



**Global Development Network 1999 - 2009**

## **GDN Working Paper Series**

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**Working Paper No. 22**

**October 2009**

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This Working Paper has been prepared within the GDN's Global Research Project *Promoting Innovative Programs from the Developing World: Towards Realizing the Health MDGs in Africa and Asia*. The project has been fully funded by the Bill & Melinda Gates Foundation, United States. The views expressed in this publication are those of the author(s) alone.

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# Impact Evaluation of the Ethiopian Health Services Extension Program

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## *Abstract*

Ethiopia has launched a pro-poor health services extension program since 2003 to deliver preventive and basic curative health services to its inhabitants. Despite the massive support and recognition the program has received, there has not been proper evaluation of its impact. This study has applied propensity score matching and regression adjustment techniques to evaluate the short- and intermediate-term impacts of the program on child and maternal health indicators in the program villages. Empirical data for the study were collected from 3095 households from both program and non-program villages in rural Ethiopia. The estimated results indicate that the program has significantly increased the proportion of children fully and individually vaccinated against tuberculosis, polio, diphtheria-pertussis-tetanus, and measles. We find heterogeneity in childhood immunization coverage as a result of differences in terms of the number of health extension workers, in the quality of health posts and in terms of the educational achievement of mothers across program villages. The proportions of children and women using insecticide treated bednets for malaria protection are significantly larger in program villages than in non-program villages. The effect on preventive maternal care is rather limited. Whereas women in the program villages appeared to make their first contact with skilled health service provider significantly earlier during pregnancy, very little effect is detected on other prenatal and postnatal care services. Moreover, the program has not reduced the incidence and duration of diarrhea and cough diseases among under-five children.

**Keywords:** impact evaluation; health services extension; propensity scores; regression adjustment; Ethiopia

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## **1. Introduction**

Several efforts have been made over the last three decades to improve human health throughout the world. Among the global commitments, the Millennium Development Goals put specific targets to reduce under-five child mortality rate by two-thirds and maternal mortality ratio by three-fourths between 1990 and 2015 (United Nations, 2005). However, despite heightened awareness and efforts by international and national governments around the world, maternal and child health have improved very slightly. Currently more than half a million maternal deaths occur annually worldwide (WHO, 2007) and nearly two million children die each year from vaccine preventable diseases (WHO, 2008) and about 26 million children are inadequately protected (UNICEF, 2008).

With 920 maternal deaths per 100,000 live births, Sub-Saharan Africa has the highest regional maternal mortality ratio and accounts for almost half of all maternal deaths worldwide. Whereas a mother in Sub-Saharan Africa is encountered with a life time risk of a death of 1 in 26, the life time risk in developed countries is only 1 in 7,300 (WHO, 2007).

As in other developing countries, Ethiopian children and mothers have been facing several health problems due to poor access to modern health care facilities and due to lack of effective demand to utilize the available ones. Until recently, health care services have been primarily provided through few health facilities (hospitals, health centers, clinics) with inadequate number of physicians, nurses and other health workers. Besides, since these facilities are concentrated in urban areas, health care seekers were forced to spend time and money to travel long distances to cities to get the health services. Access to these facilities has also been constrained by the lack of good roads and accessible transportation facilities in rural areas. In

fact, according to the Ethiopian Welfare Monitoring Survey (CSA, 2001), nearly 90% of the health service users must travel on foot to get to the nearest hospital/health center/health clinic. A recent study by the World Bank (World Bank, 2005) also points out that access to modern health care is particularly difficult to mothers and children.

As a consequence, Ethiopia's records on child and maternal health have remained rather dismal for many decades. With only 26% and 5% of the pregnant women getting antenatal care and delivery care by trained health professional, respectively, Ethiopia has one of the lowest maternal health services in sub-Saharan Africa (World Bank, 2005). As a consequence of restricted access to modern health care, over 800 maternal deaths occur for every 100,000 live births in the country, and many of the pregnancies are at high risk (FMOH, 2006). Likewise, one in every ten and one in every six babies born in the country dies before celebrating the first and fifth birth day, respectively (World Bank, 2005).

To ameliorate the above-mentioned and other related health problems, Ethiopia has launched an innovative community-based Health Services Extension Program (HSEP) in 2003 at national level. The program has been rolling out in a stepwise fashion to reach full coverage of all rural villages by 2009/2010. By the end of 2006/07, the program had covered about 57% of the rural villages in the country.

The primary purpose of the HSEP is to improve access and utilization of health care especially by children and mothers in the country. HSEP is part and parcel of the country's Health Sector Development Program, which was launched in 1997/98. The program marked a major move from Ethiopia's traditional system of facility-based health care services in a number of ways. In the first place, its primary approach is preventive and promotive health care as a way to reduce the health problems confronting the large majority of rural communities and families in

Ethiopia. HSEP aims at promoting and protecting health to its beneficiaries by assigning health extension workers, who apart from seeking out patients from the health post, are actively engaged in visiting them in their homes rather than waiting for them to come to them. Secondly, the program has tremendously expanded the construction of health posts and deployed thousands of young female health extension workers throughout the country.

An important policy question regarding the Ethiopian HSEP is to evaluate the impact it has brought to its target beneficiaries. In fact, evidence from previous studies elsewhere in developing countries show that health reform programs could have either positive, negative or negligible effects on its target population (Frankenberg, 1995). Recent empirical studies in Indonesia (Johar, 2009; Frankenberg *et al.*, 2005), China (Wagstaff and Yu, 2007), Columbia (Gaviria *et al.*, 2006), for example, found mixed results regarding the impact of health care programs on intended beneficiaries. Wagstaff and Yu's (2007) study on impact of the World Bank's Health project in China yield mixed findings regarding the impact of the project on its intended health outcomes. Among others, the authors found a significant reduction on days of illness as a result of the project on one hand and a significantly negative effect on child immunization coverage on the other hand. They also found little or no impact on either outpatient visits or inpatient admissions.

Thus, given the lack of previous impact studies on the Ethiopian HSEP, this study would provide some policy relevant insights into the performance of the program. In particular, this study will examine the impact of the program on health status indicators of mothers and children as these are the primary target beneficiaries of the program. This study also contributes to the program evaluation literature in several important directions. It demonstrates a practical

application of a non-experimental program evaluation technique to study program impact in health and other sectors of a similar setting.

In this paper we combined propensity score matching and regression adjustment to estimate the impact of Ethiopia's HSEP on several measured child and maternal health outcomes. The underlying principle in propensity scores matching is to find comparable treatment and control observations which have statistically identical distribution of pre-treatment observable characteristics.

The remaining part of the paper is structured as follows. Section 2 presents the description of the Ethiopian HSEP. Section 3 presents the empirical strategy of the study followed by the presentation of results and discussion in Section 4. Section 5 concludes the paper.

## **2. Description of the program**

Launched in 2003, the HSEP trains and assigns to every rural *Kebele*<sup>3</sup> two health extension workers (HEW) to deliver primary health care services to community and households. According to the HSEP implementation guideline, health extension workers are expected to spend 75% of their time in the field conducting outreach services by going from house to house and the remaining time at the health post. As mentioned earlier, HSEP is a community-based intervention program with a package of basic preventive, promotive, and selective curative services such as malaria and diarrhea.

The program gives special attention to mothers and children and operates from a health post. As of June 2007, the HSEP deployed 59% (17,653) of the total number of HEWs required

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<sup>3</sup> *Kebele* is the lowest administrative unit in Ethiopia. It usually has an estimated average population of about 5000 people. In this paper, we use village and *Kebele* interchangeably.

for the full implementation of the program and also constructed 66% (9,914) of the total number of required health posts (FMOH, 2007).

Rural villages have been included into HSEP in a stepwise manner and in fact the speed and intensity of the program implementation varies across the regions, as may be expected in a decentralized health system. From our discussion with health officials during the field survey, it was evident that the initial rollout of the villages into the program was largely influenced by several factors including the availability of essential inputs for the implementation of the program. As already noted, readiness to raise resources for the construction of health post and the presence of secondary school female graduates in the village or other villages in the same *Woreda* have been important criteria for receiving the program. From the supply side, availability of a health center<sup>4</sup> nearby the village and also the village's history of poor child and maternal health outcomes, and other health problems<sup>5</sup> have been considered.

The HEWs are 10<sup>th</sup> grade graduates who are trained for about a year on basic health care services, which have several components. Among others, HSEP envisages to deliver accessible and equitable services on maternal and child health, immunization services, nutrition, adolescent reproductive health, water and sanitation, malaria prevention and control, and health education and communication (FMOH, 2005).

According to the information from the FMOH, the program is designed to incur about 234 USD per month per HEW for training, 178 USD per HEW for apprenticeship practices and

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<sup>4</sup> According to the HSEP implementation guideline, a health center serves for approximately 25,000 people and acts as nucleus for five neighboring health posts.

<sup>5</sup> In some districts, some villages decided to start implementing the program with inputs which is less than (both in quantity and quality) what is indicated in the program's implementation guideline. For instance, finding program villages with one health extension worker and insufficient availability of drugs and other facilities to the health post were common during our field work.



83.4 USD in the form of monthly salary per HEW. The construction cost of a health post is estimated to be about 75,000 USD (see Appendix A for details).<sup>6</sup> The resources for the implementation of HSEP come from various contributions such as the government, international donors, and local communities. In some instances it has been found that the beneficiary communities contribute about 50% of the resources needed for the construction of the health post. Procuring and providing essential medicines and supplies is the main responsibility of the Federal Ministry of Health and Regional Health Bureaus and the *Woreda*<sup>7</sup> Health Offices.

### **3. Empirical method**

#### **3.1 Sampling strategy and Data**

This study was conducted in three administrative regions (Amhara, Oromia, and Southern Nations, Nationalities and Peoples Region) and ten districts located in these regions. The regions and districts were purposively chosen based on (1) the possibility that both HSEP and non-HSEP *Kebeles* exist in the respective districts during our field work and (2) the fact that these regions have been implementing the program for at least two years before the survey. In identifying the sample *Woredas*, we have consulted the health extension personnel at the respective regional and Zonal health offices.

After identifying the administrative regions and *Woredas*, we carried out village, facility (health post) and household level surveys to obtain empirical data needed for the study. More specifically, our empirical analysis was based on data collected from random samples of 128

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<sup>6</sup> This cost is for the construction of a standard concrete HP and local labor. The actual costs of HP construction may be less than this since in many localities HPs are constructed with mud (not with concrete) and also labor are freely contributed by the local population.

<sup>7</sup> A *Woreda* in the Ethiopian administrative structure is equivalent to a district and in this paper we use the two terms interchangeably.

villages (69 treatment villages and 59 comparison villages) and 3,095 households (1,482 households from treatment villages and 1,613 households from control villages). As a whole, the sample included 3,396 children under age five, 3,540 females in the age group 15-49. Village and household sample sizes were determined using power calculation in Stata software.

The sample frame for treatment villages included those which enrolled in the program since 2003/04 and 2004/05. In doing so, we sought to capture short-and intermediate-term child health and maternal health indicators that are likely to be affected by the program by the time of our field survey. On the other hand, comparison villages include those which have not been exposed to the program prior to the survey.

Three separate questionnaires were used to collect data from villages, households and health extension workers. Data collection from both treatment and control villages took place simultaneously. As pointed out by Heckman *et al.* (1997) this procedure helps to ensure that “outcomes and characteristics are measured in the same way for both groups”. The village survey, and the household survey and health extension workers survey were carried out in May and June 2007 and in October and November 2007, respectively.

During the village survey we gathered data on a wide range of village characteristics including access to social and market infrastructure, agro-ecology, health status, demographic and population characteristics. The data on these characteristics were obtained by interviewing a group of persons including village leaders and elders who have adequate experience and knowledge about socioeconomic development and other issues about their village. As already noted, the HSEP targets villages and hence our knowledge of village characteristics would enable us to account for initial differences between the two groups of villages in our analysis of program impact. To capture this matter, then, our village level survey was designed to elicit

information on pre-intervention attributes of the sampled villages based on respondents' recall on several aggregate characteristics. On the other hand, the household survey collected a wide range of data on several topics including socioeconomic and demographic variables, access to and utilization of health services by children and mothers, and other health related characteristics. The health extension worker questionnaire gathered data on availability of drugs and other medical facilities at the health posts, and on the demographic characteristics of health extension workers.

### **3.2 Impact evaluation method**

The basic problem for any program evaluation is to identify and quantify a counterfactual outcome. In other words, this entails knowing what would have happened to an individual's welfare indicator or outcome of interest had the program not been in place. In a randomized experimental design, the impact of a program can be estimated by a simple difference in means between treatment and control outcomes. Since we do not have such a design in this study, we used a propensity score matching method (Rosenbaum and Rubin, 1983), which has become the most widely applied non-experimental tool for impact evaluation of social programs (see e.g., Heckman *et al.*, 1998; Heckman *et al.*, 1997; Dehejia and Wahba, 2002; Jalan and Ravallion, 2003).

Program evaluation using a propensity score matching requires a series of steps. First, we fitted a logit model using pre-intervention/pre-exposure covariates ( $Z$ ) to estimate the propensity that a village is included into the treatment ( $T = 1$ ) or not ( $T = 0$ ). Second, and upon estimating the propensity scores, a relevant matching estimator is called for to match the treatment observations with comparable comparison observations using the propensity scores. An

important precursor to ensure the quality of matches is to impose what is known as “the common support condition” in which  $0 < P(T = 1|Z) < 1$  is satisfied. Discarding observations outside the common support region is an essential decision to ensure that observations with the same vector of covariates have the same probability of becoming treatments, and comparisons (Heckman *et al.*, 1997).

In the present study we used a kernel matching estimator to compute counterfactual outcome for each treated observation. Kernel matching estimates counterfactual outcome for each treatment observation based on the weighted average of all comparison observations, with the weights reflecting their relative closeness to the treated observation (Dehejia and Wahba, 2002; Heckman *et al.*, 1997).

The difference in health status between treatment and matched control villages is then computed. The *ATT* is obtained by averaging these differences in health outcomes ( $H_i$ ) across the  $k$  matched pairs of villages<sup>8</sup> as follows:

$$ATT|_{T=1} = \frac{1}{k} \sum_{i=1}^k [H_i^{i \in T=1} - H_i^{i \in T=0}] \quad (6)$$

To obtain unbiased impact estimates, the approach described in (6) identifies treatment and comparison villages with statistically identical distribution of the pre-treatment observable covariates, which entered into the propensity score function. When this assumption is violated, it is recommended to re-estimate the propensity scores function using alternative specifications of the covariates (Dehejia and Wahba, 1999, 2002) or to combine the propensity score matching

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<sup>8</sup> In the literature on impact evaluation, PSM is applied at village, household, and individual levels. In our study, we run PSM at the village level to balance distribution of covariates and track health gains as a result of exposure to HSEP. Among others, data aggregation to village level may reduce measurement error (Jalan and Ravallion, 2003). Moreover, PSM at village level is suitable to Ethiopia’s HSEP setting since the village is the primary target of the program.

with regression technique to further adjust the distribution of unbalanced covariates<sup>9</sup> (Abadie and Imbens, 2006; Glazerman *et al.*, 2003; Fredriksson and Millimet, 2004). In this paper we used the later approach since some covariates still have significantly different means between the two groups after trying alternative specifications using the former approach.

### **3.3 Choice of outcome indicators**

Although HSEP has several components, in this study we focus our attention on evaluating its short-term and intermediate-term impact on the health status of children and mothers. Regarding child health, the main indicators were rate of immunization against six major childhood illnesses: tuberculosis, diphtheria, whooping cough (pertussis), tetanus, polio, and measles. For diphtheria, whooping cough and tetanus, termed as DPT hereafter, and polio information was elicited on the number of injections or oral doses obtained. Normally three shots are given for DPT and polio (excluding the one given at birth). To measure morbidity, we gathered information on the incidence and duration of diarrhea, and cough in two weeks preceding the survey. In this connection, we also gathered data on households' utilization of curative care services for their children. Furthermore, information on usage of insecticide treated bednets (ITN) was elicited. In testing whether or not the program has influenced breastfeeding behavior, we used length of exclusive breast feeding among children aged between six and sixty months inclusive by the time of the survey. Similarly, we used several indicators to measure the program's effect on maternal health. In particular, we looked at a mother's utilization of antenatal health services such as visit to or consultations by skilled health personnel during pregnancy, tetanus toxoid injection,

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<sup>9</sup> Our regression adjustment, each indicator of health outcome was regressed against treatment status indicator, and unbalanced covariates using the matched observations.

vitamin A intake, delivery attended by skilled health professional, and up take of postnatal health care service. The study also evaluates the impact of the program on use of ITN by mothers and children. Last, but not least, we computed latrine usage to determine the effect of the program on sanitation behavior and uptake of modern contraceptive methods among females in the 15-49 age group to get an insight on the effect of the program on family planning.

## **4. Results and discussion**

### **4.1. General descriptive statistics**

As pointed out earlier, a village level survey was carried out to acquire village level information. Consequently, several village level variables were collected and considered in this study. Table 1 shows the descriptive statistics of the main village level characteristics for all the surveyed villages. Four out of five villages surveyed have a primary school and nearly 40% of them have adult basic education. About three-quarters of the surveyed villages are located more than 20 kilo meters away from secondary school.

Credit and saving institutions and agricultural extension agents are operating in 12% and 78% of the villages, respectively. The surveyed villages appeared to have had various human health problems in the past. The descriptive results, for instance, indicate malaria and water borne diseases were the major diseases in 52% and 67% of the sampled villages. The village survey results also indicate that only 13% and 33% of the villages use sanitary latrine and solid waste composting. These results imply that access to improved sanitation services is inadequate in the study areas. On the other hand, only 15% of the villages get their primary drinking water supply from protected streams or pipe. Rivers, lakes, dams, unprotected streams were the primary sources of drinking water for nearly 63% of our sample villages.

Access to health facilities has always remained difficult in Ethiopia. Most of the villages in our sample are located in remote areas and have been poorly served by the available health facilities. On average, villages in our sample are located nearly 50 kilo meters, 18 kilo meters, and 17 kilo meters away from the nearest hospital, health center and clinic. In contrast to access to health infrastructure, our descriptive results show that physical access to primary school is high in almost all of the villages we studied even though distance from the nearest secondary school remains a challenge.

**Table 1: Descriptive statistics for all villages using baseline characteristics**

<b>Variables</b>	<b>Variable type</b>	<b>Mean</b>	<b>Standard deviation</b>
Adult basic education facility in village, 1 if present	dummy	0.169	0.376
Literacy rate in village (%)	continuous	37.492	17.477
Distance from nearest primary school in kilo meters	continuous	2.620	17.106
Distance from nearest secondary school in kilo meters	continuous	27.081	29.446
Distance from district capital in kilo meters	continuous	22.860	17.899
Distance from nearest asphalt road in kilo meters	continuous	39.351	49.906
Distance from nearest health center in kilo meters	continuous	17.801	14.976
Distance from nearest clinic in kilo meters	continuous	16.948	15.517
Distance from nearest hospital in kilo meters	continuous	48.489	28.915
Primary drinking water source is unprotected stream, 1 if yes	continuous	0.307	0.463
Primary drinking water source is river, lake or dam, 1 if yes	dummy	0.321	0.468
Primary drinking water source is borehole or dug well, 1 if yes	dummy	0.146	0.354
Primary drinking water source is protected stream or pipe, 1 if yes	dummy	0.153	0.362
Primary drinking water source is other facility, 1 if yes	dummy	0.073	0.261
Village is located in Oromia State, 1 if yes	dummy	0.462	0.501
Village is located in Amhara State, 1 if yes	dummy	0.276	0.449
Village is located in SNNPR State, 1 if yes	dummy	0.262	0.441
Malaria occurred in village, 1 if yes	dummy	0.523	0.501
Water borne disease occurred in village, 1 if yes	dummy	0.676	0.469
Agricultural extension agents in village, 1 if present	dummy	0.775	0.419
Agricultural cash crop in village, 1 if present	dummy	0.854	0.355
Low altitude ( <i>kola</i> ) area in village, 1 if present	dummy	0.369	0.484



Credit and saving institution in village, 1 if present	dummy	0.116	0.322
Number of major ethnic groups in village	continuous	1.976	1.082
Composting was the primary solid waste disposal method, 1 if yes	dummy	0.328	0.471
Latrine as the primary toilet facility, 1 if yes	dummy	0.131	0.339

#### **4.2. Pre-intervention differences between treatment and comparison villages**

The village level information was disaggregated according to the treatment status of each village to gain a better understanding of the treatment and comparison villages. Table 2 presents descriptive results of different village characteristics disaggregated by HSEP status, namely treatment and comparison villages. There was a significant difference between the two village groups in terms of their physical access to health facilities. However, the two groups have significantly differential physical access to health center. For instance, treatment villages were, on the average, located 18 kilo meters away from the nearest health center whereas the figure for comparison villages was around 14 kilo meters.

It is also observed that treatment villages had significantly larger proportion of literate population than comparison villages. In terms of their agricultural production, treatment villages have better experience than comparison villages. Both treatment and comparison villages showed similar characteristics regarding their physical access to road, distance from district capital and distance from nearest school infrastructure.

**Table 2: Summary of pre-intervention characteristics for treatment and comparison villages, before (after) matching**

<b>Variable</b>	<b>Treatment village mean</b>	<b>Comparison village mean</b>	<b>Difference in means <sup>a</sup></b>
Adult basic education facility in village, 1 if present	0.157 (0.161)	0.183 (0.149)	-0.37 (0.82)
Literacy rate in village (%)	40.881 (40.018)	35.017 (42.371)	1.89* (-2.77)***
Distance from nearest primary school in kilo meters	1.298 (1.357)	1.103 (1.148)	0.52 (0.29)
Distance from nearest secondary school in kilo meters	24.03 (22.732)	26.431 (24.381)	-0.55 (-0.56)
Distance from district capital in kilo meters	23.552 (22.929)	20.328 (19.357)	1.09 (0.18)
Distance from nearest asphalt road in kilo meters	28.851 (28.411)	34.931 (29.511)	-0.93 (0.04)
Distance from nearest health center in kilo meters	18.239 (17.625)	14.569 (15.263)	1.75* (0.79)
Distance from nearest clinic in kilo meters	15.746 (16.411)	15.724 (15.958)	0.01 (-0.32)
Distance from nearest hospital in kilo meters	48.179 (46.464)	45 (47.243)	0.65 (-0.45)
Primary drinking water source is unprotected stream, 1 if yes	0.286 (0.303)	0.333 (0.238)	-1.11 (-0.06)
Primary drinking water source is river, lake or dam, 1 if yes	0.373 (0.351)	0.293 (0.311)	0.236 (1.39)
Primary drinking water source is borehole or dug well, 1 if yes	0.104 (0.125)	0.206 (0.091)	2.589* (1.31)
Primary drinking water source is protected stream or pipe, 1 if yes	0.209 (0.161)	0.103 (0.255)	2.48 (-2.07)***
Primary drinking water source is other facility, 1 if yes	0.059 (0.054)	0.052 (0.105)	0.019 (-1.12)
Village is located in Oromia State, 1 if yes	0.460 (0.411)	0.533 (0.299)	-1.84* (3.48)**
Village is located in Amhara State, 1 if yes	0.329 (0.304)	0.217 (0.385)	1.7* (-1.9)*
Village is located in SNNPR State, 1 if yes	0.271 (0.285)	0.250 (0.315)	0.35 (-1.85)*
Malaria occurred in village, 1 if yes	0.567 (0.571)	0.482 (0.597)	0.705 (-2.30)**
Water borne disease occurred in village, 1 if yes	0.716 (0.696)	0.637 (0.549)	0.968 (-0.19)
Agricultural extension agents in village, 1 if present	0.835 (0.839)	0.741 (0.909)	0.904 (-1.39)

Agricultural cash crop in village, 1 if present	0.895 (0.893)	0.810 (0.909)	1.901 (-1.35)
Low altitude ( <i>kola</i> ) area in village, 1 if present	0.328 (0.357)	0.414 (0.405)	0.738 (-0.28)
Credit and saving institution in village, 1 if present	0.119 (0.107)	0.121 (0.085)	0.007 (1.5)
Number of major ethnic groups in village	1.970 (1.946)	1.931 (1.973)	0.20 (0.08)
Composting was primary solid waste disposal method, 1 if yes	0.328 (0.357)	0.293 (0.337)	0.101 (-1.5)
Latrine as a primary toilet facility, 1 if yes	0.119 (0.125)	0.121 (0.151)	-0.02 (-0.86)

Figures in parentheses are means of variables for treatment and comparison groups after matching. \*represent statistical significance of 10%. <sup>a</sup> The t-tests for the equality of means of the variables between the treatment and comparison groups are performed using the command `pstest` in Stata.

#### 4.4. Estimation of propensity scores

The logit model estimation results of village participation into the HSEP are reported in Table 3.

The estimation was run with STATA 9.0 Software using the Stata code written by Leuven and Sianesi (2003). The dependent variable of the logit model takes a value of 1 if a village is a treatment village and 0 if it is a control village. The covariates, which were included in the logit model, refer to pre-intervention characteristics of the treatment and comparison villages. The variables included in the model are assumed to affect not only a village's participation in the program but also our measures of health outcomes.

Several authors have noted that choosing relevant covariates is a difficult task in the empirical evaluation of social programs. Unfortunately, however, there is no universal rule available for researchers on which covariate to include (or exclude) in the propensity score specification (Caliendo and Kopeinig, 2005; Smith and Todd, 2005). In this regard, researchers can get useful guide from economic theory, previous empirical studies and institutional setting (Smith and Todd, 2005). In this paper, covariates were chosen to reflect villages' inclusion criteria (based on our discussions with district health officers and villagers), and main findings of previous studies (e.g., Mekonnen and Mekonnen, 2002; Kimhi, 2003; Kebede, 2005) which

show that health outcomes in rural areas of Ethiopia are related to both supply-side factors and demand-side factors. The 2000 and 2005 Ethiopia Demographic and Health Surveys (CSA, 2000, 2005) also show the presence of substantial discrepancies in access to and utilization of health services, and health status across geographic locations, administrative regions and different socioeconomics groups. Thus, we decided to incorporate different sets of covariates into village participation model to control for heterogeneity resulting from various sources.<sup>i</sup> In other words, we tried to include all relevant village characteristics that may influence the villages' eligibility for initial enrollment into HSEP and/or demand for health care services.

The mean propensity score for the entire sample villages is 0.53 with a standard deviation of 0.24. However, the mean propensity scores significantly differ between the treatment and comparison villages. Prior to matching, the mean propensity score was estimated to be 0.64 (standard deviation of 0.21 with a range of 0.090 to 0.972) and 0.40 (standard deviation of 0.22 with range 0.029 and 0.94) for treatment and comparison villages, respectively. After the matched samples were formed, the difference in the mean propensity scores has become extremely small or statistically not significant. Furthermore, the pseudo- $R^2$  value declined by two-percentage points indicating that the matching has helped us minimize differences in observable characteristics between the two groups.

This paper used empirical data from 125 to 128 village observations depending on variables of interest for our estimation of impact.. A positive/negative coefficient of a covariate on the estimated logit model implies village participation in the HSEP had been positively/negatively influenced by that covariate. In other words, a statistically significant covariate coefficient indicates that treatment and comparison villages had a marked pre-

intervention difference with respect to the covariate. In this spirit, the estimated logit model provides evidence that participating villages were located farther from health centers, and primary schools (see Table 3). At the same time the likelihood of participation in HSEP was positively associated with proximity to secondary school and to tarmac/asphalt road even if these associations are not statistically significant. Regional characteristics have also influenced initial participation into the program significantly. Controlling for other factors, villages in Amhara were more likely than villages in Oromia to be enrolled into the program.

As expected, villages which have experienced waterborne diseases were more likely to be in the program. The presence of government agricultural extension agents in a village has positively influenced the village to participate in the health extension program. But, this effect remains statistically weak. We estimated the impacts of the program using different matching estimators and chose kernel matching with a band width of 0.25 based on consideration of its matching quality and the resulting sample size based on our dataset.

**Table 3: Logit estimates of village's participation in health extension program**

Variables	Coefficients	Standard errors
Adult basic education facility in village, 1 if present	0.180	0.657
Literacy rate in village (%)	0.013	0.015
Distance from nearest primary school in kilo meters	0.237	0.129**
Distance from nearest secondary school in kilo meters	-0.016	0.019
Distance from district capital in kilo meters	-0.002	0.021
Distance from nearest asphalt road in kilo meters	-0.003	0.013
Distance from nearest health center in kilo meters	0.093	0.033***

Distance from nearest clinic in kilo meters	-0.043	0.025
Distance from nearest hospital in kilo meters	0.014	0.009
Primary drinking water source is unprotected stream, 1 if yes	Reference group	
Primary drinking water source is river, lake or dam, 1 if yes	0.808	0.578
Primary drinking water source is borehole or dug well, 1 if yes	-0.158	0.727
Primary drinking water source is protected stream or pipe, 1 if yes	1.303	0.790*
Primary drinking water source is other facility, 1 if yes	1.704	1.255
Village is located in Oromia State, 1 if yes	Reference group	
Village is located in Amhara State, 1 if yes	2.159	0.766***
Village is located in SNNPR State, 1 if yes	0.967	1.120
Malaria occurred in village, 1 if yes	-0.234	0.549
Water borne disease occurred in village, 1 if yes	1.164	0.614**
Agricultural extension agents in village, 1 if present	0.545	0.586
Agricultural cash crop in village, 1 if present	1.092	0.742
Low altitude (kola) area in village, 1 if present	-0.502	0.729
Credit and saving institution in village, 1 if present	-0.105	0.753
Number of major ethnic groups in village	0.113	0.270
Composting was the primary solid waste disposal method, 1 if yes	0.286	0.983
Latrine was the primary toilet facility, 1 if yes	-0.104	0.755
Intercept	-5.157	1.591***
Number of observations = 125 LR chi2(24) = -35.80* Pseudo-R <sup>2</sup> = 0.207 Log likelihood = -68.418		

\*\* and \* represent statistical significance at 5% and 10% levels, respectively.

## **4.5 Impact of the program on child and maternal health**

### **4.5.1 Impact estimates on child health**

From preventive care perspective, vaccination against childhood illnesses is an important objective of Ethiopia's HSEP. In this respect, we used eight different types of childhood vaccinations, namely three doses of DPT vaccines, three polio vaccines, a BCG vaccine and a measles vaccine for 12 to 60 months age children. The information on vaccination indicators were obtained from mother's self-reports and vaccination cards. After controlling for other confounding factors we found that HSEP has a significant effect on the demand for preventive child health care services in the treatment villages. One notable result in this respect is the effect of the program on vaccination coverage of under-five children. Table 4 reports impact estimation results based on propensity score matching alone and propensity score matching combined with regression adjustment technique.<sup>10</sup> As indicated in the table, significantly larger proportion of children located in the treatment villages are vaccinated against individual major diseases such as DPT, measles, polio, and BCG. In general we also found that the proportion of children who are fully vaccinated with BCG, polio, measles and DPT vaccines is significantly larger in the treatment villages. But, it is also important to note that the program effects vary across vaccines (see Table 4). In particular, the program resulted in significant uptake of vaccinations ranging between a seven (for polio 1) to fourteen (for DPT) percentage points. While encouraging these effects are for child immunization, stronger efforts are called for to reach the WHO and

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<sup>10</sup> From here on, results based on regression adjustment are obtained by regressing corresponding outcome indicator on village's treatment status and unbalanced covariates after propensity score matching between treatment and control villages, namely, illiteracy rate, availability of pipe or protected water source, dummy for two regions (Amhara region, and Southern NationsNationalities and People's region) and incidence of malaria.



UNICEF's Global Immunization Vision and Strategy which stipulates that by 2010 at least 90 percent of children are vaccinated in each member country.

However, the above analysis rests on the strong assumption that the gains are equally shared among the villages in the program areas. To test this assumption we extended our analysis by stratifying the treatment villages according to some demand and supply side observable characteristics and recovered the impact estimates based on propensity score matching. On the demand side, we used maternal education and on the supply side we used number of health extension workers and availability of drugs and other facilities at the health post to address this point. As can be seen in Table 5, the effect of the program on childhood immunization tends to vary according to the proportion of women in the village having some primary education (grades 1 to 8). This implies that encouraging and supporting primary schooling for girls and women will enhance the program's impact on proportion of children vaccinated against major childhood illnesses. This result is consistent with our a priori expectation and also corroborates with earlier findings for the Philippines (Bondy *et al.*, 2009), Nicaragua (Barham and Maluccio, 2009) and India (Lee, 2005).

Table 4: Impact of the program on proportion of 12-60 months age children vaccinated against major diseases

	<b>Polio 1</b>	<b>Polio 2</b>	<b>Polio 3</b>	<b>BCG</b>	<b>DPT3</b>	<b>Measles</b>	<b>Full immunization</b>
PSM	0.060* (0.032)	0.084** (0.037)	0.081* (0.045)	0.077* (0.046)	0.098** (0.048)	0.084* (0.051)	0.06 (0.055)
Adjusted treatment mean	0.867	0.859	0.832	0.808	0.815	0.735	0.661
Adjusted control mean	0.807	0.775	0.751	0.731	0.716	0.651	0.601
PSM and regression adjustment	0.057** (0.024)	0.077*** (0.028)	0.091*** (0.034)	0.093*** (0.032)	0.116*** (0.036)	0.118*** (0.039)	0.099** (0.042)

\*\*\*, \*\* and \* denote significance at 1%, 5% and 10% levels, respectively. The number of village observations used in the analysis is 106 (56 in the treatment villages and 50 in the control villages).

Table 5. Differential impact of the program on proportion of 12-60 months age children vaccinated against major diseases by maternal education

Vaccination type	Proportion of women with primary education <sup>a</sup>	Proportion of women with secondary education <sup>b</sup>
Polio 1	0.163* (0.087)	-0.425 (0.878)
Polio 2	0.183** (0.095)	0.361 (1.079)
Polio3	0.246** (0.111)	-0.236 (1.539)
BCG	0.229* (0.124)	-0.013 (1.255)
DPT3	0.115 (0.121)	-1.321 (1.523)
Measles	0.369*** (0.132)	-0.317 (1.547)
Full immunization	0.436*** (0.149)	0.268 (1.734)
Number of observations	56	56

Figures in parentheses are standard errors. \* indicates significance at 10%. The unit of analysis is treatment village after matching. <sup>a</sup> refers to grades 1 to 8, <sup>b</sup> refers to grades 9 to 12.

The impact of the program on proportion of children who got vaccines against major childhood illnesses also varies according to supply side variables (see Table 6). The program has larger effects in villages with one health extension worker and with better quality health posts<sup>11</sup>. Our findings also suggest that the program impact is smaller for villages with two health extension workers. *A priori*, this is unexpected. However, there may be several reasons for this. First, in the application of propensity score matching, villages with two health extension workers might have been matched with comparison village(s) with better performance. Secondly, comparison villages used for villages with one health extension workers may have poor access to alternative sources of health services for children. Third, the result might be related to placement criteria if program administrators have placed one health extension worker in a relatively better village when she is alone.

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<sup>11</sup>We used availability of drugs and other medical supplies at a health post as a proxy for quality of the health post. In this regard, a quality index is constructed for every health post by assigning to an item a value of 1 if it was available in the health post during time of survey and 0 otherwise, and eventually sum up all these values for all items and finally divide the total number of items.

Table 6: Differential impact of the program on proportion of children vaccinated against major diseases

<b>Stratified by number of health extension workers (HEW)</b>	Polio 1	Polio 2	Polio 3	BCG	DPT 3	Measles	Full immunization
One HEW	0.068*** (0.019)	0.053*** (0.021)	0.041** (0.022)	0.068*** (0.028)	0.096*** (0.026)	0.088*** (0.033)	0.047* (0.037)
Two HEWs	0.032 (0.024)	0.037 (0.032)	-0.0001 (0.041)	0.048* (0.032)	0.064* (0.044)	0.031 (0.047)	0.024 (0.047)
<b>Stratified by availability of drugs and other supplies at the health post (quintiles)</b>							
1(poor)	0.022 (0.049)	0.007 (0.063)	-0.027 (0.80)	0.071 (0.055)	0.044 (0.072)	-0.0001 (0.081)	-0.029 (0.076)
2	0.019 (0.030)	0.048 (0.026)	0.034* (0.022)	0.061* (0.042)	0.102*** (0.031)	0.052 (0.043)	0.075 (0.060)
3	0.086 (0.024)	0.067 (0.019)***	0.038* (0.023)	0.042 (0.052)	0.154*** (0.031)	0.058* (0.039)	-0.009 (0.055)
4	0.065 (0.053)	0.065 (0.056)	0.025 (0.075)	0.080 (0.066)	0.081 (0.080)	0.129* (0.088)	0.119 (0.091)

5(good)	0.129*** (0.032)	0.116*** (0.034)	0.106** (0.040)	0.131*** (0.043)	0.183 (0.055)	0.169*** (0.058)	0.179*** (0.051)
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Note: Figures in parentheses are standard errors. Each line reports results of hypothesis testing that mean impact in each group is equal to zero. All reported results are also based on the propensity score matching and units of analysis are treatment villages. \*\*\*, \*\* and \* denote significance at 1%, 5% and 10% level of probability, respectively.

In Table 7 we present the impact estimates of the program on childhood illnesses such as diarrhoea and cough. In looking at the effects on these indicators for both types of diseases it has been found that the incidences of diarrhoea and cough are larger in treatment villages than in comparison villages, *albeit* the estimated effect is statistically significant only for the former. The estimated results also show that the duration of illness due to diarrhoea is longer in the program villages. This effect is undesirable and contrary to *a priori* anticipation on the basis of the fact that one of the primary role of health extension agents is to reduce the incidence and duration of childhood illnesses in their working areas. Perhaps, there are two possible explanations for this. First, we relied on parents' own self-report to construct this variable and the resulting data may be prone to measurement error. However, as experiences (Dow *et al.*, 2000) elsewhere also indicate self-reporting in such contexts may also be prone to reporting bias as HEW provide people in the treatment group with the information about the diseases that lead them being more likely to report themselves or their family members including children as sick. Second, it may be also the case that the health services provided by the HEW to cure these diseases are of inferior quality compared to those available in comparison villages.

On a positive note, the estimated results indicate significantly larger proportion of under-five children in treatment villages using insecticide treated bed-net to protect against malaria. In particular, the program has increased usage of ITN by a 22 percentage points. The estimated result, which is not reported here to conserve space, also shows that the effect on this indicator is statistically identical among villages with different supply side characteristics (i.e. number of health extension workers and quality of health posts).

Table 7: Impact of the program on incidence and duration of diseases among children under five

	Adjusted treatment mean	Adjusted control mean	PSM	PSM and regression adjustment
Incidence of illness due to diarrhea (%)	0.179	0.135	0.045 (0.033)	0.002* (0.001)
Duration of illness due to diarrhea (number of days in last two weeks)	3.127	1.893	1.234*** (0.486)	0.027**(0.011)
Medical treatment received for diarrhea illness (% of cases)	0.362	0.305	0.056 (0.100)	-0.001 (0.002)
Incidence of illness due to cough (%)	0.291	0.203	0.087* (0.045)	0.002 (0.001)
Duration of illness due to cough (number of days in last two weeks)	3.151	2.662	0.489 (0.674)	0.020 (0.021)
Medical treatment for cough illness (% of cases)	0.167	0.227	-0.060 (0.048)	0.001 (0.001)
Insecticide treated bed-net use (%)	0.452	0.421	0.030 (0.092)	0.079* (0.045)
Duration of exclusive breastfeeding (months)	6.135	6.739	-0.604 (0.739)	-0.721 (0.511)
Proportion of children who received vitamin A supplementation	0.213	0.136	0.077 (0.073)	0.015 (0.038)

\*Significance at 5% level. Our analysis is based on 102 villages which fall in the region of common support.

#### **4.5.2 Impact estimates on maternal health services utilization**

Treatment and control villages show quite interesting outcomes on various maternal health indicators. After controlling for observable confounding factors, however, we found statistically significant program effects only for some of them. In particular, we find that pregnant women in the treatment villages were more likely to launch their antenatal care visit to a health professional significantly earlier than those in the comparison villages (see Table 8). Stated in other words, the program has reduced contact delay by about 29 percentage points and on average a pregnant women in the treatment village makes her first antenatal care visit before the first months of pregnancy, which is in fact a time line recommended by the World Health Organization (WHO, 1994) for pregnant women in developing countries. This is an encouraging effect given the fact that early contact with skilled health professional creates opportunities for early detection of and solutions to any signs of pregnancy dangers, and for motivating subsequent antenatal care demand in the future.

Apart from this, our findings do not show statistically significant effects on other indicators of maternal care. In fact, even if not significant statistically at the 10% or lower levels, treatment villages show better records on some maternal health indicators such as occurrence of antenatal care visit and vitamin A supplementation. The program also tended to decrease the proportion of home deliveries by nearly eight percentage points. In contrast, the negative effect of the program on skilled attendance is unexpected given that the program's strong emphasis to increase prenatal care and delivery assistance by health extension workers even at the patients' home. Caution is needed in interpreting this outcome as a good or bad indicator of program effect. According to the program's implementation guideline (FMOH, 2005), increasing percentage of women delivered by health extension workers or trained traditional birth attendants is among the main targets of the program. If this is so, then the strong negative effect of the



program on skilled attendance may not be seen as a bad outcome, because traditional birth attendants (trained or not trained) are not included in our definition of skilled attendance. However, it might be worth investigating to study the extent to which traditional birth attendants are capable of handling emergency obstetric if it had occurred during delivery.

We also find that the program has statistically significant effect on ITN usage among women in the program villages. Our estimated results, which are not shown here to conserve space, indicate that this utilization is currently 44% amongst women and that the effect of the program would be 8% lower without it.

We also measured the impact of the program on family planning and usage of contraceptives. The estimated results reveal that awareness about modern contraceptive methods is substantial (over 90 percentage points) in both treatment and control villages even if the effect of the program on this indicator appears to be statistically not significant. Despite this high level of awareness about modern contraceptive methods, actual utilization remains limited. For example, the proportion of women who has ever used any modern contraceptive is around 20 percent and the effect of the program remains statistically weak. Moreover, when we look at the proportion of females in the same age group who used any modern contraceptive method over the preceding 12 months, the effect also remains weak. The huge gap between awareness about the methods and its actual utilization in one hand and the lack of any stronger effect of the program on the other hand, may suggest supply side constraints such as the inadequate supply of contraceptives across the health posts in the treatment villages, or high price.

Table 8. Impact of the program on maternal health indicators

	Adjusted treatment Mean	Adjusted control mean	PSM	PSM and regression adjustment
At least one consultation during pregnancy (%)	0.123	0.101	0.022 (0.051)	-0.001 (0.025)
First contact with skilled health service provider during pregnancy (months)	3.782	5.383	-1.601*** (0.557)	-1.263** (0.418)
Tetanus toxoid injection (%)	0.278	0.274	0.004 (0.051)	-0.006 (0.035)
Vitamin A uptake (%)	0.084	0.05	0.034 (0.026)	0.022 (0.022)
Pregnant women who slept inside ITN last night (%)	0.438	0.425	0.013 (0.101)	0.081* (0.048)
Attended delivery (%)	0.057	0.130	-0.074*** (0.019)	-0.015 (0.012)
Delivery at home (%)	0.649	0.702	-0.053 (0.043)	-0.023 (0.033)
Postnatal consultation (%)	0.028	0.023	0.005 (0.011)	-0.0001 (0.008)
Females in 15-49 age who are aware of modern contraceptives (%)	0.923	0.931	-0.015 (0.021)	-0.008 (0.015)
Females in 15-49 age who have ever used any modern contraceptive (%)	0.206	0.210	-0.004 (0.036)	-0.007 (0.025)
Females in 15-49 age who used any modern contraceptives in last 12 months (%)	0.14	0.152	-0.011 (0.028)	-0.004 (0.019)

\*\*\* and \*\* denote significance at 1% and 5% levels, respectively. Both types of estimation were based on matched villages.

### 4.5.3 Impact estimates on sanitation services

The impact of the program on sanitation particularly on access to and utilization of latrine is also worth considering as promoting and supporting effective utilization of these services are among the duties of the HEWs. However, our findings indicate that the program does not have statistically significant impact on households' pit latrine usage among the treatment villages. An interesting impact of the program on sanitary practices is observed among the treatment villages. In particular, the program has larger and significant impact on regular usage of latrine for disposing children's faecal matter<sup>ii</sup> (see Table 9).

Table 9. Impact of the program on contraceptive use and sanitation services up-take

	Treatment group mean	Control group mean	PSM	PSM and regression adjustment
Households using latrine regularly (%)	0.516	0.401	0.115 (0.091)	0.058 (0.058)
Regular usage of latrine for disposing babies' refusal/faeces (%)	0.016	0.002	0.014*** (0.006)	0.011* (0.006)

\*\*\* and \*\* denote significance at 1% and 5%, respectively. Number of observations used in both propensity score matching and regression adjustment are 114 villages.

## 5. Conclusions

The primary purpose of this study has been to evaluate the short- and intermediate-term effects of the Ethiopian health services extension program on child and maternal health indicators. To achieve this objective we used propensity score matching and regression adjustment techniques for our empirical data analysis.

Our estimation results indicate that there are significant differences in health outcomes between treatment and comparison villages, which could be attributable to the presence of the HSEP in the treatment villages. Regarding child health, favourable effects were registered for preventive types of health care services. In particular, the program has statistically significant effect on child immunization against tuberculosis, polio, diphtheria-pertussis-tetanus (DPT), and measles. The impact on full immunization is also favourable and statistically significant. But, in contrast to the preventive health care services, the program has neither reduced the incidence nor the medical care seeking behaviour to treat illnesses due to diarrhea and cough for children. Quite unexpectedly, the estimated results show that the duration of illness due to diarrhea is significantly longer for children in the program villages. However, it is difficult to give exact explanation why this has happened given the fact that protecting and promoting child health is one of the main aims of the program. Perhaps, one may argue that this is a reflection of the program's low quality of the curative health services, increased understanding of the disease's symptoms as a result of the program or both.

The effect of the program on malaria prevention is strong. The proportions of under-five children and women who slept inside ITN are significantly larger in the program villages.

The effect of the program on maternal health indicators is also mixed. It appeared that the likelihood of antenatal consultation was slightly larger in the treatment villages than in the comparison villages. More importantly, relative to the non-program villages, pregnant women in the program villages make their first contact with skilled health service provider significantly earlier. This is an encouraging result since delays in first exposure to health professional is an important means for early screening for pregnancy related problems, which is the primary cause of maternal deaths in Ethiopia. However, the program did not have statistically significant effect

on prenatal and postnatal care service indicators even if most of the effects are on the right direction. Despite its small size in absolute terms, the program also has favourable impact on regular usage of pit latrine in the treatment villages. The effect of the program on regular usage of latrine is maximized when larger proportion of a village population has primary educational attainment.

### **Acknowledgement**

The authors are very grateful to the Global Development Network (GDN) and through it the Bill and Melinda Gates Foundation for financing this study under its sixth competitive research award funding program. The authors are highly indebted to Steven Glazerman, Ruth Levine, and Biggie Mabaera for many valuable discussions and comments on earlier versions of this paper. We would also like to acknowledge the contribution of the participants of the GDN's health project workshops in Beijing, New Delhi, Brisbane and at York, UK and to the project management team of GDN, especially Lyn Squire, Shubhashis Gangopadhyay, Ranjeeta Thomas, Vidya Damera, Manisha Singh, Sonam Sethi, Vandana Kumar and others. The authors also thank the Ethiopia's Federal Ministry of Health as well as the Regional Health Bureaus for their unreserved support and cooperation. The authors alone are responsible for the contents of the manuscript.

### Appendix A. Detail Unit Costs of the Health Extension Program

No.	Items	Unit of measurement	Cost per unit (in USD)	Remark
1	Monthly training of HEW	HEW	234	
2	Apprenticeship	HEW	178	
3	Integrated refresher training every two years	HEW	312	This cost includes costs of fuel, stationeries, per diems of trainees and trainers, hall rent, etc.
4	Monthly salary	HEW	83.4	
5	Construction of HP	HP	75,000	
6	HP equipments	HP	4263	

**Source:** FMOH, 2009.

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<sup>i</sup> Rubin and Thomas (1996) argue that a covariate should only be excluded from the model if there is consensus that it is either unrelated to the outcome or not a proper covariate.

<sup>ii</sup> Poor sanitation and inadequate hygiene are among the major causes of Ethiopia's health problems. In this respect, appropriate sanitary practices such as adopting proper disposal of children's faecal matter is regarded as an important measure to prevent and reduce the severity of diarrhea disease (CSA, 2005).

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## Appendix

**Table A1. Unit costs of the health services extension program**

No.	Items	Unit of measurement	Cost per unit (in USD)	Remark
1	Monthly training of HEW	HEW	234	
2	Apprenticeship	HEW	178	
3	Integrated refresher training every two years	HEW	312	This cost includes costs of fuel, stationeries, per diems of trainees and trainers, hall rent, etc.
4	Monthly salary	HEW	83.4	
5	Construction of HP	HP	75,000	
6	HP equipments	HP	4263	

**Source:** FMOH, 2009.

Table A2. Sensitivity analysis of impact estimates for some outcomes

Outcome variables	Matching algorithm		
	Nearest 2 neighbors	Nearest 5 neighbors	Radius matching (caliper=0.1)
Polio1	0.136* (0.074)	0.088 (0.062)	0.074** (0.034)
Polio2	0.176** (0.089)	0.118* (0.073)	0.092* (0.039)
Polio3	0.171* (0.091)	0.121* (0.076)	0.089* (0.046)
BCG	0.151 (0.1)	0.112 (0.088)	0.094* (0.048)
DPT3	0.199** (0.095)	0.157** (0.082)	0.109* (0.049)
Measles	0.085 (0.102)	0.074 (0.083)	0.108** (0.052)
Full immunization	0.097 (0.102)	0.079 (0.086)	0.084 (0.056)
Number of observations	[20, 16]	[20, 16]	[42, 39]

\*\* and \* denote significance at the 5% and 10% levels, respectively. Figures in the parentheses are the respective standard errors. Numbers in the squared brackets are the numbers of treatment villages and of comparison villages, respectively.

Table A3. Sensitivity analysis of impact estimates for some outcomes using kernel matching upon a subset of variables for the propensity score specification<sup>+</sup>

Outcome variables	Impact estimates
Polio1	0.067** (0.032)
Polio2	0.088** (0.037)
Polio3	0.096** (0.045)
BCG	0.078* (0.048)
DPT3	0.104** (0.49)
Measles	0.121** (0.052)
Full immunization	0.095* (0.055)
Number of observations	[62, 51]

\*\* and \* denote significance at the 5% and 10% levels, respectively. Figures in the parentheses are the respective standard errors. Numbers in the squared brackets are the numbers of treatment villages and of comparison villages, respectively. See Table A4 for details.

Table A4. Variables used for re-estimating propensity score function for robustness check

Variables
Literacy rate in village (%)
Distance from nearest primary school in kilo meters
Distance from nearest secondary school in kilo meters
Distance from nearest health center in kilo meters
Distance from nearest clinic in kilo meters
Distance from nearest hospital in kilo meters
Primary drinking water source is unprotected stream, 1 if yes
Primary drinking water source is river, lake or dam, 1 if yes
Primary drinking water source is borehole or dug well, 1 if yes
Primary drinking water source is protected stream or pipe, 1 if yes
Primary drinking water source is other facility, 1 if yes
Village is located in Amhara State, 1 if yes
Village is located in SNNPR State, 1 if yes
Malaria occurred in village, 1 if yes
Water borne disease occurred in village, 1 if yes
Low altitude (kola) area in village, 1 if present