main goals identified by the facility QI.

2.3 Literature Review

2.3.1 Policies/programs on Maternal Healthcare Service Utilization

Most developing countries have introduced free healthcare and delivery policies for pregnant women thus eliminating financial difficulties that limit access to health services. Research shows mixed evidence on the effect of elimination of maternal user fees on service utilization. Several research papers have demonstrated positive effect of user fee elimination on maternal healthcare uptake (Susie Dzakpasu et al., 2012; McKinnon et al., 2015; Nabyonga et al., 2005; Penfold et al., 2007; Witter et al., 2008), no evidence (Grépin et al., 2019) on user fee elimination on the uptake of maternal health service. Wilkinson et al. (2001)) found an adverse effect of the abolition of user fee on ANC. They find that user fee is associated with a decline in both antenatal attendance and new antenatal registrants. Our study contributes to the existing literature on maternal health care policies or projects and maternal healthcare utilization. We study a community nutrition project that employs quality improvement tools to improve antenatal and facility delivery.

2.3.2 Antenatal Care and its Importance on Child Health

Antenatal care (ANC) is the care rendered to pregnant women by qualified health-care providers in order to ensure the good health conditions for the mother and unborn child during pregnancy. ANC offers the chance for health care providers to identify pregnancies at high risk and to communicate with and help women during the course of pregnancy. Although utilization of ANC has improved globally, however between 2007 and 2014, only 64 percent of pregnant women made the recommended minimum four ANC visits, suggesting the need to intensify efforts to address utilization of ANC (World Health Organization, 2016). Antenatal interventions encompass; health education on personal hygiene and pregnancy care, folic or iron supplementation, deworming in pregnancy, preventive treatment for malaria in pregnancy, blood pressure monitoring, screening for conditions that may interfere with the pregnancy and dietary supplementation.

Numerous evidences document the impact of antenatal care on child-health. Fung and Robles, (2016) studied the effect of antenatal testing laws on infant deaths in the US and found a reduced neonatal death rate of nonwhites by 8.6 percent. The study also revealed an 18 percent narrowing gap in neonatal death rate for the white-nonwhite and an increased in birth cohorts size in nonwhite to 7 percent owing to the mandatory antenatal syphilis testing. Currie and Grogger, (2002) studied the effects of medicaid eligibility cutoff and found that greater cutoffs of income and welfare caseloads improved the antenatal service uptake and lessened fetal deaths. Amuedo-Dorantes and Mundra (2003) and Jewell, (2007) also find that improved usage of antenatal care increases a child's birth weight. Ibrahim et al. (2012) showed that increased frequency of antenatal visit and improved prenatal care reduces risk of neonatal death and greater benefits in the fourth trimester.

Despite its benefits, not all pregnant women in Ghana attend ANC. For instance, ANC four and more visits in 2017 was 89 percent and ANC visits during the first trimester being 64 percent. Most of the women cited scarcity of money as a main motive for ANC non-attendance and others indicated that ANC was unnecessary (MHS, 2017). Since maternal health services are free, the spring Ghana project that employs PDSA project with the involvement of the community volunteers will help sensitize women on the availability of ANC services and its benefits to the mother and the fetus. We expect this will increase maternal healthcare service uptake.

2.4 Data and Description of Variables

The Ghana Maternal and Health Survey (GMHS) data set is used for this study. The GMHS is a national survey that collects information on maternal mortality and health issues. The GMHS is conducted after every 10 years and there exist two waves of the survey data set for Ghana, thus 2007 and 2017. We use the 2017 dataset for the main analysis and the 2007 dataset for the falsification test. The survey uses the 2010 Ghana Population and Housing Census (PHC) sampling frame. The frame is a comprehensive list of census enumeration areas (EA) used for the 2010 PHC. There are 37,675 EAs; 16,503 and 21,172, in both urban and rural areas respectively. There is an average of 145 households in each EA. The stage one of the surveys involves a selection of 900 EAs, 466 and 434 in both urban and rural areas respectively. In all, a total sample of 27,000 households were randomly selected for the main survey. Women of reproductive age (15-49) who resided in the selected households or were visitors and stayed a night before the survey in the identified households were eligible for the interview (Ghana Statistical Service et al., 2017).

The dataset contains several measures of maternal antenatal usage and covers a reference period of 5years. The survey obtained information on women's antenatal visit during pregnancy and their first month of visit for antenatal care of the youngest under-five year child. We use the month of first initiation (timing of first antenatal check imputed in months) to create the variable, first trimester antenatal visit[9] and the number of antenatal visits during pregnancy to generate the variable antenatal four plus visits[10]. The survey also collected Information on a

[9] First trimester ANC visit: is the first antenatal visits within the first three months of pregnancy at a healthcare facility.

[10] ANC four plus visits: is the antenatal visits for four and more times. Ghana follows the World Health Organization (WHO) standard in which four and more visits are recommended for pregnant women with no complications. And above four visits for those with complications

woman's place of delivery of her youngest under-five child. We use this information to create another outcome variable of interest, facility delivery[11]. the fourth dependent variable is terminated pregnancy; the woman was also asked whether she ever had a pregnancy that resulted in still birth, miscarriage, or abortion. That is pregnancy that did not lead to live birth.

In table 2.1, we present the description of variables and summary statistics for the main variables used for our analysis. A total of 16,454 sample size is used for this study; 5,629 for the treatment region and 10,825 for the control region. An average of 91 percent of women in the treatment regions made ANC visit four plus and 92 in the control regions. The number of women in the treatment regions who made their first ANC visit during the first trimester is 71 percent and 81 in the control regions. An average of 16 percent of women experienced miscarriages, 4.9 percent stillbirth in the control regions compared to 12 percent miscarriages and 4 percent stillbirth in treatment regions. Mothers between the ages of 35 and above are the majority in our sample, with the majority of them having basic education, an average of 59 percent from the treatment regions and 30 percent from the control regions. Most of the women belong to the mole-dagbani ethnic group, 59 percent from the treatment regions and 29 percent from the control regions with majority of them being from the poorest households, an average of 62 percent of the treatment regions were from the poorest households and 70 percent of them being rural dwellers compared to 23 percent poorest households from the control regions with 52 percent of them being rural dwellers. We also present a definition of variables in Table B.1.

[11] Facility deliveries comprises delivery at a maternity home, clinics, health centres, and hospitals

Table 2. 1: Summary Statistics

	Treatment		Control	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
Antenatal attendance visits in the first trimester	0.617	0.486	0.682	0.466
Antenatal attendance four plus visit	0.914	0.280	0.916	0.278
Number of miscarriages	1.226	0.574	1.270	0.638
Facility delivery	0.710	0.454	0.807	0.395
Miscarriage	0.127	0.333	0.163	0.369
Number of stillbirths	1.109	0.393	1.120	0.347
Ever had Stillbirth	0.044	0.205	0.049	0.217
Post	0.752	0.432	0.737	0.440
Mother education:				
Basic (excluded category)	0.303	0.460	0.587	0.492
Secondary	0.087	0.282	0.138	0.345
Higher	0.044	0.205	0.062	0.241
Mother age	29.32	8.25	29.08	7.884
Mother religion:				
No religion (excluded category)	0.036	0.186	0.029	0.168
Christian	0.406	0.491	0.785	0.411
Moslem	0.481	0.500	0.171	0.376
Traditionalist	0.077	0.267	0.015	0.121
Other religion	0.000	0.000	0.000	0.014
Ethnicity				
Akan	0.025	0.157	0.448	0.497
Ewe	0.012	0.107	0.130	0.336
Ga-Dangwe	0.000	0.000	0.060	0.237
Mole-Dagbani	0.592	0.491	0.218	0.413
Other tribes (excluded category)	0.350	0.477	0.122	0.327
Place of residence (Rural)	0.700	0.458	0.523	0.499
Married	0.838	0.369	0.755	0.430
Wealth index:				
Poorest (excluded category)	0.617	0.486	0.225	0.418
Poorer	0.175	0.380	0.221	0.415
Middle	0.099	0.299	0.193	0.395
Richer	0.071	0.256	0.188	0.391
Richest	0.038	0.191	0.174	0.379
Multiple birth (Twin)	0.041	0.198	0.038	0.191
Observations	5,629		10,825	

Note: the sample contains all women of reproductive age, however, the outcome variables maternal health service uptake only represents women who have ever given birth or had pregnancies. Sample for antenatal attendance visit in the first trimester, antenatal attendance four plus visits and facility delivery are 12,088, 12,103 and 12,173 for both control and treatment regions. This makes summary statistics not comparable with the observations for the analysis. However, outcome variables ever had miscarriage and still births are comparable with the summary statistics women.

2.5 Identification Strategy

One most reliable design in impact evaluation literature is natural experiment. Where there exists an absence of random assignments of subjects to both treatment and control, one can exploit the variation in the implementation of the policy or project to estimate causal effect. In our setting, the Spring Ghana project was implemented in the northern and the upper east regions of the country in 2014 and ended in December 2017. The nature of the implementation (two regions benefited, and eight regions did not benefit) of the program is a natural experiment setting that we can rely on to estimate the causal impact of the program using the difference in difference approach. Thus, comparing pre-program differences with the post-program difference between project and non-project regions, we estimate the effect of the project on maternal health service utilization and pregnancy outcome using the 2017 GMHS set. This study departs from the traditional DID estimation approach, in that we use a one-year cross sectional survey dataset to estimate the causal impact of the program. The reason for this is that the data set contains information on women's antenatal visit during pregnancy for the youngest under-five year child. The survey covers a reference period of 6 years from 2012 to 2017 and we consider women who gave birth in 2012 and 2013 as the non-intervention group and 2014 to 2017 as the intervention group. Although we have baseline and follow up data, which we could rely on to estimate the causal impact, however, we may be capturing women who gave birth in 2012 and 2013 as part of the treatment group thus biasing our estimates. Using the actual birth year of a child captures only mothers who were treated under project since our target is pregnant women only.

A potential threat to the validity of our identification assumption is that a project with similar objectives with the spring project, RING project was also implemented in one of the spring implementation regions (Northern) in 2014 but had no activities on antenatal attendance and facility delivery and thus could not affect our results. Another project that employs a similar approach and could interfere with our results is project five alive which was implemented in three northern regions of Ghana in 2008 but had expanded to the entire country in May 2013 (Sodzi-Tettey et al., 2015) and thus affects both our control and treatment regions equally. We use the DID model below to estimate the project impact:

$$MHEALTH_{ijt} = \beta_1 Treatment_j + \beta_2 Post_{\ t} + \delta\, Treatment_j * post_t + \beta_3 X'_{ijt} + \beta_4 region_j * birthyear_t + \beta_5 region_j + \beta_6\, birthyear_t + \mathcal{E}_{ijt}$$

$MHEALTH_{ijt}$ represents maternal health service utilization and pregnancy outcome. Maternal health service indicators: 1. Antenatal attendance during the first trimester (ANC first trimester), which denotes 1 if pregnant woman i in region j at time t visited ANC during the first three months of her pregnancy and 0 otherwise. 2. Antenatal attendance fourth visit and above (ANC4 plus visits) is a binary variable indicating 1 if woman i in region j at time t had visited antenatal clinic four times and above and 0 otherwise. 3. Facility delivery is a dummy variable which represents 1 if woman i in region j at time t gave birth at the health facility and 0 otherwise. Miscarriage is a measure of pregnancy outcome; is also a binary variable equal to 1 if woman i in region j at time t ever had miscarriage and 0 otherwise. Stillbirth is another measure of pregnancy outcome; is also a binary variable equal to 1 if woman i in region j at time t ever had stillbirth and 0 otherwise. $Treatment_t$ takes the value of 1 if regions are the Northern and Upper east regions and 0 if otherwise. $Post_t$ represents 1 if child birthyear is 2014, 2015, 2016 and 2017, and 0 otherwise. $Treatment_j * post_t$ is the Interaction of treatment and post. δ is the difference-in-difference estimator – program impact. X'_{ijt} represents a vector of variables. $\beta_4 region_j * birthyear_t$ represents a region-specific birth year time trend; it captures the trend in region-level characteristics that might affect antenatal and delivery care uptake such as the number of health facilities. $\beta_5 region_j$ refers to region fixed effects to control for time-invariant, unobserved heterogeneity across regions which may have influenced maternal healthcare service uptake. $\beta_6\, birthyear_t$ refers birth year fixed effects to control for national health events which may have affected maternal healthcare uptake. $\mathcal{E}_{ijt}$ is the error term. we adjusted standard errors by clustering the error term at the primary sampling unit[12].

2.6 Empirical Results

2.6.1 Effect of the Spring Project on Maternal Health Service Utilization

Our choice of variables is based on previous studies. Several literatures document a positive association between family income/socioeconomic status and facility utilization (Nolan, 1993; van Doorslaer et al., 2000; van Doorslaer & Wagstaff, 1992), owing to that, we control for wealth index[13] in all the models. We include woman age, education dummies, religion dummies, ethnicity, and birth year fixed effects in all the models.

In Table 2.2, we present the effect of the spring project on maternal health service utilization. Panel A is the main results of the project. In column 1 of Panel A, the interaction term 'treatment*post' is not significant, thus holding all other covariates constant, the project increases the probability of antenatal care (ANC) visit during the first trimester by 10 percentage points for women in the treated regions, albeit statistically insignificant. Thus, the project had no effect on ANC first trimester visit. In column 2, we use Poisson distribution because it is a count variable positively skewed (see Figure 1 in appendix 2). The coefficient for the interaction term in column 2 is statistically significant, that is holding all other variables constant, the project increases the expected at least one ANC visit by 22 percentage points[14]. In column 3, the coefficient for the interaction term is statistically significant, that is holding

[12] The pre-clustering level comprises 900 clusters, chosen using probability proportional to size in phase one. The fieldwork involved is in phase 2 of the survey. 30 households each were chosen from the identified clusters in phase one, making up a total of 27, 000 households and stratified on region bases (urban-rural residence) and households with women (15-49) were selected and interviewed. The error term is clustered at this level

[13] Scores are given based on household ownership of consumer goods. They include televisions, bicycle, car, and household toilet facilities, drinking water source and flooring materials. Scores are generated using principal component analysis and each household is then assigned a score ranking each household member by their score and the distribution is then divided into five equal parts (Ghana statistical service et al., 2014)

[14] The interpretation is derived from this formula; {[Exponential (β)-1]*100}

all other covariates constant, the project increases the probability of pregnant women who made ANC four plus visit by 10 percentage points. Our results indicate that pregnant women in the intervention region were more likely to visit ANC four and more times. In column 4 the interaction term is statistically significant at 1 percent; Holding all other control variables constant, the project strongly increases the probability of facility delivery by 24 percentage points in the treatment regions compared to the non-treatment regions. This shows that women in the project implementation regions in the intervention years were more likely to give birth at the health facility compared to those in the non-intervention regions.

In Panel B and C of Table 2, we restrict post years to two childbirth years making it comparable to our baseline childbirth years (2012 and 2013). In column 2 of Panel B, the project increases the expected attendance of ANC at least one visit by 21 percent, and ANC four and more visits by 10 percentage points. In column 4 of Panel B, the project increases the probability of facility delivery by 24 percentage points, an increase by 2 percentage points from the main results. For Panel C we see no impact on ANC visit. However, in column 4, we observe a modest impact on the probability of facility delivery, that is 19 percentage points at 5 significance levels. The reason for the no significant impact in Panel C could be that because the project had not gained traction in 2014 and 2015 since it was the early years of its take-off. Thus, it takes time for a project to make a significant impact or for beneficiaries to acknowledge the benefit of the project and start utilizing the services of a project.

2.6.2 Effect of the Spring Project on Pregnancy Outcome

In Table 2.3, we present estimates of the project effect on pregnancy outcome (miscarriage, and stillbirth). Panel A is our main results of the project effect on pregnancy outcome. The coefficient of the interaction term treatment*post in column 1 is statistically significant at 5 percent significance level, that is holding all other covariates constant, the project reduces the probability of women who ever had miscarriage in the treatment regions by 10 percentage points compared to the non-treatment regions. In column 2, the project reduces the probability of number miscarriages in the treatment regions by 27 percentage points albeit insignificant. We also find no impact of the project impact of women who ever had stillbirth, as we show in column 3. In column 4, holding all other covariates constant, the project reduces the expected number of women who ever had stillbirth in the treatment regions by 32 percent compared to the non-treatment regions.

We also restrict post years to two childbirth years since we have only two years as our baseline years (2012 and 2013) and present the results in Panel B and C of Table 2.3. We see a significant effect on both women who ever had miscarriage and number of stillbirths in Panel B, but no significant effect on still births.

2.6.3 Robustness Checks

For robustness checks, we estimate a falsification test using the 2007 GMHS data set. We adopted the method by Lechner (2010) creating Pseudo-post equal to 1 if childbirth year is 2007 to 2004 1 and zero if childbirth year is 2003 and 2002 and interacting it with the fake treatment and then estimating above the equation. In Table 2.4 we show estimates of the falsification test on maternal health service uptake. The interaction term (Fake treatment*pseudo-post) which is our coefficient of interest is not significant in all the columns. Thus, our results indicate the existence of the parallel trend in ANC attendance in the first trimester, ANC attendance four plus, facility delivery and pregnancy outcome (measured by terminated pregnancy) in the intervention and comparison regions before the introduction of the Spring-Ghana project. We also present estimates of the falsification test on pregnancy outcome in Table 2.5. The interaction term (Fake treatment*pseudo-post) which is our coefficient of interest is not significant in all the columns. The results show common trend in the miscarriage, still birth and number of still births in the intervention and comparison regions before the project introduction.

Table 2. 2: Project Effect on Maternal Health Service uptake

Variables	(1) ANC first trimester visit	(2) ANC at least 1 visit	(3) ANC four plus visit	(4) Facility delivery
Panel A: (birthyear 2014 – 2017)				
Treatment	0.05	-0.15**	0.07*	0.10
	(0.11)	(0.07)	(0.03)	(0.08)
Post (2014-2017)	-0.15*	-0.23***	-0.11***	-0.04
	(0.09)	(0.07)	(0.04)	(0.06)
Treatment*post	0.10	0.22***	0.10**	0.24***
	(0.12)	(0.08)	(0.05)	(0.09)
Constant	0.54***	1.90***	0.83***	0.57***
	(0.09)	(0.06)	(0.04)	(0.07)
Observations	12088	12103	12103	12173
R-squared	0.05	.z	0.05	0.20
Panel B: (birthyear 2016 - 2017)				
Treatment*post	0.09	0.21***	0.10**	0.24***
	(0.12)	(0.08)	(0.05)	(0.09)
Observations	7254	7259	7259	7291
R-squared	0.05	.z	0.05	0.20
Panel C: (birthyear 2014 & 2015)				
Treatment*post	-0.02	0.11	0.01	0.20**
	(0.13)	(0.08)	(0.04)	(0.09)
Observations	6727	6737	6737	6789
R-squared	0.05	.z	0.04	0.20
Individual variables	Yes	Yes	Yes	Yes
Household level variables	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
Birth year fixed effect	Yes	Yes	Yes	Yes
Region specific time trend	Yes	Yes	Yes	Yes

Note: this table reports the main results of the project effect on maternal service utilization**.** Treatment is equal 1 if region is northern region and the upper east regions. Panel A is the main results of the policy. Post in Panel A is equal 1 if child birthyear is 2014 to 2017 and 0 if child birthyear is 2012 and 2013. In Panel B and C we restrict child birth years to two year period comparable to the baseline line years. Treatment*post' is the difference-in-difference estimator of the project impact which is our variable of interest. We control for the following in all the modules: Individual variables we control are; multiple birth (multiple pregnancy), woman religion, woman age dummies, woman education, marital status and ethnicity. The household level variables controlled for are; wealth index, place of residence. Column 2 is Poisson distribution, column 1, 3 and 4 are OLS estimates. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10%, respectively. Standard errors are clustered at the primary sampling unit and are in the parentheses.

Table 2. 3: Project Effect on Pregnancy Outcome

Variables	(1) Ever had miscarriage	(2) No. of miscarriage	(3) Ever had still birth	(4) No. of stillbirth
Panel A: (birthyear 2016 & 2017)				
Treatment	0.04	0.29	-0.03	0.13
	(0.04)	(0.26)	(0.03)	(0.14)
Post (2014-2017)	0.13***	0.04	-0.00	0.09
	(0.03)	(0.16)	(0.03)	(0.07)
Treatment*post	-0.09**	-0.24	-0.00	-0.28*
	(0.05)	(0.25)	(0.04)	(0.15)
Constant	-0.24***	-0.12	-0.01	0.08
	(0.04)	(0.19)	(0.03)	(0.10)
Observations	16454	2477	16454	781
R-squared	0.06	.z	0.02	.z
Panel B: (birthyear 2016 & 2017)				
Treatment*post	-0.09*	-0.29	-0.00	-0.27*
	(0.05)	(0.26)	(0.04)	(0.16)
Observations	9848	1505	9848	472
R-squared	0.06	.z	0.02	.z
Panel C: (*birthyear 2014 & 2015*)				
Treatment*post	-0.09**	-0.25	0.01	-0.17
	(0.04)	(0.28)	(0.03)	(0.16)
Observations	10851	1671	10851	541
R-squared	0.06	.z	0.02	.z
Individual variables	Yes	Yes	Yes	Yes
Household level variables	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
Birth year fixed effect	Yes	Yes	Yes	Yes
Region specific time trend	Yes	Yes	Yes	Yes

Note: this table reports the main of the project effect on pregnancy outcome**.** Treatment is equal one if region northern region and the upper east region. Post in Panel A is equal 1 if child birthyear is 2014 to 2017 and 0 if child birthyear is 2012 and 2013 and its the main results. In Panel B and C we restrict child birth years to two-year period comparable to the baseline line years. Treatment*post' is the difference-in-difference estimator of the project impact which is our variable of interest. We control for the following in all the modules: Individual variables we control are multiple birth (multiple pregnancy), woman religion, woman age dummies, woman education, marital status and ethnicity. The household level variables controlled for are wealth index, place of residence. Columns 2 and 4 are poisson distribution estimates and are samples for women with miscarriage and still births only, women without miscarriage and still births are not captured in these variables. Column 1 and 2 are OLS estimates. Statistical significance is indicated by ***, **, and * at 1%, 5%, 10%, respectively. Standard errors are clustered at the primary sampling unit and are in the parentheses.

Table 2. 4: Falsification test – Project Effect on Maternal Health Service Utilization

Variables	(1) ANC first trimester visit	(2) ANC at least 1 visit	(3) ANC four plus visit	(4) Facility delivery
Treatment	-0.19	0.48	0.01	0.21**
	(0.15)	(0.40)	(0.11)	(0.10)
Pseudo-post	-0.02	-0.10*	-0.05	-0.09
	(0.09)	(0.06)	(0.05)	(0.06)
Fake Treatment*pseudo-post	**0.11**	**-0.36**	**0.17**	**-0.01**
	(0.15)	**(0.39)**	**(0.13)**	**(0.15)**
Constant	0.45***	1.68***	0.62***	0.72***
	(0.11)	(0.11)	(0.08)	(0.08)
Observations	4801	4803	4783	4901
R-squared	0.05	.z	0.11	0.25
Individual variable	Yes	Yes	Yes	Yes
Household level variables	Yes	Yes	Yes	Yes
Region fixed effects	Yes.	Yes	Yes	Yes
Birth year fixed effects	Yes.	Yes	Yes.	Yes
Region specific time trend	Yes	Yes	Yes	Yes

Note: this table reports the falsification test of project effect on maternal health service utilization. we use the 2007 MHS dataset to estimate the results. Pseudo post is 1 if childbirth year is 2007-2004, and 0 if 2003 and 2002. Fake treatment is the regions destined be treated (northern, upper east). The variable "Fake treatment*Pseudo-post'" is the estimator of the baseline trend of the outcome variable. We control for the following in all the modules: Individual variables; multiple birth (multiple pregnancy), woman religion, woman age dummies, woman education dummies, marital status and ethnicity. The household level variables controlled for are; wealth index, place of residence(rural). Column 2 is Poisson distribution, column 1, 3 and 4 are OLS estimates. Statistical significance is indicated by ***, **, and * at the 1%, 5%, and 10%, respectively. Standard errors are clustered at primary sampling unit level and are in parentheses.

Table 2. 5: Falsification test – Project Effect on Pregnancy Outcome

Variables	(1) Ever had miscarriage	(2) No. of miscarriage	(3) Ever had still birth	(4) No. of stillbirth
Treatment	0.06	-0.21	0.06	-0.12
	(0.09)	(0.17)	(0.07)	(0.20)
Pseudo-post	-0.01	-0.09	0.01	0.05
	(0.03)	(0.16)	(0.03)	(0.10)
Fake Treatment*pseudo-post	**-0.08**	**-0.14**	**-0.06**	**-0.03**
	(0.08)	**(0.24)**	**(0.08)**	**(0.18)**
Constant	0.07	0.02	0.05	0.33
	(0.05)	(0.17)	(0.04)	(0.22)
Observations	4903	797	4903	237
R-squared	0.03	.z	0.03	.z
Individual variable	Yes	Yes	Yes	Yes
Household level variables	Yes	Yes	Yes	Yes
Region fixed effects	Yes.	Yes	Yes	Yes
Birth year fixed effects	Yes	Yes	Yes	Yes
Region specific time trend	Yes	Yes	Yes	Yes

Note: this table reports the falsification test of project effect on pregnancy outcome. We use the 2007 MHS dataset to estimate the results. Pseudo post is 1 childbirth year is 2007-2004, and 0 if 2003 and 2002. Treatment is the regions destined be treated (northern, upper east). The variable "Fake treatment*pseudo-post'" is the estimator of the baseline trend of the outcome variable. We control for the following in all the modules: Individual variables we control are; multiple birth (multiple pregnancy), woman religion, woman age dummies, woman education, marital status and ethnicity. The Household level variables controlled for are; wealth index, place of residence. Column 2 and 4 are Poisson distribution estimates, column 1 and 2 are OLS estimate. Statistical significance is indicated by ***, **, and * at the 1%, 5%, and 10%, respectively. Standard errors are clustered at primary sampling unit level and are in parentheses.

2.6.4 Quality of Care

We also investigate whether the increased health facility delivery translates into quality of delivery care services rendered. The data set contains variables on the person who rendered care to the woman for her last birth, which are binary variables for a specific healthcare provider. We investigate whether a pregnant woman exposed to the spring project received care from a qualified health professional. We present the results of our estimates in Table 2.6. We find a strong impact on delivery care rendered by skilled personnel by 20 percentage points and a reduction in care rendered by unskilled personnel by 21 percentage points in column 1 and 2 respectively. We also investigate whether the increase in first trimester ANC utilization translates to quality of antenatal care services rendered. Our coefficient of interest in column 3 is statistically insignificant indicating no effect on skilled ANC services rendered. The increases in skilled delivery care explains the reasons for the reduction in the number of stillbirths.

Table 2. 6: Personnel Rendering Care during Prenatal Attendance and Delivery

Variables	(1) Skilled birth attendant	(2) Unskilled birth attendant	(3) Skilled ANC Attendant	(4) Unskilled ANC attendant
Treatment	0.11	-0.08	0.02	-0.02
	(0.08)	(0.08)	(0.02)	(0.02)
Post	-0.03	0.03	0.02	-0.02
	(0.06)	(0.06)	(0.02)	(0.02)
Treatment*post	0.20**	-0.21***	-0.02	0.02
	(0.08)	(0.08)	(0.02)	(0.02)
Constant	0.57***	0.36***	0.98***	0.03
	(0.07)	(0.07)	(0.03)	(0.03)
Observations	12326	12326	12103	12103
R-squared	0.20	0.19	0.01	0.02
Individual var	Yes	Yes	Yes	Yes
Household level variables	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
Birth year fixed effects	Yes	Yes	Yes	Yes
Region specific time trend	Yes	Yes	Yes	Yes

Note: this table presents complimentary analysis of care rendered by individual health professionals. The dependent variables are; **skilled birth attendant** refers to attendant during delivery by medical doctor, midwife, nurse, or community health nurse or officer. **Unskilled birth attendant** refers to attendant during delivery by traditional birth attendant, traditional healers, and village health volunteer. Same definitions refer to skilled and unskilled ANC attendance. The coefficients of interest are treatment*post. Treatment is northern and upper east region and post is interview year 2014. We control for the following in all the modules: Individual variables we control are; multiple birth (multiple pregnancy), woman religion dummies, woman age dummies, woman education dummies, marital status and ethnicity. The household level variables controlled for are; wealth index, place of residence. Statistical significance is indicated by ***, **, and * at the 1%, 5%, and 10%, respectively. Standard errors are clustered at primary sampling unit level and are in parentheses.

2.6.5 Heterogeneous Effect

The effect of the Spring Ghana project can differ for different sub-groups of pregnant women in the intervention regions. It may be the interest of policy makers to know the category of pregnant women affected by the Spring Ghana project, and magnitude of the effect. The project effect on rural dwellers may be different from its effect on urban dwellers. The Spring Ghana project may also vary by household wealth. We show our analysis of the heterogeneous place of residence and education.

2.6.5.1 Effect by Place of Residence

In Table 2.7 we present results of the spring project on rural dwellers. In column 1 the coefficient of the project is insignificant which shows that the project has no effect on rural women who made ANC first trimester visits. In column 2 and 3 of panel A, compared to urban resident's, the project has a strong impact on rural residents who made at least 1 ANC visit and ANC four plus visit by 30 percent and 19 percentage points respectively. In column 4 of Panel A the project increases health facilities deliveries by 29 percentage points for rural women. However, we find no effect of the project on the urban resident's in in all columns of Panel B.

Panels C and D presents the heterogeneous effect of the project on pregnancy outcome. In column 1 of Panel C, project also significantly reduces the probability of the number of women who ever had miscarriage among rural women by 9 percentage points, albeit at modest level and the number of miscarriages by 36 percent as in column 2. In column 3 and 4 of Panel C we find no effect of the project on urban women who ever had stillbirth and the number of stillbirths. However, we find no evidence of the impact of the project among urban women.

2.6.5.2 Effect by Education

Table 2.8 reports the project impact among women with various levels of education. Panel A reports the effect on women with basic education. The project only affects antenatal care attendance (ANC) at least one visit among women with basic education by 21 percentage points and facility delivery by 29 percentage points. In Panel B we see the effect only on ANC at least one visit among women with higher education – that is an increase by 30 percentage points. In Panel C we find no effect of the project on pregnancy outcome among women with basic education. Moderate effect was observed, that is 26 percentage points among women with higher education who ever had miscarriage in column 1 of Panel.

Table 2. 7: Project Effect by Place of Residence

Heterogenous effect on maternal health uptake				
Variables	(1) ANC first trimester visit	(2) ANC at least 1 visit	(3) ANC four plus visit	(4) Facility delivery
Panel A: among rural dwellers				
Treatment*post	0.03	0.26***	0.19***	0.29**
	(0.15)	(0.10)	(0.06)	(0.12)
Observations	6877	6889	6889	6940
R-squared	0.05	.z	0.05	0.18
Panel B: among urban dwellers				
Treatment*post	0.20	0.19*	-0.01	0.10
	(0.19)	(0.11)	(0.07)	(0.13)
Observations	5211	5214	5214	5233
R-squared	0.07	.z	0.03	0.11

Heterogenous effect on pregnancy outcome				
Variables	(1) Ever had Miscarriage	(2) No. of miscarriage	(3) Ever had still birth	(4) No. of stillbirth
Panel C: among rural dwellers:				
Treatment*post	-0.09*	-0.22	-0.02	-0.31*
	(0.05)	(0.21)	(0.05)	(0.18)
Observations	9609	1292	9609	467
R-squared	0.06	.z	0.03	.z
Panel D: among urban dwellers				
Treatment*post	-0.09	-0.28	-0.28	-0.12
	(0.09)	(0.39)	(0.39)	(0.11)
Observations	(0.02)	(0.05)	(0.05)	(0.06)
R-squared	6845	1185	1185	314

Note: this table reports the heterogenous effect of the project on the outcome variables among rural and urban resident women. Panel A and B report the project effect on effect on maternal health uptake while Panels C and D report effect on pregnancy outcome. We control for the following in all the modules: Individual variables we control are; multiple birth (multiple pregnancy), woman religion dummies, woman age dummies, woman education dummies, marital status and ethnicity. The household level variables controlled for are; wealth index, place of residence. We also control for region and birth year fixed effects and Region specific birthyear time trend; to account for region specific year shock that might influence maternal health service uptake. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10%, respectively. Standard errors are clustered at the primary sampling unit are in the parentheses.

Table 2. 8: Project Effect by Education

Variables	(1) ANC first trimester visit	(2) ANC at least 1 visit	(3) ANC four plus visit	(4) Facility delivery
Project impact on maternal health maternal health service utilization by education				
Panel A: Basic education				
Treatment*post	0.12	0.19*	0.07	0.30**
	(0.17)	(0.11)	(0.06)	(0.14)
Observations	5995	6005	6005	6036
R-squared	0.05	.z	0.05	0.14
Panel B: Higher education				
Treatment*post	-0.05	0.26*	0.10	0.14
	(0.18)	(0.15)	(0.07)	(0.13)
Observations	2277	2277	2277	2276
R-squared	0.09	.z	0.06	0.12
Project impact on pregnancy outcome by education				
Variables	Ever had miscarriage	No. of miscarriage	Ever had still birth	No. of stillbirth
Panel C: Basic education				
Treatment*post	-0.05	-0.01	0.03	-0.18
	(0.07)	(0.27)	(0.04)	(0.12)
Observations	8056	1178	8056	346
R-squared	0.08	.z	0.04	.z
Panel D: Higher education				
Treatment*post	-0.26*	-0.74	0.01	-0.08
	(0.15)	(0.53)	(0.05)	(0.07)
Observations	2903	451	2903	97
R-squared	0.10	.z	0.06	.z

Note: this table reports the heterogenous effect of the project on the outcome variables by education status. Panel A and B represents the project impact on maternal health maternal health service utilization by education. Panel C and D reports impact on pregnancy outcome by education. Basic education comprises; primary, junior high school and middle school, whilst higher education entails; senior high/secondary, colleges and university. We control for the following in all the modules: Individual variables we control are; multiple birth (multiple pregnancy), woman religion dummies, woman age dummies, woman education dummies, marital status and ethnicity. The Household level variables controlled for are; wealth index, place of residence. We also control for region and birth year fixed effects and region specific birthyear time trend; to account for region specific year shock that might influence maternal health service uptake. Statistical significance is indicated by ***, **, and * at 1% 5%, and 10% respectively. Standard errors are clustered at the primary sampling unit are in the parentheses.

2.7 Discussions and Conclusions

We use the Ghana maternal and health survey (GMHS) to estimate the effect of the project on maternal health service uptake and pregnancy outcome. The GMHS is a national representative data making our results generalizable to the entire population of the country. To the best of our knowledge, this paper is the first study that estimates the causal effect of the project on maternal health service utilization and pregnancy outcome. Our results reveal that the Spring Ghana project led to an increase in the likelihood of pregnant women who made ANC visits at least once and four and more visits during the intervention period by 27 and 10 percentage points respectively. The study also show that the project increases the probability of health facility delivery by 24 percentage points. Larson et al.,(2019) evaluated the effect of quality improvement initiative on health facility birth and showed an increase in health facility birth by 6.7 percentage points, which is in line with our findings. Our findings are also consistent with the other studies on maternal health projects/policies and health service utilization (S. Dzakpasu et al., 2014; Manthalu, 2019; Powell-Jackson, 2015; Powell-Jackson & Hanson, 2012). We find no evidence of the project effect on the number of pregnant women who made first ANC visits during the first trimester. We also show that the policy has a significant positive association on pregnancy outcome. The results show reduction in the probability of adverse pregnancy outcome (miscarriage and stillbirth) suggesting that more of the pregnancies in the treated regions ended up in live births.

We examine the heterogeneous effect of project among women by place of residence and find an increase in the probability of antenatal attendance at least one visit and four and more visits, and health facility delivery among rural women by 26, 19 and 29 percentage points respectively, and reduction of miscarriage among rural women by 10 percentage points. However, no evidence of its effect on ANC first trimester visits and ANC four plus visits and delivery among urban women. We also examine the heterogeneous effect by education, and we find that women with basic education were more likely to attend antenatal care at least one visit and to give birth at the health facilities compared to those with higher education. The reason for this could be community sensitization on the significance of antenatal attendance and institutional delivery.

The mechanism of the project effect on the maternal health service utilization and pregnancy outcome include: First, **community durbars**: The team organized community and household meetings and sensitized them on the importance of antenatal attendance, counselling of husbands and couples to improve antenatal attendance. Second**, involvement of the community-based volunteers**: The QI team also involved the community volunteers to encourage women who get pregnant to attend ANC and also made regular home visits to pregnant women for health education on several issues including the importance of regular ANC attendance. And thirdly, **Male involvement**; during the community durbars (meeting), males were encouraged to visit ANC along with their wives. We believe these mechanisms led to the increase in maternal health service utilization, however we could not empirically show it since our data set has no such variables.

Although there exists free delivery healthcare policy for healthcare utilization by pregnant women in Ghana, which affects the outcome variables of interest thus questioning the validity of our estimates, the free delivery policy was implemented nationwide in 2008 and does not affect the outcome variable in the intervention regions only. If our results are picking up the differential trend in our outcome variables, the falsification test will as well capture the differential trend, making our estimates for the main results invalid. However, this was not observed as the results of the falsification test show statistical insignificant results. We have no doubt that our results are valid given that the falsification test for difference in difference estimates is satisfied as we presented in Table 2.4 and 2.5.

In a nutshell, our results show that the Spring Ghana project which incorporated quality improvement methods increases ANC at least one visit, four plus visits and facility-based deliveries and increases the probability of positive pregnancy outcome. We find no evidence of the project effect on antenatal attendance during the first trimester. We provide complementary investigation on quality of ANC and delivery care in Table 2.6. We show evidence of increased health professional care services for delivery suggesting quality of care for institutional delivery during the project period.

Our findings suggest that policies or projects that promote maternal health services uptake yields desired benefits. Policy makers should incorporate QI tools in maternal healthcare policies or project designs. Based on our findings it is evident that user fee exemption alone is not sufficient to achieve the desired targets of maternal health service utilization but with projects or policies that incorporate quality improvement methods as the Spring Ghana project. The Quality Improvement initiative of determining barriers to health service uptake has proven to be effective as demonstrated in our study and should be considered a practicable measure for improving maternal health service uptake.

Our findings on maternal health facility utilization are relevant for the following reasons. First, antenatal and delivery care utilization, especially when the service providers are skilled workers, is positively correlated with the probability of early detection of complications during pregnancy and delivery and thus averting complications for the mother and the fetus or the child. Although we find no evidence of skilled antenatal attendance but the increase in health facility utilization and skilled delivery attendance has translated into improved pregnancy outcomes as we present in Table 3. Second, the results also are of significance because adequate antenatal care uptake for about four and more times is considered necessary and recommended healthcare practices (World Health Organization, 2016).

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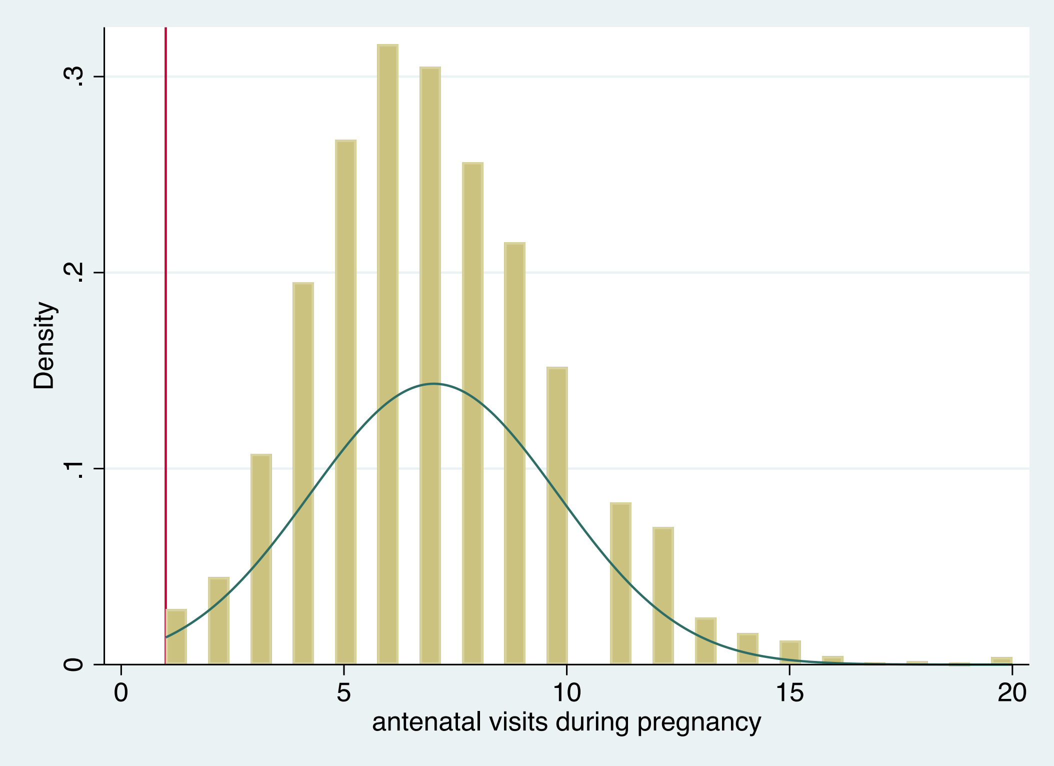
APPENDIX B

Table B. 1: Definition of Variables

Variable	definitions
Dependent Variables:	
ANC first trimester visit	(=1 if first month if visit is within 3 months of pregnancy, 0 otherwise)
ANC four plus visit	(=1 if Antenatal visit during pregnancy is four and above, 0 otherwise)
Facility delivery	(=1 if women deliver at health facility, 0 otherwise)
Ever had miscarriage.	(=1 if woman ever had miscarriage, 0 otherwise)
Number of miscarriages	(Equals to the number of miscarriages a woman ever had)
Ever had still birth	(=1 if woman ever had still birth, 0 otherwise)
Number of still birth	(Equals to the number of stillbirths a woman ever had)
Independent variables:	
Treatment	(=1 if region is Northern and upper east, 0 otherwise)
Post	(=1 if childbirth year is 2014-2017, 0 otherwise)
Woman education:	
Basic education	(=1 if primary and junior high school, 0 otherwise)
Secondary education	(=1 if woman had secondary or senior high, 0 otherwise)
Higher education.	(=1 if higher education, 0 otherwise)
Woman age	(represents age of respondent)
Woman religion:	
Christian	(=1 if woman religion is a Christian, 0 otherwise)
Islam	(=1 if woman religion is a moslem, 0 otherwise)
Traditionalist	(=1 if woman religion traditionalist, 0 otherwise)
Other religion	(=1 if woman religion other religion, 0 otherwise)
No-religion	(=1 if woman had no-religion, 0 otherwise)
Place of Residence	
Rural	(=1if woman reside in rural, 0 otherwise)
Wealth index:	
Poorest	(=1 if wealth index is poorest, 0 otherwise)
Poorer	(=1 if wealth index is poorer, 0 otherwise)
Middle wealth	(=1 if wealth index is middle wealth, 0 otherwise)
Richer	(=1 if wealth index richer , 0 otherwise)
Richest	(=1 if wealth index richest, 0 otherwise)
Birth status:	
Multiple birth	(=1 if birth is multiple, 0 otherwise)
Ethnicity:	
Akan	(=1 if ethnicity is akan, 0 otherwise)
Ewe	(=1 if ethnicity is Ewe, 0 otherwise)
Ga-dangwe	(=1 if ethnicity is Ewe, 0 otherwise)
Mole/dangbani	(=1 if ethnicity is Ewe, 0 otherwise)
Married	(=1 if woman is married or in union, 0 otherwise)

Figure B. 1: Antenatal Visits during Pregnancy



CHAPTER 3

EFFECT OF THE COMMUNITY-BASED HEALTH PLANNING AND SERVICES ON ANAEMIA AND ACUTE MALNUTRITION AMONG THE VULNERABLE IN GHANA

3.1 Introduction

Anaemia is an endemic problem, causing adverse long-lasting impact to individuals through poor health, cognitive problems, early death (WHO, 2015), and reduced physical activity (Haas & Brownlie, 2001). Although anemia prevalence is estimated at 9 percent in developed nations, in developing nations the prevalence is 43 percent, with women of childbearing age and children under-five being the high-risk group. The global prevalence rate is 47 percent in children less than five years, 42 percent in pregnant women, and 30 percent in non-pregnant women aged 15–49 years (McLean et al., 2009). Africa and Asia accounts for more than 85 percent of the anemia burden among the high-risk groups. Although the principal cause is iron deficiency it rarely exists in separation. More commonly if coexist with other causes including worm infestation, malaria, genetic disorders, most of which could be prevented if appropriate strategies are implemented.

Most countries have implemented several strategies to combat anemia, for example, sleeping under mosquito nets to prevent anemia, deworming to treat intestinal worms in pregnant women and children, iron supplementation in pregnant women, good nutritious food, and health education on healthy living and among others. Most of these strategies require the services of a trained health personnel to deliver to the people. The Community-Based Health Planning and Services (CHPS) expansion is one means used to reach people in deprived communities. As a step to honor the World Health Organization declaration at Alma-Alta on Primary Health Care (PHC) in 1978, and to make health care services accessible to the people of Ghana, the Ministry for health, Ghana in 1999 adopted a Community-Based Health Planning and Services (CHPS) as a national policy to ensure the provision of essential package of basic health services to the most deprived communities following the successful trial in the Navrongo and the Nkwanta districts of Ghana.

In an effort to support the implementation of community-based health planning and services in Ghana, Japan International Cooperation Agency (JICA) implemented a project for scaling up CHPS in the upper west region of Ghana that employs a distinct approach for running CHPS activities, involving improvement of capacities of community health officers (CHOs) through refresher trainings, monitoring by facilitative supervision, introduction of community health action plans, community emergency transport systems, as oppose to the conventional implementation of CHPS where CHOs are only given an orientation of the CHPS program and then assigned to a zone. The treatment of minor ailments and the door-to-door visit to households by the CHOs for health education and promotion is one method that can change the attitude of the communities in terms of hygiene, eating habits and right balance of food required for human health. The community health officers render school health activities where they periodically deworm the pupils, treat malaria and other minor infections, which we expert will tackle anemia caused by worm infestation, malaria and other infections.

Studies have also shown the effectiveness of the above interventions in the reduction of anemia in children. For instance, Friis et al. (2003) found an improvement in hemoglobin level in a randomized experiment in Kenya using antihelminth. Coffey et al. (2018) showed an improvement in hemoglobin level for children exposed to better environmental sanitation in Peru. In a randomized trial aimed at improving mother's knowledge on child nutrition in Malawi, Fitzsimons et al. (2016) found an improvement in infant diet, household consumption and children's physical growth. We also expect the health promotion and education on nutrition by the CHOs to help mothers gain knowledge on health, improve household consumption on iron rich diet and early seeking for health care for treatment of minor illness. We expect that the activities of the CHOs through the supportive supervision with active involvement of the community will reduce anemia since most of the causes of anemia is iron deficient in daily food intake.

The CHPS policy focuses on a wide range of services, however we limit our study to anemia and acute malnutrition because we expect the home visiting and health education by the community health officers to increase household consumption of iron rich diet and an increase in coverage of school health deworming which will have positive impact on hemoglobin levels. Ghana has implemented a Community-Based Management of Acute Malnutrition (CMAM) an approach which helps in early identification and treatment of acute malnutrition children to avoid complications. The approach provides family members with ready-to-use-therapeutic foods (RUTF) to administer/care to the child at home. These services are effectively administered through the CHPS system and we expect the upper west region where CHPS service is more intensified to achieve a wider coverage.

Although the policy is meant for both curative and prevention health, there exist rare studies that investigates the policy impact on disease prevalence. To the best of our understanding, this paper is the first study that investigates the policy impact on anemia among children less than five years and women 15 to 49 years of age. In a review of the CHPS policy in 2009, CHOs indicated that CHPS had reduced anemia, but they were unable to quantify the magnitude of reduction. This paper serves to provide empirical evidence on CHPS contribution to anemia prevalence using the JICA model as a case study. We hypothesize that the community-based health planning and service model implemented by JICA will improve preventive health services, thus reducing the prevalence of anemia and acute malnutrition in Ghana. The fact that the implementation has been ongoing since 2006 in the region allows a sufficient time frame for households to gain sufficient knowledge on good nutrition, sanitation and healthy living especially the deprived.

Using the difference-in-difference model, we compare the upper west, the region implementing the JICA model with two other regions of the north (upper east and the northern region) implementing the conventional model. We investigate the effect of the project on anemia in children less than five years and women 15 – 49 years of age. We find a reduction in the probability of anemia prevalence among children under-five and women of reproductive age by 15 and 19 percentage points respectively. We also estimate the policy effect on acute malnutrition in children and we find a reduction in the probability of acute malnutrition by 8 percentage points in the treatment region.

We have established in our finding that lack of nutrition information and disease environment is the main cause of anemia among the poor. Addressing anemia in children and women of reproductive age can be achieved by changing behaviors of the community through active participation of the community members in health planning and delivery, a key contribution to policy. This paper contributes to two strands of literature. First, our findings contribute to literature on the effectiveness of health investment on child and women health. Second, our findings contribute to literature on the effect of CHPS on anemia prevalence.

We structure the rest of the paper as follows: In section 2 we provide background of the CHPS and JICA project of scaling up CHPS. Section 3 describes the data source and variables. Section 4 presents a detailed identification strategy and model. We report empirical findings in Section 5 and in section 6 discussion and conclusion.

3.2 Background

3.2.1 Community-Based Health Planning and Services (CHPS)

Community-based health planning and services (CHPS) is a national policy that provides health services to the community involving health planning, decision making and service delivery with the communities. Its principal aim is to draw health services close to the doorsteps of the people in the most deprived communities. CHPS strategy is considered as one of the practical approaches to achieve universal health coverage. It was initiated with regards to the fact that over 70 percent of Ghanaians live more than 8 kilometers from health facilities, compounded by poor road networks and lack of transport thus worsening health indicators of the country. CHPS departs from the traditional approach of primary healthcare service provision as the health staff are resident in the community where they bi-weekly/monthly make home visits to give health education on healthy living, good sanitation and on nutrition.

Community-based health planning and services operations started on pilot bases in three sub-districts of the Navrongo municipality, Ghana in 1994. The successes from the pilot project in Navrongo and subsequent pilot in Nkwanta district necessitated the nationwide adoption of the strategy in 2000 to reduce geographical barriers limiting access to health care services with the main aim of reaching every community in Ghana with a basic package of essential health services towards achieving universal health coverage thus bridging access in equity gap in health care services. A main principle of CHPS policy is that community leaders must accept the CHPS concept and pledge themselves to assist it (Nyonator et al., 2005). It recognizes households as the primary producers of health.

The CHPS operation is managed by a community health officer (CHO) and assisted by a volunteer drawn from the community of service. The CHO is a community health nurse who is reoriented with the requisite skills to fit into the CHPS zone. This enables him/her to deliver health care to the doorsteps of the people. A CHO engages each community within the catchment area when planning for health activities for the community. The services rendered by the CHO includes family planning, immunizations, treatment of minor ailments (malaria, respiratory tract infection, diarrheal disease and other childhood illness), supervising delivery, antenatal/postnatal care, and health promotion and education: nutrition education and care and community and compound level education and on primary health care.

The CHPS zone initially covered a catchment population of 3000 to 4500 with a maximum of two community health officers (Nyonator et al., 2005). However, this definition was changed in 2016 to a demarcated geographical area of 5000 persons or 750 households and may be coterminous with electoral areas and a maximum of three community health officers. Every CHPS zone was expected to be made up of CHPS compound with a community health officer's accommodation and a place for rendering health services. Patients whose conditions could not be handled by the community health officers are referred to the next level-Health Centre, district hospital and regional hospital in that order of upward referral. To ensure the CHPS zones were functional, the Ministry of Health increased the training of community health nurses in 2003 by issuing a policy directive to the nursing training institutions to increase the training of community health nurses and additional training institutions opened by the end of 2010 (Ministry of Health, 2016).

The key elements of the CHPS include the community (as social capital), household and the individual as target, planning with the community (community participation) and services delivery with the community (client focused). A CHPS zone is composed of the following milestones; preliminary planning, community entry, community health compound, community health officer, equipment and volunteers (Ghana Health Service, 2005). Thus, a functional CHPS zone is where all the milestones have been or not been completed but a community health officer has been assigned to provide a defined package of services to the catchment area.

3.2.2 JICA Project of Scaling up of CHPS in the Upper West Region

Japan International Cooperation Agency (JICA) implemented a project for 'scaling up of CHPS in the upper west region of Ghana in March 2006 which ended in March 2010. The projects incorporate facilitative supervision (FSV), community health action plans (CHAPs) and refresher training for CHOs into the CHPS strategy. Facilitative supervision is a technique of supervision where superiors or managers at the levels of the organization focus on the needs of the staff they direct. Traditionally, the supervisor visits the clinic, collects data and reports issues or problems. But with facilitative supervision the facilitator guides staff in new approaches of improving quality and enables them to implement it. This approach encompasses; monitoring, joint problem solving, and collaborative approach between the supervisor and the supervisee. This approach shifts from finding faults and criticism to critical assessment and collaborative problem solving to continuous improvement of quality of care.

The Project revised the conventional monitoring within CHPS implementation system to Facilitative Supervision (FSV). Guidelines and tools for FSV were developed for the four levels of health system, thus regional, district, sub-district and the community levels and training conducted for all the teams of the levels. The order of facilitative supervision is carried out throughout the four levels of health system at the regional level: FSV to district health management teams (DHMTs) is by regional health management teams (RHMTs), FSV to sub-district health teams (SDHTs) is by district health management teams (DHMTs), FSV to community health officers (CHOs) is by SDHTs and FSV to community health volunteers /committee (CHV/CHC) is by community health officers (CHOs). DHMTs need to carry out regular monitoring of CHPS in all the CHPS zones, however with facilitative supervision DHMTs only monitors CHPS performance through the SDHTs which is cost effective than the DHMTs visiting all CHPS zones in district. Monitoring of the respective subordinate is done monthly, and supervisory report analyze by an information office and analyzed report submitted to the immediate director. See Aikins et al. (2013) for details.

Areas of assessment of FSV of SDHT by the DHMT includes equipment and transport, submission of supplies in a timely manner, supplies management, information management, technical support, and procedure for referrals. The final stage involves supervision of the CHO by the SDHT, which is conducted once a month, and this is followed by the monitoring sheet and the supervisory report to the DHMT on the 5th of every month. Areas of assessment of FSV of CHO by SDHTs includes:

1. CHPS compound condition with regards to basic facilities, how rooms in the CHPS compounds and documents are organized, with filing being of immense importance.
2. Questions on documentation which deals with reports written to the SDHT; and as well as statistical reports, documentation of Logistics (ledger books, checking tally cards, requisitions, motorcycle logbooks, documentation of program-based activities; Health Promotion, and home visits assessment.
3. Assessment of assessment of reproductive health: Immunization, child welfare clinics and morbidity (concerning malaria, diarrhea etc.)

The project contracted a non-governmental organization that implemented a community health action plan (CHAP), an action plan introduced by community members to improve the condition of a CHPS zone. CHAPs enhance community participation and cooperation in CHPS activities. The CHAP established Community Emergency Transport Fund; this fund is contributed by the community members to assist members of the community members in cases of health emergency referral situation, other CHAPs advocated for construction of roads linking to CHPs compound. Whilst others assisted in the construction of buildings of the clinics.

Fresher and refresher training on first aid, facilitative supervision and community health action plan was conducted to CHOs. The training was centered on improving knowledge, skills on community entry and motivation of Community Health Volunteers (CHVs) and Community health communities (CHCs) on community participation (Ampiah, 2017). In a nutshell, JICA CHPS has the following unique features.

- Refresher training of community health officers on emergency /first aid community health activities and supervision of community health volunteers.
- Training of community health officers on the use of Ambu-bag (Resuscitation kit) to enable them to use it in the event of emergency
- Training of regional and district management teams on proposal writing for support for the construction of CHPS compounds.
- Trainings of Ghana Health Service Staff on Community Entry Skills
- Referral procedure training was conducted based on low referral rate discovered during the baseline survey
- Improved community participation through the implementation of Community Health Action Plan
- Strengthening of monitoring and supervision using the facilitative supervision approach at all levels of the health care system
- Review and refinement of training materials for community health volunteers (CHV) and Implementation of training sessions for the CHV.

The evaluation report shows a strengthened institutional capacity of Ghana health service on CHPS implementation in the upper west region; evidenced by increase in Facilitative Supervision at each level of health system within the Ghana health service. Baseline survey shows an average referral rate of 1.1 percent. Post evaluation shows an increased referral rate of to 80 percent. The evaluation also shows an increase in the number of functional CHPS zones and an increase in households visited by Community health officers (Ampiah, 2017). The evaluation did not consider the project impact on health service indicators. There also exist rare studies that investigates the project impact on disease prevalence. To the best of our knowledge, this is the first paper that investigates the project impact on anemia and acute malnutrition prevalence among the vulnerable.

3.2.3 Burden of Anaemia

Anaemia is defined as a low level of haemoglobin in the blood. Haemoglobin transports oxygen from the lungs to the entire parts of the body. Although the primary cause is iron deficiency, it seldom exists in isolation. More commonly it coexists with a number of other causes, such as parasitic infection, malaria, hemoglobin disorders and nutritional deficiencies. Anemia impedes brain development of the fetus and limits child memory capacity hindering the ability to learn in school. The persistence or untreated anemia will adversely affect human capital development of affected individuals or children and thus impeding economic development. Preventing or reducing anemia prevalence can mitigate these effects as revealed by Chong et al. (2016) that iron supplementation improves school performance among adolescents in a randomized experiment in Peru. They show that iron supplementation is effective for reducing iron deficiency anaemia.

Given the burden of this pathology in the nations of the world, several countries have implemented interventions to minimize anemia prevalence; especially in the groups highly vulnerable to its overwhelming effects: pregnant women and children under five. In Ghana, anemia prevalence is 66 percent among children under-five (2014) and in women of reproductive age is 42 percent (GSS, GHS, and ICF International 2014). The risk factors for anemia in Ghana includes malaria, helminth infections, iron deficiency, vitamin A and micronutrient deficiencies.

Anaemia awareness and its consequences for health especially in children and women, has improved in the past few years. The World Health Assembly in 2012 set frameworks and global targets for maternal, and child nutrition, to reduce anemia prevalence in women 15 to 49 years of age by 2025 in its 65th annual conferences. As a result, attention has been given to nutrition strategies and expansion of nutrition interventions. Ghana has also taken steps to reduce anemia among the vulnerable group by supplying iron to pregnant women and deworming of children under-five and pregnant women. Most of the interventions are channeled through the health facilities and majority of Ghanaians live in rural and hard to reach areas where health facilities rarely exist thus worse health situation of the vulnerable. The CHPS expansion is to remedy this situation as it brings health services to the doorsteps of the people**.** This study examines the JICA project for scaling up CHPS in the upper west region of Ghana and its effect on anemia and malnutrition prevalence among the vulnerable in the community.

3.3 Data Source and Description

The Ghana Demographic and Health Survey (GDHS) is used for this study. It is a comprehensive survey data set conducted every five years in Ghana. The Surveys (GDHS) program is designed to provide data to monitor the population and health situation in Ghana. There are about six waves of the dataset, that is 1988, 1993, 1998, 2003, 2008 and 2014 waves. The 2014 and 2003 waves are used for the study. The 2014 survey was conducted in the month of September 8th to November 25th, 2014 on a national representative sample of 12,831 households. Women of reproductive age (15-49) who are residents in the selected households or visitors who had stayed in the selected households the night before the survey were interviewed (DHS, 2014).

The Women's Questionnaire was used to obtain information from women of 15-49 years in selected households about the health status of women and children under five. A total number of 4,916 eligible women were interviewed. Anemia was ascertained during the survey by taking a capillary blood sample of children less than five years and women of reproductive age using hemocue to obtain hemoglobin level. Blood hemoglobin of less than 7 g/dl is severe anemia, 7 to 9.9g/dl moderate and 10 to 10.9g/dl as mild anemia and 11 and above is considered not anemia for children. Anemia in non-pregnant women was defined as any anemia if hemoglobin concentration was 11.0 – 11.9 g/dL mild, 8 to 10.9g/dl moderate and severe anemia if it was below 8.0 g/dL and above 12g/dl not anemic. The measurement of anemia in pregnant women is the same as that of children under five. The dataset also contains the child's weight for height which we used to create the variable acute malnutrition. We used this information to create the outcome variables of interest, anemia in children and women of reproductive age for the analysis.

In Table 3.1, we present summary statistics and description of variables. We use 4,102 observations in our analysis, 1,023 for the treatment region and 3,079 for the control region. About 78 percent of children under-five are anemic in the JICA CHPS region whereas 79 percent are anemic in the two traditional CHPS regions. Anemia in the JICA CHPS region in women of reproductive age is more (50 percent) compared to the two traditional CHPS regions (48 percent). Most of the women are rural residents (86 percent in JICA CHPS and 79 percent two traditional CHPS) and mostly Christians (62 percent in JICA CHPS and 59 percent in the two traditional CHPS) and of the poorest households and most of them have had their secondary education (33 percent). Most households are within the poorest wealth quintile and mainly from the two traditional CHPS) regions (71 percent) and 67 percent in the JICA CHPS region.

Table 3. 1: Summary Statistics

Variables	JICA CHPS Mean	JICA CHPS Std. Dev.	Traditional CHPS Mean	Traditional CHPS Std. Dev.
Anemia in under5	0.784	0.412	0.789	0.408
Anemia in women 15-49	0.496	0.500	0.483	0.500
Low-weight-for age	0.113	0.316	0.084	0.278
Treatment (=1 if upper east)	1.000	0.000	0.000	0.000
Post (=1 if survey year is 2014)	0.492	0.500	0.468	0.499
Rural (=1 if place of residence is rural)	0.863	0.344	0.792	0.406
Woman religion:				
Christian (=1 if religion is Christian)	0.618	0.486	0.586	0.493
Islam (=1 if religion is Islam)	0.261	0.439	0.264	0.441
Traditionalist (=1 if religion is traditionalist)	0.035	0.184	0.049	0.217
No-religion (=1 if woman has no religion)	0.018	0.132	0.025	0.156
No education (=1 if woman has no education)	0.138	0.345	0.116	0.320
Woman/mother education:				
Mother/woman primary education	0.138	0.345	0.116	0.320
Mother /woman secondary education	0.101	0.301	0.106	0.308
Mother /woman higher education	0.019	0.135	0.013	0.113
Mother/woman age	30.983	7.342	31.059	7.196
Wealth index:				
Poorest (=1 household is poorest wealth index)	0.673	0.470	0.711	0.453
Poorer (=1 household is poorer wealth index)	0.152	0.359	0.129	0.336
Middle (=1 if middle wealth index)	0.077	0.267	0.081	0.273
Richer (=1 if household is richer)	0.071	0.258	0.057	0.231
Richest (=1 if household is richest)	0.027	0.163	0.022	0.146
Twins (=1 if child is a twin)	0.031	0.174	0.039	0.194
Child's gender (male)	0.553	0.497	0.512	0.500
Child's gender (female)	0.447	0.497	0.488	0.500
Mother Ethnicity				
Ga_dan (=1 if woman ethnicity is Ga/dangwe)	0.001	0.035	0.006	0.077
Mole/dagbani (=1 if ethnicity Mole/dangbani)	0.795	0.404	0.612	0.487
Other tribe (=1 if ethnicity is other tribe)	0.196	0.397	0.303	0.460
Akan (=1 if woman ethnicity is Akan)	0.005	0.070	0.019	0.137
Partner primary education	0.139	0.346	0.086	0.281
Partner secondary education	0.171	0.377	0.130	0.336
Partner higher education	0.031	0.174	0.046	0.209
Partner age	40.098	11.560	40.562	11.722
Observations	1,023		3,079	

Note: this table reports the summary statistics of the key variables data used for the analysis. JICA CHPS is the is the project implementing region (Upper west region) and the traditional CHPS represents the conventional CHPS in the other two regions of the north (Northern and upper east regions). Summary statistics are not tallying with those of the analysis because observations for anemia, malnutrition partner education and partner age are less than the total sample size.

3.4 Identification Strategy

JICA employed a different approach of CHPS implementation in one of the regions of the North by improving capacities of CHOs through refresher trainings, monitoring by facilitative supervision, introduction of community health action plan (CHAPS) and community emergency transport systems, as oppose to the conventional implementation of CHPS where CHOs are only given an orientation of the CHPS program and then assigned to a zone. The distinct model implemented by JICA makes it appropriate to investigate the model that yields the desired effect on disease burden of disease using the difference-in-difference approach. We use the upper west region as a treatment region and the other two regions of the north (Northern and the upper east regions) implementing the traditional model as control since these three regions have similar demographic characteristics. We used the DHS data set for 2003 as the baseline and 2014 as post year. We use the model below to estimate our results:

$$\mathrm{Y_{ijt}} = \beta_1 \mathrm{X}'_{\mathrm{ijt}} + Treatment_j + Post_t + \delta\ \mathrm{Treatment}_j * \mathrm{post_t} + \gamma_{\mathrm{t}} + \mathrm{T_j} + \varepsilon_{\mathrm{ijt}}$$

In which *i* denote individual (woman of 15-49 years and child under five) and *j* represents region and *t* denotes year. Y_{ijt} represent the outcome variables of interest; Anemia in women between the ages of 15 to 49 years, and anemia and acute malnutrition in children less than five years of age. Anemia is an ordinal variable ranging from mild, moderate, severe and not anemic. We created a binary variable equal one if anemic and zero if otherwise, separately for mother and child anemia. We also created acute malnutrition equal 1 if child weight-for-height is less than -2 standard deviation and 0 otherwise. δ is the difference in difference estimator of the project effect. It can be presented mathematically as:

$$\delta = (\mathrm{Y2014_{JICA\_CHPS}} - \mathrm{Y2014_{Traditional}}) - (\mathrm{Y2003_{JICA\_CHPS}} - \mathrm{Y2003_{Traditional}})$$

$\mathrm{Treatment}_j * \mathrm{post_t}$ is the interaction term for the treatment region (=1 if upper west, and 0 if northern and the upper east regions) with post (survey year 2014). $\mathrm{X}'_{\mathrm{ijt}}$ is the vector of maternal, child, household, community variables used for this study. The individual variables we control for include mother's age, mother education (primary, secondary, tertiary), mother ethnicity, mother place of residence, sex of child (male or female), birth status (multiple or single birth) and childbirth year. Community level variables: place of residence (rural, urban). The household level variables control for are household wealth (poorest, poor, middle wealth, richer and richest), partner age and education, as covariates for women and child anemia analysis. γ_t represents year fixed effects; it accounts for national events which might have affected anemia and acute malnutrition prevalence among children under-five and anemia in women of reproductive age in a given year. Such as national immunizations programs and malaria control program. T_j represents region fixed effects, which help purge any time-invariant region characteristics that might influence anemia in children and women of reproductive age. ε_{ijt} is the error term. We adjusted the standard errors by clustering at the primary sampling level[15].

3.5 Empirical Results

3.5.1 Effect of the Project on Anemia and Acute Malnutrition in under-five

We present results of our analysis of the effect of the JICA project on anemia and acute malnutrition using both OLS and probit marginal effect in Table 2.2. Panel A shows the main results of our project effect. In column 1, holding all other covariates constant, the project significantly reduces the probability of anemia prevalence in under five by 15 percentage points in the treatment region. This is consistent with the study by Berry et al. (2020) who show that the folic acid supplementation program in India reduces anemia among students. It is also in line with the study by Coffey et al. (2018) that shows an improvement in hemoglobin level for children exposed to better environmental sanitation in Peru. In column 3 of panel A, holding

[15] The Primary sampling units contains 427 groups, and we cluster the error term at this level

all other covariates constant, the project reduces the probability of low-weight-for height (acute malnutrition) among children under-fives by 7 percentage points in the treatment region. A maternal and child nutrition project in Uttar Pradesh that employed the services of community-based volunteers to counsel families "at risk" resulted in a significant reduction of severe malnutrition (Vir, 2013), which is consistent with our estimates. We report the marginal effect after probit in column (2) and column (4), which confirms the OLS findings as they are negatively related in magnitude and same significance level indicating the robustness of the findings. Thus, in column 2, the children under the project have 15 percent lower probability of being anemic and 7 percent lower probability of being acutely malnourished.

In Panel B of Table 2.2, we combine data sets for 2008 and 2014 in the post years. Our findings as in column 1 of Panel B decreases by 5 percentage points. Holding other covariates constant, the project reduces the chances of anemia under-five prevalence by 10 percentage points and in column 3 by 7 percentage points. We also report the marginal effect after probit in column (2) and column (4) of Panel B, which confirms the OLS findings. They have similar magnitude and same significance level indicating the robustness of the findings. Thus, in columns 2 and 4 of Panel B, the children under the project have 11 percent lower probability of being anemic and 7 percent lower probability of being acutely malnourished respectively.

3.5.2 Effect of the Project on Anemia in Women of Reproductive age

We also estimate the JICA project effect on anemia in women of reproductive age. The results are in Table 3.3. In Panel A of column 1, holding other covariates constant covariates, the project reduces the probability of anemia in women between the ages of 15-49 years by 19 percentage points. In Panel B of column 3, holding other covariates constant, the project reduces the probability of anemia in women between the ages of 15-49 years by 11 percentage points albeit insignificant. We report the marginal effect after probit in column (2) of Panel A and in column (4) of Panel B, which confirms our OLS estimates; they are in magnitude, sign and significance level indicating the robustness of the findings.

2.5.3 Effect on Sub-groups of Anemia and Acute Malnutrition

We also examine the effect of the project on sub-groups of anemia among children under-five and women of reproductive age. Policy makers may need to know the type of the anemia that the project affected most to aid in designing or reviewing the CHPS or anemia policies. We present the results in Table 3.4. The findings indicate that the reduction of the under-five anemia benefited children who were moderately anemic as we show in Panel A of Table 3.4. That is, in column 2 of Panel A, the policy reduces the probability of moderate anemia by 11 percentage points albeit at a modest level. We also observe a similar trend in panel B, that is the policy reduces the probability of moderate anemia among women of reproductive age by 13 percentage points.

Table 3. 2: Effect of the Project on Anemia and Acute Malnutrition in Under-five

Variables	(OLS) Anemia in under5	(Probit) Anemia in under5	(OLS) Child's Low - weight-for-height	(Probit) Child's Low-weight-for-height
Panel A: Post is 2014				
Treatment	0.20	0.06	-0.06	0.05**
	(0.12)	(0.04)	(0.06)	(0.02)
Post	0.00	0.17*	0.03	-0.00
	(0.00)	(0.09)	(0.03)	(0.07)
Treatment*post	-0.15***	-0.15***	-0.07**	-0.07**
	(0.06)	(0.05)	(0.03)	(0.03)
Constant	0.77***	–	0.24***	–
	(0.15)	–	(0.07)	–
Observation	2325	2325	2324	2324
R-squared	0.096	–	0.071	–
Panel B: Post is 2008&2014				
Treatment	0.06	0.06*	-0.08***	0.06***
	(0.16)	(0.04)	(0.03)	(0.02)
Post	0.09**	0.05	0.00	-0.51***
	(0.04)	(0.11)	(0.00)	(0.04)
Treatment*post	-0.10**	-0.11**	-0.07***	-0.07***
	(0.04)	(0.04)	(0.03)	(0.03)
Constant	0.64***	–	0.29***	–
	(0.20)	–	(0.08)	–
Observation	2926	2926	2889	2889
R-squared	0.086	–	0.093	–

Note: this table reports the effect of the project on child anemia and acute malnutrition. Panel A is the main results. Whiles in Panel B combines two dataset as the post years (2008&2014). Treatment*post is the difference-in-difference estimator of project effect. We report both the OLS and the Probit marginal effect. The main outcomes variables are: Anemia in children under-five, acute malnutrition (low weight-for-height). We control for the following in all the models: Individual covariates: Child; gender, twin and birth year. Mother age, mother education dummies, mother religion dummies, mother ethnicity dummies, place of residence(rural). Household level variables: wealth index, partner age and education. We also control for region and year fixed effects in all the models. Statistical significance is indicated by ***, **, and * at 11%, 5%, and 10% respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

Table 3. 3: Effect of the Project on Anemia in Women of Reproductive age

	Panel A Post 2014		Panel B Post is 2008&2014	
Variables	(OLS) Anemia in women age 15-49	(Probit) Anemia in women age 15-49	(OLS) Anemia in women age 15-49	(Probit) Anemia i women age 15-4
Treatment	0.29*	0.12**	0.06	0.10*
	(0.16)	(0.06)	(0.14)	(0.06)
Post	0.00	0.05	0.07	0.06
	(0.00)	(0.10)	(0.06)	(0.13)
Treatment*post	-0.19**	-0.19**	-0.11	-0.11
	(0.08)	(0.08)	(0.07)	(0.07)
Constant	0.41***	–	0.34***	–
	(0.14)	–	(0.13)	–
Observation	2689	2689	3375	3375
R-squared	0.0652	–	0.0614	–

Note: this table reports the main effect of the project on anemia in women aged 15-49. Treatment*post is the difference-in-difference estimator of project effect. We report both the OLS and the Probit marginal effect. The main outcome variable is Anemia in children women 15-49 years. We control for the following in all the models: Individual covariates include woman age, woman education dummies, woman religion dummies, woman ethnicity dummies, place of residence(rural). Household level variables: wealth index, partner age and education dummies and childbirth year and twin pregnancy. We also control for region and year fixed effects in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

Table 3. 4: Effect of the Project on the Sub-groups of Anemia

Variables	(1) Anemia	(2) Mild-Anemia	(3) Moderate anemia	(4) Severe Anemia
Panel A: Children Under5				
Treatment	0.20	-0.00	0.14	0.06*
	(0.12)	(0.10)	(0.14)	(0.03)
Post	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Treatment*post	-0.15***	-0.03	-0.11*	-0.01
	(0.06)	(0.05)	(0.06)	(0.03)
Constant	0.77***	0.18	0.50***	0.10**
	(0.15)	(0.12)	(0.16)	(0.04)
Observation	2325	2325	2325	2325
R-squared	0.096	0.038	0.079	0.059
Panel B: women 15-49				
Treatment	0.29*	0.10	0.22*	-0.04
	(0.16)	(0.14)	(0.11)	(0.04)
Post	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Treatment*post	-0.19**	-0.07	-0.13***	-0.00
	(0.08)	(0.06)	(0.05)	(0.00)
Constant	0.41***	0.13	0.23***	0.05
	(0.14)	(0.13)	(0.07)	(0.05)
Observation	2689	2689	2689	2689
R-squared	0.065	0.064	0.044	0.019

Note: this table reports the effects of the analysis of the subgroups of anemia. Panel A report anemia in children under-five and Panel B anemia in women15-49 years. Column 1 repeats the main results from table 2 and 3. We control for the following in all the models: Individual covariates include: Mother age, mother education, mother religion, mother ethnicity dummies, place of residence(rural). Household level variables: wealth index, partner age and education and childbirth year and twin pregnancy. We also control for region and year fixed effects in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

3.5.4 Mechanisms of Project Impact

The JICA CHPS project can impact on anemia and acute malnutrition through several channels. The services rendered during antenatal attendance, home visiting and school health activities by CHOs include health education on nutrition and hygiene, deworming and folic acid supplementation, all of which aid in anemia reduction and prevention. We expect the services rendered at the ANC and child welfare clinic (CWC) will improve maternal and under-five nutrition and anemia. Worm infestation causes anemia, and we expect the home visiting and health education by the CHOs will reduce open defecation- a major source of worm infestation and thus improve household toilet facilities and drinking water source. The CHOs services are also expected to increase coverage of school deworming as well as improvement in coverage of national immunization programs since the CHO resides in the communities. A study by Sufiyan et al., (2011) revealed an increase in mean hemoglobin level for pupil's dewormed and had hygiene education. Stoltzf us et al., (1998) also showed a reduction in iron deficiency anemia for a school deworming program in the first year of operation.

The results of this study show that the JICA project reduces significantly the probability of anemia and acute malnutrition under-five and anemia in women of reproductive age in the treatment region. To further explore the mechanisms through which the JICA project reduces anemia and acute malnutrition, we investigate the project impact on CHPS facility utilization by pregnant women. Holding other covariates constant in column 1 of Table 3.5, the project increases the probability of antenatal care attendance at the CHPS centers by 23 percentage points and in column 3, the project increases delivery at CHPS centers by 10 percentage points. Columns 2 and 4 reports the marginal effects after probit estimation and the results are consistent with the OLS results in terms of sign and significance level, however the probit results in column 4 are bigger in magnitude compared to the OLS results. In Table 3.6, we show whether antenatal care services rendered by a community health officer or nurse is higher in the treatment region compared to the non-treatment regions. Holding other controls constant in column 1 of Table 6, the project increases the probability of ANC services rendered by a CHO/Nurse centers by 23 percentage points and In column 3, the project increases delivery assistance by CHO/Nurse by 11 percentage points. Our results show that increase in CHPS antenatal attendance, CHPS delivery care and the quality of services rendered by CHOs at CHPS level as we show in Tables 3.5 and 3.6, translated into a reduction in anemia prevalence in women and children under-five and acute malnutrition prevalence in children under-five. Iron supplementation in non-pregnant women of reproductive age also expected to increase hemoglobin level in women, however, we could not empirically show it because our data set does not contain such variables.

Estimates by Green et al. (2016) indicates that an improved sanitation increases hemoglobin level (anemia reduction) among rural women in Cambodia. Coffey et al., (2018) compared under-five cohorts exposed to improved sanitation with those with poor sanitation and found a rise in hemoglobin levels. The presence of the community health officers within the community and the home visiting couple with health education is expected to improve community toilet facility and drinking water sources in the JICA project region in Ghana. We investigate this by estimating the project effect on improved toilets and improved drinking water sources employing the WHO and UNICEF, (2010) criteria. We present the results in Table 3.7. In column 1, holding all other variables constant, the project increases the probability of improved household toilet facilities by 15 percentage points. In column 3, the project increases the probability of improved household drinking water source by 24 percentage points. The probit marginal effect results in columns 2 and 3 confirms the OLS results as the sign and significance level are similar. We expect these increases to translate into soil helminth and water drinking source contamination reduction with correspondence reduction in worm infestation and dysentery and subsequent reduction in anemia.

Table 3. 5: Effect on Maternal uptake of CHPS Services

VARIABLES	(OLS) ANC at CHPS Centre	(Probit) ANC at CHPS Centre	(OLS) Delivery at CHPS facility	(Probit) Delivery at CHPS facility
Post	0.00	-0.13*	0.03	-0.20***
	(0.18)	(0.07)	(0.04)	(0.05)
Treatment	0.00	-0.07	-0.01	0.02
	(0.00)	(0.10)	(0.01)	(0.02)
Treatment*post	0.23***	0.23***	0.10***	0.27***
	(0.07)	(0.07)	(0.03)	(0.06)
Constant	0.06	–	0.00	–
	(0.14)	–	(0.03)	–
Observations	2,275	2134	3,552	2097
R-squared	0.12	–	0.08	–

Note: this table reports the mechanisms of project effect on anemia and acute malnutrition. It shows the project effect on antenatal care (ANC) and delivery services at the CHPS centers. Treatment*post is the difference-in-difference estimator of project effect. We report both the OLS and the Probit marginal effect. We control for the following in all the models: Individual covariates include: Mother age, mother education dummies, mother religion dummies, mother ethnicity dummies, place of residence(rural). Household level variables: wealth index, partner age and education childbirth year and twin pregnancy. We also control for region fixed and year fixed effects in all the models. Statistical significance is indicated by ***, **, and * at %1, 5%, and 10%, respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

Table 3. 6: Services Rendered by Community Health Officer (CHO)/ Nurse

Variables	(OLS) ANC rendered by CHO/ C.Nurse	(Probit) ANC rendered by CHO/ C.Nurse	(OLS) Deliveries Assisted by CHO/ C.Nurse	(Probit) Deliveries Assisted by CHO/C.Nurse
Post	0.15	-0.11*	0.04	0.01
	(0.11)	(0.06)	(0.05)	(0.03)
Treatment	0.00	0.10**	0.02	0.03
	(0.00)	(0.04)	(0.01)	(0.04)
Treatment*post	0.23***	0.20***	0.11***	0.04
	(0.06)	(0.06)	(0.03)	(0.03)
Constant	-0.02	–	0.02	–
	(0.06)	–	(0.05)	–
Observations	2,514	2407	3,550	3414
R-squared	0.17	–	0.07	–

Note: this table reports the mechanisms of project effect on anemia and acute malnutrition. It shows the services rendered by the community health officer (CHO) and community health Nurse (C.Nurse). Treatment*post is the difference-in-difference estimator of project effect. We report both the OLS and the Probit marginal effect. We control for the following in all the models: Individual covariates include: Mother age, mother education dummies, mother religion dummies, mother ethnicity dummies, place of residence(rural). Household level variables: wealth index, partner age and education and childbirth year and twin pregnancy. We also control for region and year fixed effects in all the models. Statistical significance is indicated by ***, **, and * at %1, 5%, and 10%, respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

Table 3. 7: Impact on Improved Toilet and Drinking Water Sources

Variables	(OLS) Improved Toilet	(Probit) Improved Toilet	(OLS) Improved drinking water	(Probit) Improved drinking water
Treatment	0.13***	-0.02	0.73***	-0.20***
	(0.04)	(0.04)	(0.07)	(0.07)
Post	0.00	0.06	-0.11***	0.46***
	(0.00)	(0.04)	(0.03)	(0.08)
Treatment*post	0.15***	0.10**	0.24***	0.33***
	(0.05)	(0.05)	(0.06)	(0.09)
Constant	-0.01	–	-0.05	–
	(0.06)	–	(0.10)	–
Observation	3548	3548	3552	3552
R-squared	0.417	–	0.614	–

Note: this table reports the mechanisms of project effect. It shows project effect on improved toilet and drinking water sources. Treatment*post is the difference-in-difference estimator of project effect. We report both the OLS and the Probit marginal effect. We control for the following in all the models: Individual covariates include: Mother age, mother education dummies, mother religion dummies, mother ethnicity dummies, place of residence(rural). Household level variables: wealth index, partner age and education and childbirth year and twin pregnancy. We also control for region and year fixed effects in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

3.5.5 Robustness Checks

The validity of our identification strategy rests on the fact that outcome variables of interest did not experience differential trends before the implementation in 2006. However, the DHS dataset for 1998 does not contain the variable anemia thus we could not show the parallel trend for anemia in children under5 and women of reproductive age. In order to tackle this issue, we conduct balancing a test to determine the correlations between the treatment status and the covariates used for the analysis. We present the results of the balancing test in Table 3.8. Significant differences in the covariates indicates that the treatment and the comparison regions are distinct at baseline, and this may bias our results. However, almost all the covariates were balanced at the baseline except for woman primary education and partner primary education, with the mean difference above the accepted threshold of 5 %. Since most of the covariates are balanced at baseline (below threshold of 5 %.), it supports parallel path theory, and we have no course of concern about differential trend at the baseline.

We estimate the parallel trend for low-weight-for-height (acute malnutrition) in children under-five using DHS 1998 and 2003 and present the results in Table 3.9. The results of the interaction term; Fake treatment*pseudo-post shows insignificant results indicating the existence of a common trend in acute malnutrition before the introduction of the JICA CHPS project. In Table 3.10, we also show the pre-trend of the mechanism of the project impact. Our results of the interaction term (Fake treatment*pseudo-post) are not significant in all the columns indicating that there exist parallel trends in improved toilets, improved drinking water, delivery at CHPS Centre, delivery assisted by CHO/nurse, and ANC rendered by CHO/nurse before the implementation of the JICA CHPS project.

Table 3. 8: Balancing Test of Covariates

Variable(s)	Mean Control	Mean Treated	Mean Diff.	t	Pr(T>t)
Urban	0.13	0.07	-0.06	0.82	0.414
***Woman religion**:*					
Christian	0.71	0.72	0.01	0.18	0.856
Traditionalist	0.00	0.00	0.00	1.01	0.318
***Woman education*:**					
Primary education	0.07	0.14	0.07	1.84	0.0703*
Secondary education	0.05	0.06	0.01	0.37	0.715
Higher education	0.01	0.00	-0.01	1.63	0.108
***Wealth index*:**					
Poorer	0.15	0.12	-0.03	0.72	0.472
Middle wealth	0.09	0.09	0.00	0.12	0.901
Richer	0.05	0.05	0.01	0.24	0.809
Richest	0.02	0.02	0.00	0.16	0.876
Twins	0.03	0.00	-0.03	4	0.0001***
Mother age	31.33	30.91	-0.42	0.46	0.647
Mother Ethnicity:					
Akan	0.03	0.01	-0.02	1.21	0.231
Ga-dangwe	0.01	0.00	-0.01	1.01	0.318
Mole -dagbani	0.67	0.74	0.07	0.51	0.610
Other tribe	0.22	0.25	0.03	0.21	0.832
Partner primary educ	0.05	0.16	0.12	3.5	0.0008***
Partner Secondary educ	0.10	0.12	0.02	0.6	0.551
Partner higher educ	0.03	0.01	-0.01	1.26	0.211
Partner age	41.45	40.01	-1.45	0.82	0.417
Child birthyear	2000.96	2000.83	-0.13	1.92	0.0592*
Child's gender-female	0.49	0.47	-0.02	0.42	0.674

Note: This table reports balancing test of covariates. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively.

Table 3. 9: Parallel trend - Acute Malnutrition in Children Under-five

Variables	(OLS) Low-weight-for-height	(Probit) Low-weight -for-height
Pseudo-Post	-0.02	0.02
	(0.02)	(0.03)
Fake treatment	0.01	0.02
	(0.01)	(0.04)
Fake treatment*pseudo post	**0.01**	**0.02**
	(0.03)	**(0.05)**
Constant	0.16***	–
	(0.04)	–
Observations	1539	599
R-squared	0.07	–

Note: this table reports the parallel trend for low-weight-for-height (acute malnutrition). We report the OLS and probit marginal effect. Pseudo-post is equal 1 if interview year 2003 and zero if 1998. Fake treatment*pseudo-post is the difference-in-difference estimator of the pre-project. We control for the following in all the models: Individual covariates: Child; gender, twin and birth year. Mother age, mother education dummies, mother religion dummies, mother ethnicity dummies, literacy, place of residence(rural). Household level variables: wealth index, partner age and education, childbirth year. We also control for region and year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

Table 3. 10: Parallel Trend-Mechanisms of Project Impact

Variables	(1) Improved drinking water	(2) Im-proved toilet	(3) Delivery at the CHPS	(5) Deliveries Assisted by CHO/ C. Nurse	(4) ANC rendered care by CHO
Pseudo-Post	0.08	0.08	0.00	-0.01	-0.06
	(0.07)	(0.06)	(0.01)	(0.12)	(0.09)
Fake treatment	0.04	-0.00	-0.00	-0.09**	-0.02
	(0.03)	(0.03)	(0.00)	(0.04)	(0.05)
Fake treatment*pseudo post	**-0.03**	**0.00**	**0.00**	**0.18**	**0.09**
	(0.04)	**(0.04)**	**(0.01)**	**(0.12)**	**(0.09)**
Constant	0.17	0.14	-0.04	-0.03	0.17
	(0.11)	(0.13)	(0.03)	(0.19)	(0.24)
Observations	2115	2115	2111	2112	1775
R-squared	0.464	0.455	0.068	0.050	0.076

Note: this table reports the parallel trend for the mechanisms of the project impact. We report the OLS and probit marginal effect. Pseudo-post is equal 1 if interview year 2003 and zero if 1998. Fake treatment*pseudo-post is the difference-in-difference estimator of the pre-project. We control for the following in all the models: Individual covariates: Child; gender, twin and birth year. Mother age, mother education dummies, mother religion dummies, mother ethnicity dummies, literacy, place of residence(rural). Household level variables: wealth index, partner age and education. We also control for region and year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

3.5.6 Simple Cost-effectiveness Analysis

We conduct cost-effectiveness analysis of the project impact on anemia. Our cost-effectiveness analysis is based on the assumption that the project objective is to reduce anemia prevalence. We present the analysis in Table 3.11. Since the project is for the entire populace of upper west region and it cost US$4,043,549[16], and our analysis is limited to only women of reproductive age and children under-five. We obtained the actual amount spent on each individual per year by dividing the total project amount by the total population of the implementing region for the period 2006-2010. We then calculated the total cost for under-five and women 15-49 years (column 1) by multiplying cost per person per year ($1.2038) by the under-five and women 15-49 years population[17] for the implementing region in Panel A and B respectively. Column 3 is anemia prevalence averted which is 15 and 19 precents of our study estimates for under five and women 15-49 years respectively in column 1 of Table 2 and column 1 of Table 3 multiply by total population of under-fives and women 15-49 years. Column 4 and 5 is the cost-effectiveness ratio of the intervention, which is obtained by dividing total cost (column 1) by the health benefit (column 3). Our results indicate that the JICA CHPS project averted 73,803 anemia prevalence among children under-fives, and 158,675 anemia prevalence among women of reproductive age from 2006 to 2010. The analysis shows that the JICA CHPS project averts anemia prevalence at a cost of $8 and $6 per year among children under-five and women of reproductive age respectively. If Cost-effectiveness ratio (CER)[18] is less than the Cost-effectiveness threshold[19] for Ghana, then it is cost-effective. Ochalek, Lomas & Claxton (2015)

[16] Project cost is obtained from Ampiah, K. (2017). Page 125

[17] Is sourced from https://www.populationpyramid.net/ghana/2010/. From the Ghana Statistical Service, (2020). Population by sex and district 2010 and 2019 (https://statsghana.gov.gh/nationalaccount_macros.php?Stats=MTA1NTY1NjgxLjUwNg==/webstats/s679n2sn87), the average Population for JICA project region is 2.85 percent of the total Ghanaian population. We use this percentage to calculate under 5 population out of the total under5 Ghanaian population obtained from population pyramid. We also did same for women 15-49 years of age.

[18] Cost-effectiveness ratio refers is the amount of money an intervention needs in order to avert 1 DALY. Is the measure for cost-effectiveness. It indicates 'value for money'

[19] Cost-effectiveness threshold refers to the productivity of a country healthcare system or the opportunity cost of health care spending. Is normally compared to an intervention CER.

assessed the productivity of the Ghana health system and estimated that it cost the healthcare system in Ghana US$432 to avert 1 DALY. Our results are far less than their estimates, indicating that the JICA CHPS project is very cost-effective. Our estimates are also far below the cost-effectiveness estimates by Shaker et al.(2009), who estimated 440 US dollars per case of anemia prevented. Clearly, the JICA CHPS project is highly cost-effective.

Table 3. 11: Cost-effectiveness Analysis of JICA CHPS Project on Anemia

Cost ($)	Population	Health benefit (Anemia prevalence averted)	CER calculation (Total cost/health benefit)	CER ($ per anemia prevalence averted)
(1)	(2)	(3)	(4)	(5)
Panel A: Cost-effectiveness analysis of the JICA CHPS on anemia under-five				
$592,301.71	49, 2019	492,019*0.15= 73,802.85	$592,301.71/ 73,802.85	$8
Panel B: Cost-effectiveness analysis of the JICA CHPS on anemia in women 15-49				
$1,005,330.7	835,131	835,131*0.19= 158,674.89	$1,005,330.7/ 158,674.89	$6.3
Cost per person per year $1.2038[20]				
Total population for the implementing region (2006 - 2010) = 3,358,935				

Note: if an intervention CER is less than cost-effectiveness threshold then the intervention is deemed cost-effective.

3.5.7 Heterogeneous Effect

Anemia is commonly patterned by wealth, place of residence. For instance, the study by Balarajan et al. (2011) revealed that the risk of anemia was 25 percent higher among women in the lowest wealth quintiles compared to those with highest wealth quintiles. Since the CHPS was first designed for the underprivileged, policy makers may be interested in knowing the category of people who benefited, to aid in reviewing and re-designing the CHPS policy and maternal and child health policies. We investigate the heterogeneous effect of the project on anemia and malnutrition by wealth index, and place of residence.

[20] It is obtained by dividing the total cost (US$4,043,549) by the total population (3,358,935) of the population of the implementing region

3.5.7.1 Effect by Wealth Quintile

In Table 3.12, we present the project effect by wealth quintile. We estimate the effect of the project among the bottom 2 wealth quintile (poor and poorest). In column 1 of panel A, our results indicate that the project strongly reduces the probability of under-five anemia among the bottom 2 wealth quintiles by 19 percentage points. In column 3, we also find a reduction in the probability of the project effect on acute malnutrition (low weight-for-height) among the bottom two wealth quintiles by 7 percentage points. In column 3, our results indicate that the policy is effective in reducing the probability of anemia in women aged 15-49 years among the two-bottom wealth quintile 24 percentage points. Panel B presents the effect of the project among top 2 wealth quintiles (richer and richest). the project is only effective in reducing anemia among women 15-49 years among the top 2 wealth quintiles (richer and richest) households in column 2, however in column 1 and 3 of the panel B the coefficients are not statistically significant, suggesting that policy is effective in reducing anemia and acute malnutrition in children. The results show the project benefited the poor more, which supports the main idea of the CHPS implementation.

3.5.7.2 Effect by Place of Residence

Table 3.13 presents analysis of heterogeneous effect by woman's place of residence. In column 1 of panel A, the policy significantly reduces the likelihood of anemia prevalence among rural children by 14 percentage points. We also find a reduction in acute malnutrition, that is holding all other controls constant, the policy also reduces the probability of acute malnutrition (low weight-for-height) among rural under-fives by 4 percentage points. In column 2 of panel A, the policy significantly reduces the likelihood of anemia prevalence among rural women of reproductive age by 20 percentage points. Panel B of Table presents estimates of the project effect among urban children and women of reproductive age. We find no significant effect of the project among urban children under-five and women in panel B. It shows that rural dwellers were the most beneficiaries of the project which support the main objective of the CHPS of bringing health service to the underserved population.

Table 3. 12: Effect on Anemia and Acute Malnutrition by Wealth Quintiles

Variables	(OLS) Anemia in under5	(OLS) Anemia in women 15-49	(OLS) Low -weight-for-height
Panel A: Bottom 2 wealth quintiles			
Post	0.24***	-0.01	-0.02
	(0.07)	(0.06)	(0.08)
Treatment	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
Treatment*post	-0.19***	-0.24***	-0.07*
	(0.06)	(0.09)	(0.03)
Constant	0.78***	0.59***	0.21**
	(0.09)	(0.13)	(0.10)
Observation	1944	2251	1942
R-squared	0.10	0.07	0.08
Panel B: Top 2 wealth quintiles			
Post	0.46*	-0.17	-0.27
	(0.26)	(0.27)	(0.18)
Treatment	-0.06	-0.15	0.00
	(0.19)	(0.18)	(0.00)
Treatment*post	-0.00	0.40*	-0.04
	(0.25)	(0.23)	(0.13)
Constant	0.74	0.90	0.01
	(0.48)	(0.60)	(0.29)
Observation	187	220	189
R-squared	0.29	0.17	0.24

Note: this table presents analysis of the heterogenous effect of the project. We present the project effect on both anemia in children and women and acute malnutrition in children. Panel A represent bottom 2 wealth quintile (poorest and poorer), while Panel B represents top 2 wealth quintile (richer and richest). The main outcomes variables are: Anemia in children under-five, acute malnutrition (low weight for height). We control for the following: Individual covariates: Child; gender, twin and birth year. Mother; age, education, religion, ethnicity, place of residence. Household level variables; wealth index, partner age and education. We control for all these variables in all the models except child gender which is not control for in column 2. We also control for region and birth year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

Table 3. 13: Effect of the Project by Place of Residence

Variables	(OLS) Anemia in under5	(OLS) Anemia in women	(OLS) Low -weight-for-height
Panel A: among rural			
Post	0.13	-0.12*	-0.03
	(0.12)	(0.06)	(0.07)
Treatment	0.12***	0.03	0.00
	(0.04)	(0.07)	(0.00)
Treatment*post	-0.14**	-0.20**	-0.06*
	(0.06)	(0.09)	(0.03)
Constant	0.63***	0.52***	0.29***
	(0.09)	(0.13)	(0.07)
Observation	1936	2230	1920
R-squared	0.10	0.07	0.07
Panel A: among urban			
Post	-0.34	0.47*	-0.18
	(0.21)	(0.24)	(0.11)
Treatment	0.00	0.00	-0.17***
	(0.00)	(0.00)	(0.06)
Treatment*post	-0.08	-0.04	0.08
	(0.18)	(0.17)	(0.07)
Constant	1.15***	0.29	0.19
	(0.27)	(0.26)	(0.24)
Observation	389	459	404
R-squared	0.19	0.13	0.15

Note: this table reports the heterogenous effect of the project by place of residence. The main outcomes variables are: Anemia in children under-five, acute malnutrition (low weight for height): Individual covariates: Child; gender and birth year. Mother; age, education, religion, ethnicity. Household level variables: wealth index, partner age and education. We control for all these variables in all the models except child gender which is not control for in column 2. We also control for region and birth year fixed effect in all the models. Statistical significance is indicated by ***, **, and * at 1%, 5%, and 10% respectively. Standard errors are in the parentheses and are clustered at the primary sampling unit.

3.6 Conclusions and Policy Implications

This study examines the effect the JICA project of scaling up CHPS in the upper east region on anemia in under-five and women of reproductive age. We use the Ghana demographic and health survey which is a nationally representative dataset making our results generalizable to the entire population of the country. To our understanding, this is the first paper that examines the policy impact on anemia and acute malnutrition prevalence. The results show a positive association of the JICA project on anemia prevalence reduction. The results reveal that the policy strongly reduces the possibility of anemia prevalence among children under-five by 15 percentage points. The results also reveal that the policy significantly reduces the probability of anemia prevalence in women of reproductive age by 19 percentage points. We have no doubt of the robustness of our results since the balancing test reveals that most of the covariates were balanced at the baseline supporting the parallel trend theory.

We also show the project effect on sub-groups of anemia among children and women of reproductive age. The findings reveal that the project benefited women and children with moderate anemia only. Other health interventions projects or programs aim at combating anemia should place more emphasis on moderate anemia. Our results in Tables 5 also indicate that the bottom 2 wealth quintiles (poor and poorest) are more likely to benefit from the policy than the top 2 wealth quintiles (richer and richest) supporting the main objective of the CHPS policy.

We explore the mechanisms through which the project increases the prevalence of anemia and acute malnutrition in under five. The results show an increase in the probability of CHPS antenatal attendance, CHPS delivery care and the quality of services rendered by CHO level as we show in Tables 5 and 6 and also an improved households toilet facility and drinking water sources. We have no doubt that the increase in the above channels translated into a reduction in anemia prevalence in women and children under-five and acute malnutrition prevalence in children under-five.

It is evident that the JICA model of CHPS is effective in disease prevention. We have established in our estimates that active community participation and response is a key determinant factor in the prevention and reduction of anemia prevalence. Second, our findings on CHPS contribute to literature on child and women health. We have also discovered in our finding that lack of nutrition information and disease environment is the main cause of anemia among the poor. Addressing anemia in children and women of reproductive age can be achieved by changing behaviors of the community through active participation of the community members in health planning and delivery, a key contribution to policy. All managers involved in primary health care delivery in all levels of the health system needs to be trained in facilitative supervision to ensure effective health outcomes. Our simple cost-effectiveness analysis shows that the JICA CHPS project is very cost-effective, with an estimated cost of $8 and $6 per anemia prevalence averted among children under-five and women of reproductive age respectively. Our estimates provide strong support for replicating the JICA model of CHPS in all the regions of the country and also countries intending to reduce disease (anemia and acute malnutrition) prevalence.

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