# The Impact of Community Midwives on Maternal Healthcare Utilization

## 1. Introduction

### 1.1 Motivation

Globally 800 women die every day from preventable causes related to pregnancy and childbirth. Ninety four percent of these maternal deaths are from developing countries, with one in every five occurring in the South Asian region.[1] For Pakistan, the fifth most populous country in the world, the Maternal Mortality Ratio (MMR) stands at 178 deaths per 100,000 live births compared to just 12 in the developed world (UNICEF 2019). Half of all maternal deaths worldwide occur in six countries; Pakistan is one of them (Hogan et al. 2010).

High maternal mortality rates in developing countries such as Pakistan are associated with low proportion of deliveries attended by Skilled Birth Attendants (SBA) (Girum and Wasie 2017). Out of an estimated 4-5 million births per year in Pakistan, less than one in every two is attended by a skilled health personnel.[2] The rate of pre-natal checkups is also low, with less than 40 percent women receiving four or more pre-natal checkups and one in every three receiving no pre-natal care at all (PDHS 2007).

To address this issue of low utilization, and the broader goal of reducing maternal deaths, the Government of Pakistan drafted the Maternal Newborn and Child Health (MNCH) Policy in 2005. One of the major tools employed was the introduction of Community Mid-Wives (CMWs) as front line health workers. In this study, I estimate the impact of deploying CMWs on maternal

[1] http://www.who.int/mediacentre/factsheets/fs348/en/

[2] The number of births is based on the birth rate according to www.data.worldbank.org/. The rate of skilled birth attendance is based on the data used in this study (See Table 1).

healthcare utilization at the time of giving birth as well as during pregnancy and post-partum.

### 1.2. The Pakistani Context

The Pakistan Demographic and Health Survey (PDHS) of 2006-07 shows that pregnancy related illnesses are the leading cause of death for women of childbearing age (PDHS 2007). Pakistan ranked 149, out of 179 countries in the world, on the Mother's Index Rank in the year 2015 (Save the Children 2015). The state of maternal health in Pakistan maybe attributed to both demand and supply side problems. The low demand for professional maternal health care is associated with low female literacy, lack of trust in medical professionals in favor of local traditional practitioners and low mobility of women. On the supply side, lack of healthcare facilities that provide appropriate pre-natal care, limited access to emergency obstetric and newborn care and lack of SBAs are often cited as the main reasons for high maternal deaths (Technical Resource Facility 2013).

Pakistan's MNCH policy of 2005-06 was designed to improve the high maternal, infant and child mortality rates in the country, with the aim of bringing these numbers in line with the Millennium Development Goals. In particular, the program aimed to achieve these goals by increasing utilization of pre-natal care, institutional births and presence of skilled attendants at birth. One of the major tools employed was the introduction of Community Mid-Wives (CMWs) as front line health workers; a concept new to Pakistan's healthcare system. The program was inspired by Indonesia's Village Midwife Program of early 1990s, which introduced more than 50,000 midwives in rural areas of Indonesia (Shrestha 2010). The Pakistan government envisioned the program to expand up to one CMW per 5000 of the population in the very long term, with a short term goal of each CMW being assigned to a catchment area of 10,000 (Government of Pakistan 2006).

The eligible candidates for CMW training were females aged 18-35 years, who had cleared the national level matriculation exam (10th grade). Women from all regions of the country were to be recruited, trained and deployed back in areas of their residence and origin, where they would have both the knowledge about and trust of the local communities, making it easier for the locals to accept their role. The selected candidates were trained in-class for a year at one of the certified institutes of Pakistan Nursing Council, followed by six months of field training.[3]

Pakistan, on average, invests less than 4.2 percent of its overall budget in health, which is low compared to other comparable countries in the region such as Sri Lanka (11.17%), Indonesia (6%), Bangladesh (5.7%), and India (5%).[4] Training and deploying CMWs is a relatively low cost solution to address the problem of maternal health and increase the number of skilled front line workers to assist in deliveries. CMWs can be trained in a much shorter time period (18 months) and at a lower cost in comparison to doctors and nurses. Other developing countries like, Indonesia, Sri Lanka and Sierra Leon, have in the past used CMWs to address maternal and infant health.[5]

While inherently a supply side intervention, the policy also catered to barriers in demand by ensuring CMWs were placed back in areas of their origin upon successful completion of training. Being accustomed to the local language, culture and community would help the CMWs in reaching out to women in their areas and the familiarity would make the local community more receptive to them. Upon deployment, their role was to provide individualized care to the pregnant women throughout the maternity cycle and subsequently to the newborn. It was expected that the interaction of the local women with these CMWs would change health-seeking behaviors by impacting the take up of pre- and post-natal visits, and the rate of skilled birth attendance.

[3] See Appendix B for details of the program
[4] Data retrieved from http://apps.who.int/gho/data/
[5] See Weaver et al. (2013); Ngongo et al. (2013); Siriwardhana, Pathmeswaran & Wickremasinghe (2019)

Additionally, the CMWs were trained to identify actual or anticipated conditions requiring medical attention and make timely referrals of obstetric and newborn complications, bringing down the number of deaths due to untreated complications.[6]

In terms of roll out and implementation, deployment of CMWs to their respective catchment areas started in 2008. By 2013, 45% of the planned 12,000 CMWs were trained, out of which 64% were deployed successfully (Technical Resource Facility 2013).

### 1.3 Existing Evidence on CHWs and CMWs

Community Health Workers (CHW) are defined as members of the community who are trained to promote health or carry out some healthcare services (Lipp 2011). These workers traditionally act as a bridge between the health care delivery system and the community, leveraging their ability to help others due to their knowledge of the communities they serve and the close bond they are able to form with them (Kowiit 2015). Recently, there has been a renewed interest in CHWs. In particular, developing countries are especially interested in leveraging the cost effectiveness and outreach of these workers to remote areas. These workers can be trained in a much shorter time and at lower cost than doctors or nurses. CHWs are employed for various purposes. Improving maternal, infant and child health, increasing take up of immunizations and family planning services, promoting health seeking behavior, and awareness of diseases such as HIV and malaria are some of the most popular ones. In conservative regions, where women are traditionally restricted in physical movement, female workers are often very effective in reaching out to women who otherwise have limited access to healthcare services (Rahman et al. 2008;

[6] For details on the aim and objectives of the CMW program see Appendix B. These details are based on the information on the Maternal Newborn and Child Health Program (PC-1) document (Government of Pakistan 2006) and the Pakistan MNCH website.

Bolton, Bass & Neugebaur 2003; Ayias 2015). Numerous studies find strong support for CHWs, in terms of their association with better health behaviors and outcomes. In the U.S., they have been used to target disadvantaged communities as enablers of HIV testing (Massnegale, Morrison & Sudha 2016), health care of aging population (Kaur 2015), chronic disease measurement (Kim et al. 2016), and asthma interventions in children (Stephens et al. 2009), among others. In the developing world, they are found to be positively associated with breast-feeding practices, family planning, antenatal care, neonatal check-ups, and immunizations (Omer et al. 2008; Lipp 2011; Corluka et al., 2009).

In the early 1990s, Indonesia introduced a special cadre of CHWs, Community Midwives (CMWs), to deal with high fertility, maternal mortality and infant mortality rates. With over 50,000 CMWs introduced in rural areas under the program, evidence on the effectiveness of the intervention is mixed. Studies have shown that the program was ineffective in terms of increasing use of contraception (Weaver et al. 2013). Others find that while the deployment of a mid-wife in every village increased skilled birth attendance, it did not lead to timely referrals to specialized obstetric care for those in need of it (Ronsman et al. 2001). Evidence from an evaluation in Bangladesh shows reduced rates of maternal mortality from training and deploying midwives at the village level (Fauveau et al. 1991).

Studies evaluating the CMW program of Pakistan largely use qualitative techniques such as focus group discussions and interviews to assess outreach and effectiveness (See e.g. Noorani et al. 2013; Sarfraz and Hamid 2014; Ahmed et al. 2017). Other research evaluates the equity, class and social exclusion aspect of the program in selected districts (Mumtaz et al., 2012). These studies provide important insights into barriers to outreach and the effectiveness of the program. They are, however, often geographically restricted to one or two districts of the country (e.g.

Mumtaz et al. 2012 focus on two districts in Punjab, Ahmed et al. 2017 focus on 2 districts each in Punjab and Khyber Pakhtunkhwa), limiting the scope of their findings to the districts evaluated.

### 1.4 Purpose of the Study & Contribution

In this study, I pool six years of cross sectional household surveys in Pakistan to quantitatively analyze the impact of deploying CMWs on maternal health care utilization. I make use of information on maternal health care from over 90 districts in the country to assess the average impact at the national level.

This is, to my knowledge, the first attempt to study the impact of the program on a national scale. As discussed in the literature review, there are only a few studies around the world that use data to quantitatively assess the impact of frontline, low cost health workers. This study bridges the gap by evaluating the effectiveness of such workers for improving maternal health in developing countries and focuses on Pakistan- a country with one of the highest number of maternal deaths worldwide.

From a policy perspective, the study evaluates whether the deployment and training of CMWs is an effective policy tool in encouraging women to seek maternal health care. Results of the study provide information on whether this cadre of health workers might be part of an effective solution for improving maternal healthcare utilization for other developing countries faced with these issues.

## 2. Methods

### 2.1 Data

The study primarily employs the Pakistan Social and Living Measurement Survey (PSLM). The PSLM is a cross sectional survey conducted each year across the country, alternating between being representative at the district or provincial level.[7] The survey focuses on measuring progress toward the Millennium Development Goals (MDGs), along with detailed sections on employment and household wealth. The universe for the survey consists of all urban and rural areas of the main provinces of Pakistan, excluding Federally Administered Tribal Areas (FATA) and military restricted areas, which comprise 2% of the overall population. The data was obtained from the Pakistan Bureau of Statistics.

For this study, I use six years of the district level representative data sets for the years between 2004 and 2014. In each of these rounds approximately 75,000 households and their members were interviewed on questions related to employment, education, water and sanitation, household wealth and health, with specific sections on the health of children, and women of childbearing age. In addition, questions pertaining to health utilization and satisfaction with regard to available health services were also included in the survey. The relevant outcomes of interest for this study are from the section on women's health, which is applicable to women who had given birth in the three years prior to the survey. Details of the total sample size of PSLM for each round of the survey and the number of such women, over the six rounds used for estimation purposes in this study, are provided in Table A1.

[7] District is the third tier of governance in Pakistan, while province is the second after Federal.

I supplement this main data set with data on the deployment of CMWs at the district level. This data was obtained from the MNCH website.[8] The data provides information on the number of midwives deployed, disaggregated by district. Details on the number of CMWs in each district are provided in Table A2. Lastly, statistics related to population sizes and their growth rates, to help with per capita calculations, were obtained from the World Bank and reports from the Census of Pakistan 1998.[9]

Summary statistics for variables used in the study are shown in Table 1.[10] The average number of CMWs in a district is around 35, while some districts had no CMWs deployed as of 2008. Districts in Pakistan differ widely in population size. I therefore use CMW per 10,000 of the population as the main variable of interest.

The relevant sample for this study are women who are in the childbearing age (16-50 years). This yields a sample size of more than 173,000 observations over six rounds of the survey. The four outcomes of interest are binary indicators for (i) pre-natal checkup, (ii) post-natal checkup, (iii) birth attended by a SBA and (iv) birth at a medical institution. Table 1 shows that each of these are statistically different in the pre and post periods. Figure 1 shows the distribution of binary responses for each of these outcomes of interest in the pre- and post-treatment periods. In the pre-treatment period, one in every two women did not have any pre-natal check-ups. In the post period a larger proportion of women (64 percent) report seeking pre-natal care during pregnancy. In contrast, the number is much lower for post-natal checkups where only one in every four women underwent a post-natal examination in the pre-treatment period and the number increases to only 27 percent in the post period. In terms of healthcare at the time of delivery, only

[8] http://dynasoft.org/mnch/
[9] http://data.worldbank.org/indicator/
[10] For detailed description of the variables see Table A3

42 percent women had a skilled birth attendant assisting them at the time of delivery in the pre-treatment period. This proportion increased to 45 percent in the post-treatment period. We see a big change in the proportion of births occurring at a medical facility (as opposed to home). While only 29 percent women gave birth at a medical facility in the pre period, 40 percent of women report delivering at a medical institution in the post period; a change of 11 percentage points.

As seen in Table 1, the average woman in the sample is 29 years of age. Average years of education for head of the household (HH) is around 4.8 years in both pre and post time periods. Each household has around 8 members. In terms of access to health services, a little over half of the households report that a LHW visited their house in the 30 days prior to the survey. The average household resides around 15-29 minutes from the closest health facility.[11] Although these variables are statistically different from each other in the pre- and post-treatment periods, the size of the difference for each of these variables is very small.

There is, however, a significant increase in the proportion of households residing in urban areas; 45 percent in post period compared to 36 percent in the pre-period. The household income and wealth indicators are also substantially higher on average in the post treatment period. The change in household income is consistent with the increase in real GDP per capita for Pakistan for the time period over which the data spans.[12] I control for all these variables in my analysis to account for any difference in outcomes that might be due to these factors.

[11] Nearest Health Facility includes Basic Health Unit, Rural Health Unit, Hospital or a Doctor's Clinic.
[12] Between 2004 and 2014 real GDP per capita in Pakistan increased by more than $150 (or PKR 15000 in 2010 exchange rate terms). This information was collected from www.data.worldbank/indicator.

## 2.2. Empirical Specification

I use a difference in differences approach with a continuous treatment variable. More precisely, I use the difference in "dosage" of the treatment, measured by CMWs deployed per capita in the district, to determine the impact of the program using pre- and post-period data. The outcomes of interest are binary in nature. I estimate a Probit model as follows. Let $y_i^*$ be the latent unobserved variable related to the explanatory variables:

$$y_i^* = \boldsymbol{X_i'\beta} - \epsilon_i$$

While $y_i^*$ is not observed, the actual (yes or no) decision made by the individual is observable and is defined as:

$$y_i = 1 \; if \; y_i^* > 0$$

$$y_i = 0 \; if \; y_i^* \leq 0$$

with $y_i^*$ being unobserved, we model the probability of making a particular choice.

$$y_i^* = \boldsymbol{X_i'\beta} - \epsilon_i > 0$$

$$\epsilon_i < \boldsymbol{X_i'\beta}$$

Then:

$$\Pr(y_i = 1) = F(X_i'\beta)$$

where $F_\epsilon(X_i'\beta)$ denotes the Cumalative Density Function (C.D.F) of $\varepsilon$ at $X_i'\beta$.

In case of the Probit model, $\varepsilon \sim N(0, I)$ resulting in the following C.D.F.:

$$F(X_i'\beta) = \int_{-\infty}^{X_i'\beta} \frac{1}{(2\pi)^{1/2}} e^{-0.5t^2} \, dt = \Phi(X_i'\beta)$$

The decisions being modeled in this study are as follows: (i) having undergone at least one prenatal checkup during pregnancy, (ii) having a post-natal checkup within 6 weeks of delivery, (iii) having a skilled birth attendant present at the time of delivery and, (iv) delivering at a medical facility (i.e. institutional birth). The probability of each of these outcomes ($y_{id}$) is modeled as follows:

$$\Pr(y_{id} = 1) = \Phi\,(\beta_0 + \beta_1 CMW_d + \beta_2 X_{id} + \beta_3 Z_{id} + \delta_t + \gamma_d + \varepsilon_{id}) \qquad (1)$$

where $i$ indicates the individual, and $d$ indicates districts; $CMW_d$ is the continuous treatment variable defined as CMWs deployed per 10,000 of population in district *d*, taking on a value of zero for pre-treatment periods. $X_{id}$ represents individual and household level controls while $Z_{id}$ represents other controls related to area of residence and the available health facilities. $\delta_t$ are year fixed effects while $\gamma_d$ represents district fixed effects (For details on the variables and outcomes of interest see Table A3). In order to gauge the magnitude of the impact, Average Marginal Effects (AME) for the variable of interest ($CMW_d$ ) were estimated as follows:

$$\text{AME} = \frac{1}{N}\sum_{i=1}^{N} \phi\,(x_i'\beta)\beta_1 \text{ , estimated at } \beta_1 = \widehat{\beta_1} \qquad (2)$$

where $\phi$ is the corresponding probability density function.

### 2.2.1 Testing for Endogeneity in Placement of CMWs

The Government of Pakistan implemented the policy at the national level, with varying dosage of treatment for each district. There is, however, concern that the treatment may be endogenous. For example, if districts with worse maternal health care receive a higher dosage of the treatment, the estimate of the impact will likely be biased. I follow the approach taken by Bollen, Guilkey and Mroz (1995) to test for endogeneity. I model the treatment variable at the

district level. For this, I aggregate the independent variables up to the district level and model the treatment variable ($CMW_d$) on *pre-period* values of these variables, using Ordinary Least Squares (OLS) as follows:

$$CMW_d = \beta_o + \boldsymbol{\beta_1 X_d} + \boldsymbol{\beta_2 Z_d} + \varepsilon_d$$

where $CMW_d$ is the treatment variable defined as the number of CMWs per 10,000 of the population in district *d*, $X_d$ represents a vector of controls capturing the economic conditions of households in the districts, $Z_d$ represents a vector of controls capturing pre-period trends in maternal health practices and $\varepsilon_d$ represents the random error term (For details on the variables in this model, see Table A4).

I test whether district characteristics in the pre-period (2004 and 2006 rounds of the PSLM survey) predict the deployment of CMWs. In particular, I test whether the outcomes of interest (pre and post-natal check-ups, skilled birth attendance and institutional birth) in the years prior to the introduction of CMWs predict the number of CMWs per capita. In addition, I check whether other characteristics such as the economic well-being of the district (average district income, proportion of HHs with TV, proportion of rural HHs) and outreach of existing health facilities (proportion of HHs visited by LHWs) are predictive of the treatment.

Table 2 shows the results. I find no significant correlation of a district's economic well-being with the CMWs deployed per capita. I also include measures approximating the pre-treatment values of the main outcomes of interest for Equation 1. Finally, I also account for prevalence of health services in the district as measured by indicator for a LHW visit.

If the policy was implemented in a way most beneficial for districts most in need, we would expect these pre-period characteristics to predict the per capita deployment of CMWs. This would

in turn mean that estimates from Equation 1 would be biased. In Table 2 however, we see that pre-period values of our outcomes of interest do not predict CMWs per capita in a district. Further, other characteristics are also not significantly correlated with CMW per capita. However, the proportion of households in the district that received a visit from the Lady Health Worker (LHW) is positively correlated with CMWs per capita. This might indicate that districts with better services were targeted more by the policy, possibly owing to ease of implementation, as opposed to the need. Households residing in districts with better health facilities and outreach of LHWs might be more receptive to the CMW program, since the major responsibility of LHWs is to visit households to educate people about health services and promote health seeking behaviors. I control for this in all estimations of Equation 1 (Tables 3-6).

Following Bollen et al. (1995), I predict residuals from the estimation in Table 2. I use these estimated errors as a control in my main estimations of Equation 1, along with other variables. A statistically insignificant coefficient on these errors terms in Equation 1 would imply that the CMW per capita variable is plausibly exogenous and a simple probit or ordinary least squares estimation can be used to estimate the impact on outcomes of interest.

## 3. Results and Discussion

I estimate the impact of CMWs on maternal health care utilization using individual level micro data from six rounds of PSLM. Results for estimation of Equation 1 are shown in Table 3. Panel A shows coefficients for CMWs per capita and "residuals" from the estimation in Table 2. In each of the estimations in Table 3 the coefficient on the residuals obtained from Equation 2 are statistically insignificant.

I begin by looking at utilization behavior prior to and after delivery. In Columns 1 and 2, I find no evidence of a significant impact of CMWs deployment in the district on the probability of women seeking pre- and post-natal check-ups. The coefficients though imprecisely estimated are positive, giving only some suggestive evidence that women may be likely to seek these services where higher CMWs are deployed.

Next, I look at the impact of CMWs on whether the women are attended by a skilled birth attendant (SBA) at the time of delivering the child. A positive coefficient in Column 3 of Table 3 shows that women are more likely to have a SBA at the time of birth if there are more CMWs per capita available in their district. More precisely, the marginal effects in Panel B show that for each additional CMW per capita in the district, women are 19 percentage points more likely to have a SBA present and assisting at birth.

Likewise, women in areas with high CMW per capita are more likely to deliver the child at a medical institute (as opposed to home). Column 4 in Panel B shows for each additional CMW per capita, women are 17 percentage points more likely to birth at a medical institution, where they arguably receive better care than delivering at home. With an average of 0.16 CMWs per capita introduced by the program, this implies that as a result of the program women were on average 2.72 percentage points more likely to give birth at a medical facility and 3.04 percentage points more likely to be attended by a SBA at the time of birth.

I also estimate a linear probability model and find results that are very similar to the marginal effects. Results for the linear probability model are shown in Panel C. I find no evidence of impact on pre- and post-natal check-ups and find that women are more likely to birth at a medical facility (17 percentage points) and in the presence of a skilled birth attendant (19 percentage points).

The basic aim behind the policy of CMWs was to improve maternal health by increasing utilization. This included pre and post-natal checkups, as well as ensuring skilled medical attendants at birth. Additionally, it was expected CMWs would make timely referrals, when needed, to medical facilities where higher skilled personnel like doctors would be available, aiding in reducing the deaths due to undiagnosed or untreated complications.

The results in Table 3 imply that each additional CMW per capita increases the probability of women having a skilled attendant at birth by 19 percentage points. These results are highly encouraging, and given high fertility rates in Pakistan, CMWs may bring about large changes in absolute numbers. Results in Table 3 also show that the deployment of an additional CMW per capita increases the probability of giving birth at an institution (as opposed to delivering at home) by 17 percentage points. This can be explained in two ways. CMWs are provided resources by the Government under the MNCH policy to set up their own 'clinic' with 'birthing stations.' District Public Health Specialists and Lady Health Supervisors are assigned the role of visiting these birthing stations and ensuring their readiness to be operational.[13] Zafar et al. (2015) show, in their mixed methods study, that almost half of women interviewed in rural areas of Pakistan expressed a preference for such birthing stations of CMWs, while only 20 percent preferred deliveries at home. Birthing stations were favored because of the availability of space and equipment and the proximity to their homes. This can explain the increase in institutional births post the deployment of CMWs. Referrals by CMWs in case of complications to medical facilities higher up in the health system, such as Basic and Rural Health Units (B.H.U and R.H.U) and hospitals, might also explain this positive impact. Analysis into breakdown of births within these medical institutions and

[13] See https://www.unfpa.org/news/pakistan-empowering-midwives-empower-women for example of such clinics.

birthing stations may provide information on these channels, however the data used in this study does not allow such an analysis.

There is, however, no evidence of impact on utilization of pre and post-natal check-ups. Coupled with a positive and large impact on giving birth at a medical institutions, these results suggest that while utilization at the time of birth is improving, there is no evidence of change in the behavior regarding the care needed during pregnancy and in the time period after childbirth. In terms of outreach then, utilization of CMWs seems to have improved utilization at the time of birth but we do not find evidence of similar success in terms of pre- and post-natal care.

This has a number of important implications. First, the point of having *community* midwives was to bridge any local and cultural barriers so that they are easily accepted in their roles by the local communities. However, it appears that despite increased contact with skilled birth attendants at the time of birth, women are not convinced about the importance of post-natal checkups. Affordability is unlikely to be a barrier here since CMWs are allowed to charge only a very nominal fee from their patients and their basic compensation comes from the Government (Devlin, Egan, Pandit-Ranjani 2016).

A large part of the role outlined for CMWs is to provide individualized care during the entire course of the pregnancy and identify complications at any point during it. Lack of impact on pre-natal checkups may signal deficiencies in outreach efforts of CMWs in terms of actively reaching out to pregnant women in their communities and making their presence and the services they offer more salient. If this is the case, CMWs may need to be informed more clearly that their role is centered not only around delivering the child, but their services pre and post birth also have equal importance.

On the other hand, this may also be explained by lack of understanding on the patients' end regarding the importance of pre and post-natal checkups and the trust placed in CMWs (Khan & Khan 2012). In more remote districts CMWs may be misunderstood as 'doctors' who need to be consulted in the event of a birth complication only (Mumtaz et al. 2012). In this case, policy requires that efforts be made to educate people about both the importance of these checkups, as well as toward building trust in reaching out to CMWs for these check-ups. Lack of information provision and advertisement might be the missing element in this case. Unfortunately given the data limitations, I cannot speak to the channel that might be at play here.

Existing initiatives, like LHWs who visit households, can be used to educate people about the importance and availability of the services offered by CMWs. In Table A5 we see no significant correlation of LHWs with most measures of maternal health care utilization. On the contrary we see a negative correlation with institutional births. This is a puzzling finding. However, some reports suggest that LHWs have not been used to refer patients to CMWs and medical health centers (Khan and Khan, 2012) and cite lack of coordination with other health providers as one of the impediments to the success of this policy. The government can likely use the help of LHWs already in place to raise awareness about the availability of CMWs and the services they offer.

Further, some research shows that most CMWs being young and unmarried, are deemed as untrustworthy or inexperienced by the community with respect to their roles (Khan and Khan, 2012), in contrast to findings from remote districts where the opposite might be true (Mumtaz et al. 2012). Faisel (2012) reports that many CMWs feel their title does not depict their level of expertise, thereby limiting their acceptance. Efforts geared toward selling the role of CMWs to the local communities, beyond just deploying the CMWs back to their areas of residence may be needed.

Tables A5 also shows other interesting relationships. First, having a more educated head of the household and a higher income for the household, is positively related to all the outcomes of interest. This suggests that demand side may be at play and developing policies aimed at informing the less educated households about the importance of these services may be helpful. Second, on the supply side, in terms of access we see a consistent pattern for all outcomes. The longer it takes to reach the nearest health facility, individuals are less likely to utilize any maternity related service. This has two important implications. First, health workers like LHWs who are assigned responsibility to visit households are of great importance especially for households that are away from medical facilities like Basic Health Units or Rural Health Units. While individuals in these households are less likely to go out and seek services, providing services closer to home might help change health behaviors. For CMWs as well, it may be more important to reach out to households that are a considerable distance away from health facilities.

Results in Table A5 also reflect the rural urban divide. Individuals residing in rural areas are less likely to seek maternal health care, even after controlling for other household and access variables. This may have implications for future deployment of such health workers.

### 3.1 Further tests

Around 10 percent of the districts receive no CMWs under the program. For robustness, I exclude these districts from the sample and re-estimate the main model. Results in Table 4 show that probit estimation and the corresponding marginal effects for institutional births and SBA are robust to excluding those districts.

Second, the recall period for maternal healthcare related questions is 3 years. That is, the survey is administered to women who had given birth three years prior to the time of survey. With

the CMWs deployed in 2007-08, the only year of survey used in this study that is of concern with regard to the recall period is the 2008-09 round of PSLM. To address this concern, I exclude the 2008-09 PSLM sample from my data and estimate the main analyses excluding that round of survey. Results are shown in Table 5 for both Probit (Panel A) and Linear Probability (Panel B) models. Compared to earlier results in Table 3, results remain similar with some changes in the magnitude of the estimates.

I also perform a simple falsification test by estimating Equation 1 for three outcomes that are expected *not* to be impacted by deployment of CMWs. These are (i) whether an individual was employed last month or not (ii) whether an individual had an illness or injury in the last 30 days and (iii) in case of an illness/injury whether an individual sought medical assistance/consultation. These questions, unlike the maternal health care variables, are administered to all members in the household regardless of their gender (and previous maternity history).[14] If the estimations in Table 3 were picking up some arbitrary spurious correlation, we would see a similar significant relationship here has well. If some differentials in economic well-being and health facilities between districts over time were being picked up by the main estimation in Table 3, I would expect to see a similar effect on employment and medical consultation as well. Results for this falsification test are shown in Table 6. I find no evidence of impact of the CMWs variable on any of these outcomes. This is reassuring; there appears to be no spurious correlation picked up the variable of interest in the main equations of interest.

[14] This explains the difference in sample size in Table 6 compared to earlier estimations for Table 3.

## 4. Conclusion

Evidence on the effectiveness of initiatives for safe motherhood in developing countries is inconclusive. In particular, while it is generally agreed that skilled personnel should attend all births, the crucial question of where deliveries should take place and who qualifies as a skilled attendant remains a matter of debate. Nonetheless, indicators such as the proportion of births attended by skilled health personnel have gained credence, as is apparent by the push by the World Health Organization to set targets on proportion of births attended by skilled birth attendants.

In this paper, I evaluate the introduction of a new cadre of CMWs in Pakistan as frontline health workers aimed at impacting maternal health behaviors and increasing skilled attendance at birth. I find that CMWs positively impact skilled birth attendance and institutional births. Approximately 2/3$^{rd}$ of maternal deaths in developing countries occur in late pregnancy through 48 hours after delivery (Nabudere et al. 2013). The four main causes of maternal deaths are obstructed labor, eclampsia, puerperal sepsis and obstetric hemorrhage, collectively accounting for 54% of maternal deaths in Pakistan (PDHS 2007). SBAs are trained to identify and treat these causes and refer to higher skilled medical personnel when needed. Graham et al. (2001) show that these complications are preventable by 20-85 percent by SBAs depending on the complication and whether one takes a pessimistic or an optimistic estimate. The authors deduce a reduction of 16 percent to 33 percent in maternal mortality assuming competent skilled attendants as well as an enabling environment for them to perform the necessary obstetric care, which is provided under the CMW program of Pakistan as well. Estimates from this study show that each additional CMW per 10,000 of the population increases the likelihood of women being assisted at birth by a SBA by 17 percentage points. Using Graham et al.'s (2001) estimates this implies a reduction in likelihood of maternal death by 2.72-5.61 percent. The value of statistical life in Pakistan is

estimated at USD 0.25 million (Viscusi et al. 2017). In monetary terms then the gain from lives saved translates to USD 6800-14000 for each CMW per 10,000 of the population. In comparison, the cost of training and deploying a CMW in Pakistan is estimated at USD 4710 and the cost of each subsequent delivery is USD 38.[15]

I do not, however, find any evidence of impact on pre and post-natal checkups. Further research is needed to evaluate whether measures such as enhancing the trust of the community and forming better linkages between other health initiatives (e.g. LHW) and facilities (e.g. linking CMWs to R.H.Us) may potentially improve pre and post-natal check-ups as well. Increase in post-natal check-ups may potentially also lead to gains in infant health as well, since CMWs are also trained to provide newborn care. Further research may help inform policy makers how the ultimate goal of reducing maternal and infant mortality was impacted by the CMWs. This study is also limited in not being able to speak to the possible mechanisms which might be leading to a significant impact on utilization at the time of birth but not on pre and post-natal check-ups. With more informative data, these questions may be answered to provide insights for better future implementation.

[15] Technical Resource Facility (2013) estimates the cost of training and deploying a community midwife in Pakistan at PKR 200,000 and PKR 270,000 respectively. The cost of each delivery is PKR 3750. These are converted into USD based on the exchange rate in 2013.

**References**


Ahmed, J., Rehman, S. U., & Shahab, M. (2017). Community midwives' acceptability in their communities: A qualitative study from two provinces of Pakistan. *Midwifery*, *47*, 53-59.

Ayiasi R.M., Atuyambe, L.M., Kiguli,J. , Orach,J.C., Kolsteren,P., & Criel,B. (2015) Use of mobile phone consultations during home visits by Community Health Workers for maternal and newborn care: community experiences from Masindi and Kiryandongo districts, Uganda. *BMC Public Health,* 15, 1-13

Bollen, K. A., Guilkey, D. K., & Mroz, T. A. (1995). Binary outcomes and endogenous explanatory variables: tests and solutions with an application to the demand for contraceptive use in Tunisia. *Demography*, *32*(1), 111-131.

Bolton, P., Bass, J. & Neugebauer,R. (2003) Group Interpersonal Psychotherapy for Depression in Rural UgandaA Randomized Controlled Trial *Journal of American Medical Association,* 289(23):3117-3124

Devlin,K., Egan,K.F., & Pandit-Rajani,T. (2016). Community Health Systems Country Profile: Pakistan (Punjab). *Arlington, VA: Advancing Partners & Communities*

Corluka,A., Walker, D.G., Lewin,S., Glenton, C. & Scheel, I.B. (2009) Are vaccination programmes delivered by lay health workers cost-effective? A systematic review, *Human Resources for Health,* 7:81

Faisel, A., (2012). Are CMWs Accessible in Punjab? *Maternal and Newborn Health Program Research and Advocacy Fund (RAF).*

Fauveau, V., Stewart, K., Khan, S. A., & Chakraborty, J. (1991). Effect on mortality of community-based maternity-care programme in rural Bangladesh. *The Lancet*, *338*(8776), 1183-1186.

Frankenberg, E., Suriastini, W., & Thomas, D. (2005). Can expanding access to basic healthcare improve children's health status? Lessons from Indonesia's ‘midwife in the village’programme. *Population Studies*, *59*(1), 5-19.

Girum, T. and Wasie, A. (2017). Correlates of maternal mortality in developing countries: an ecological study in 82 countries. *Maternal health, neonatology and perinatology*, *3*(1), pp.1-6.

Graham, W.J., Bell, J.S. and Bullough, C.H. (2001). Can skilled attendance at delivery reduce maternal mortality in developing countries? *Safe motherhood strategies: a review of the evidence*.

Government of Pakistan. (2006). National Maternal Newborn and Child Health Program. *Government of Pakistan, Ministry of Health*

Hogan, M. C., Foreman, K. J., Naghavi, M., Ahn, S. Y., Wang, M., Makela, S. M., ... & Murray, C. J. (2010). Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5. *The lancet*, *375*(9726), 1609-1623.

Kaur, M. (2016) Community Health Workers— Birth of a New Profession, *Journal of the American Society on Aging, 40(1), 56-63*

Khan, A. & Khan, A. (2012) The Community Midwives Program in Pakistan. *Research and Development Solutions. Policy Briefs Series No. 20*

Kim,K.,Choi,J.S., Choi,E.,Nieman,C.L.,Jao.J.H., Lin,F.R.,….Han,H.R. (2016) Effects of Community-Based Health Worker Interventions to Improve Chronic Disease Management and Care Among Vulnerable Populations: A Systematic Review. *American Journal of Public Health*, 106(4), 3-28

Kristen Devlin, Kimberly Farnham Egan, and Tanvi Pandit-Rajani. (2016). Community Health Systems Country Profile: Pakistan (Punjab). *Arlington, VA: Advancing Partners & Communities*

Kowitt, S.D., Emmerling,D., Fisher,B., & Tanasugarn,C. (2015) Community Health Workers as Agents of Health Promotion: Analyzing Thailand's Village Health Volunteer Program. *Journal of Community Health*, *40*, 780-788

Lipp, A. (2011). Lay Health Workers in Primary and Community Health Care for Maternal and Child Health and the Management of Infectious Diseases: A Review Synopsis. *Public Health Nursing*, 28 (3), 243–245

Massnegale, K.E., Morrison, S.D. & Sudha, S. (2016). Community Health Advocate-Identified Enablers of HIV Testing for Latina Immigrant Women. *AIDS Education and Prevention*, 28(4), 325–340

Mumtaz, Z., O'Brien, B., Bhatti, A., & Jhangri, G. S. (2012). Are community midwives addressing the inequities in access to skilled birth attendance in Punjab, Pakistan? Gender, class and social exclusion. *BMC health services research*, *12*(1), 326.

Nabudere, H., Asiimwe, D. and Amandua, J., (2013). Improving access to skilled attendance at delivery: a policy brief for Uganda. *International Journal of Technology Assessment in Health Care*, *29*(2), pp.207-211.

Ngongo, C., Christie, K., Holden, J., Ford, C. and Pett, C. (2013). Striving for excellence: Nurturing midwives' skills in Freetown, Sierra Leone. *Midwifery*, *29*(10), pp.1230-1234.

Noorani, Q. A., Azam, I., Shaikh, B. T., Ranasinghe, T., Abbas, S., Wali, S., ... & Javed, W. (2013). Role of community based savings groups (CBSGs) enhancing the utilization of community midwives in Chitral district of Pakistan. *BMC pregnancy and childbirth*, *13*(1), 185.

Omer,K., Mhatrre,S., Ansari,N., Laucirica,J., Andersson,N. (2008). Evidence-based training of frontline health workers for door-to-door health promotion: A pilot randomized

controlled cluster trial with lady health workers in Sindh Province, Pakistan. *Patient Education and Counseling,* 72, 178–185

Rahman,A.,Malik,A., Sikander,S., Roberts,C., & Creed,F.(2008) Cognitive behaviour therapy-based intervention by community health workers for mothers with depression and their infants in rural Pakistan: a cluster-randomized controlled trial. *Lancet*, 372, 902–09

Ronsmans, C., Endang, A., Gunawan, S., Zazri, A., McDermott, J., Koblinsky, M., & Marshall, T. (2001). Evaluation of a comprehensive home-based midwifery programme in South Kalimantan, Indonesia. *Tropical Medicine & International Health*, *6*(10), 799-810.

Siriwardhana, D.D., Pathmeswaran, A. and Wickremasinghe, A.R. (2019). Socioeconomic inequality and determinants of postnatal home visits made by public health midwives: An analysis of the Sri Lanka Demographic and Health Survey. *PloS one*, *14*(4), p.e0215816.

Sarfraz, M., & Hamid, S. (2014). Challenges in delivery of skilled maternal care–experiences of community midwives in Pakistan. *BMC Pregnancy and Childbirth*, *14*(1), 59.

Save the Children (2015). The Urban Disadvantage: The state of the World's Mothers 2015.

Shrestha, R. (2010). The village midwife program and infant mortality in Indonesia. *Bulletin of Indonesian Economic Studies*, *46*(2), 193-211.

Stephens, T.B., Kurian,C., Guo,R., & Zhao,H. (2009) Impact of a Household Environmental Intervention Delivered by Lay Health Workers on Asthma Symptom Control in Urban, Disadvantaged Children With Asthma. *American Journal of Public Health*, *99*, 657-665

Technical Resource Facility (2013). *Pakistan National Maternal and Child Health Programme Mid Term Evaluation*

PDHS. (2007). Pakistan Demographic Health Survey 2006-2007 Report. *National Institute of Population Studies, Islamabad, Pakistan. Columbia MA: IRD/Macro International*, 25.

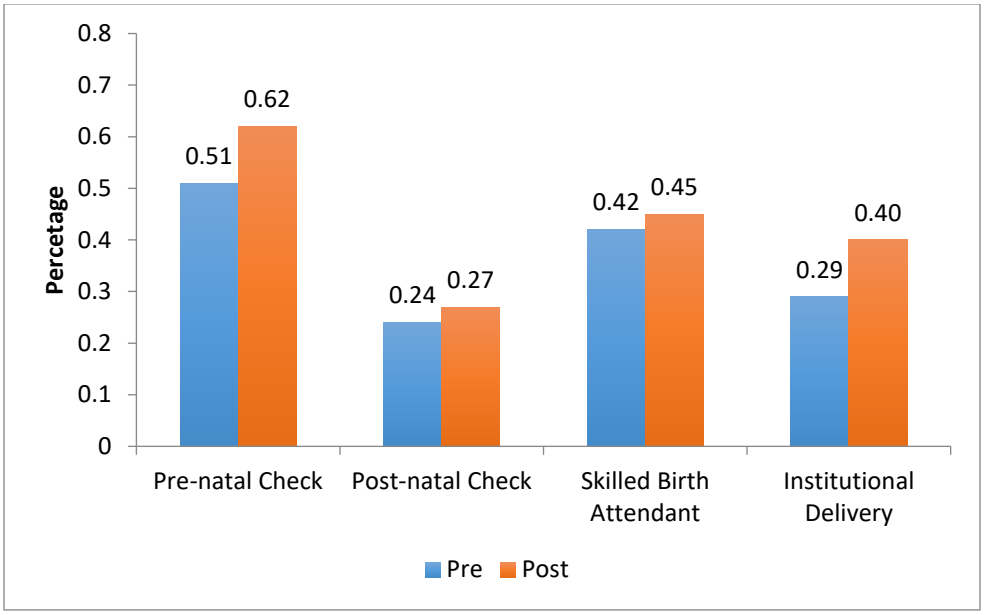
Viscusi, W.K. and Masterman, C.J. (2017). Income elasticities and global values of a statistical life. *Journal of Benefit-Cost Analysis*, *8*(2), pp.226-250

Weaver, E. H., Frankenberg, E., Fried, B. J., Thomas, D., Wheeler, S. B., & Paul, J. E. (2013). Effect of village midwife program on contraceptive prevalence and method choice in Indonesia. *Studies in Family Planning*, *44*(4), 389-409.

Zafar, S., Sikander, S., Ahmad, I., Ahmad, M., Parveen, N., Saleem, S., Nawaz, T., Suleman, Z., Suleman, N., Naeem, A. and Bashir, A. (2015). Is home delivery really preferred? a mixed-methods national study in Pakistan. *Health Research Policy and Systems*, *13*(1), pp.31-36.

## Figures

### Figure 1: Outcomes of interest and their distribution in the sample




Notes: The pre-period data is from the 2004 and 2006 rounds of PSLM. The post period data is from 2008, 2010, 2012 and 2014 rounds of PSLM. Prenatal is a binary indicator for woman having at least one prenatal check-up during pregnancy. Postnatal is a binary indicator for woman having a postnatal check-up within 6 weeks of delivering the child. Skilled Birth Attendant is a binary indicator for whether the woman delivered the child in the presence of a skilled birth attendant. Institutional delivery is a binary indicator for woman delivering the child in the medical facility (as opposed to delivering at home).

## Tables

### Table 1: Summary Statistics

| Variable | Mean Pre | Mean Post | Difference (Post-Pre) | Min | Max |
|---|---|---|---|---|---|
| $CMW_d$ (total) | - | 35.18 | - | 0 | 109 |
| $CMW_d$ (per 10,000 of the population) | - | 0.161 | - | 0 | 0.860 |
| Pre-natal checkup | 0.510 | 0.617 | 0.097*** | 0 | 1 |
| Inst. birth | 0.289 | 0.400 | 0.111*** | 0 | 1 |
| Skilled birth Attendant | 0.424 | 0.448 | 0.024*** | 0 | 1 |
| Post-natal check up | 0.238 | 0.267 | 0.028*** | 0 | 1 |
| Age | 28.95 | 28.98 | 0.022 | 16 | 50 |
| Urban residence | 0.359 | 0.457 | 0.098*** | 0 | 1 |
| Education of the HH head | 4.821 | 4.799 | -0.022 | 0 | 21 |
| No. of members in the HH | 8.310 | 7.967 | -0.343*** | 2 | 20 |
| Real HH income (in 000 PKR.)[16] | 8.682 | 16.721 | 8.040*** | 1.50 | 500 |
| Time to nearest health facility[17] | 2.211 | 2.058 | -0.152*** | 1 | 5 |
| LHW visit | 0.510 | 0.589 | 0.078*** | 0 | 1 |
| TV ownership | 0.446 | 0.507 | 0.061*** | 0 | 1 |
| House ownership | 0.868 | 0.682 | 0.187*** | 0 | 1 |
| Observations | 55,794 | 118, 620 | | | |

Notes: The pre-period data is from the 2004 and 2006 rounds of PSLM. The post period data is from 2008, 2010, 2012 and 2014 rounds of PSLM. Prenatal is a binary indicator for woman having at least one prenatal check-up during pregnancy. Postnatal is a binary indicator for woman having a postnatal check-up within 6 weeks of delivering the child. Skilled Birth Attendant is a binary indicator for whether the woman delivered the child in the presence of a skilled birth attendant. Institutional delivery is a binary indicator for woman delivering the child in the medical facility (as opposed to delivering at home). Details on other variables are provided in Table A3.

[16] Household Income is adjusted for inflation over the different years of the surveys and reported in 2010 terms.
[17] This is a categorical variable: 0-14 minutes, 15-29, 30-44, 45-59, more than 60 minutes.

**Table 2 : Predicting Deployment of CMW in the District**

| | CMWs per capita |
|---|---|
| Proportion of rural HHs in the district | 0.278 |
| | (0.210) |
| Average HH income (PKR 000) | 0.00547 |
| | (0.00937) |
| Proportion of women who had a post-natal check up | 3.052 |
| | (3.499) |
| Proportion of women who had a pre-natal check up | -2.228 |
| | (2.939) |
| Proportion of institutionalized births | -3.633 |
| | (5.836) |
| Proportion of births with skilled attendance at birth | 6.599 |
| | (5.621) |
| Proportion of HHs that own a TV | 0.0302 |
| | (0.127) |
| Proportion of HHs that received a LHW visit | 0.236*** |
| | (0.0812) |
| Observations | 99 |
| R-squared | 0.207 |

Notes: All variables are aggregated up to the district level. Outcome variable is the number of CMWs deployed in the district. This estimation uses data from the pre periods (2004-05 and 2006-07 rounds of PSLM) to check if deployment of CMWs at the district level is predicted by the district characteristics prior to the program implementation. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Table 3: Impact of CMWs on Maternal Health Care Utilization**

| | 1<br>Pre-natal | 2<br>Post-natal checkup | 3<br>SBA | 4<br>Inst. Birth |
|---|---|---|---|---|
| *Panel A: Probit Estimation* | | | | |
| CMW per capita | 0.0957 | 0.294 | 0.577*** | 0.521*** |
| | (0.197) | (0.237) | (0.151) | (0.139) |
| Residuals | -0.128 | -0.501 | -0.455 | -0.562 |
| | (0.318) | (0.331) | (0.372) | (0.394) |
| *Panel B: Marginal Effects* | | | | |
| CMW per capita | 0.0324 | 0.0911 | 0.1923*** | 0.1710** |
| | (0.0668) | (0.0740) | (0.0528) | (0.0457) |
| *Panel C: Linear Probability Model* | | | | |
| CMW per capita | 0.0338 | 0.0870 | 0.193*** | 0.173*** |
| | (0.0569) | (0.0746) | (0.0489) | (0.0468) |
| Mean of the outcome | 0.58 | 0.26 | 0.44 | 0.36 |
| Observations | 173,317 | 173,317 | 173,317 | 173,317 |

Notes: Panel A shows the coefficients from the Probit estimations. Panel B shows the corresponding marginal effects from the estimations in Panel A. Panel C shows the coefficients from estimating a linear probability model using OLS. All estimations have the following controls: age dummies, education of the household head, real income, number of members in the households, wealth of the household, rural/urban locality, time to nearest health facility, district fixed effects and year fixed effects. "Residuals" are predicted residuals from the estimation in Table 2. CMW per capita is the number of CMWs per 10,000 of the population in the district. SBA stands for "skilled birth attendant". Standard errors are clustered by district. *** p<0.001, ** p<0.01, * p<0.05.

**Table 4: Robustness Check- Impact of CMWs on Maternal Healthcare Utilization (excluding districts with no CMWs)**

| | (1)<br>Prenatal | (2)<br>Postnatal | (3)<br>SBA | (4)<br>Inst. Birth |
|---|---|---|---|---|
| CMW per capita | -0.109 | 0.365 | 0.398** | 0.374** |
| | (0.210) | (0.260) | (0.157) | (0.159) |
| Marginal Effect | -0.076 | 0.0936 | 0.138** | 0.122** |
| | (0.1055) | (0.0796) | (0.0573) | (0.0515) |
| Observations | 146,024 | 146,024 | 146,024 | 146,024 |

Notes: Results here are based on estimating Equation 1, excluding the sample of women from districts where no CMWs were deployed. SBA stands for "skilled birth attendant". All estimations have the following controls: age dummies, education of the household head, real income, number of members in the households, wealth of the household, rural/urban locality, time to nearest health facility, district fixed effects and year fixed effects. Standard errors in parentheses are clustered by district. *** p<0.01, ** p<0.05, * p<0.1

**Table 5: Robustness Check- Impact of CMWs on Maternal Healthcare Utilization (excluding the 2008-09 round of PSLM)**

| Panel A: Probit | (1) Pre-natal | (2) Post-natal | (3) SBA | (4) Inst. Birth |
|---|---|---|---|---|
| CMW per capita | 0.102 | 0.201 | 0.610*** | 0.597*** |
| | (0.200) | (0.221) | (0.139) | (0.124) |
| Marginal Effect | 0.0343 | 0.0625 | 0.213*** | 0.198*** |
| | (0.067) | (0.069) | (0.048) | (0.041) |
| Observations | 140,759 | 140,759 | 140,759 | 140,759 |

| Panel B: LPM | (1) Pre-natal | (2) Post-natal | (3) SBA | (4) Inst. Birth |
|---|---|---|---|---|
| CMW per capita | 0.0363 | 0.0585 | 0.212*** | 0.200*** |
| | (0.0579) | (0.0702) | (0.0441) | (0.0419) |
| Observations | 140,759 | 140,759 | 140,759 | 140,759 |
| R-squared | 0.125 | 0.061 | 0.151 | 0.186 |

Notes: Sample excludes the data from the PSLM 2008-09 survey. Panel A shows the coefficients and the corresponding marginal effects from estimating Equation 1. Panel B shows estimates from a linear probability model. All estimations have the following controls: age dummies, education of the household head, real income, number of members in the households, wealth of the household, rural/urban locality, time to nearest health facility, district fixed effects and year fixed effects. SBA stands for "skilled birth attendant". Standard errors in parentheses are clustered by district. *** p<0.01, ** p<0.05, * p<0.1

**Table 6: Falsification tests- Impact of CMWs on Employment, Incidence of Illness and Consultation for illness**

| Variables | (1) Employment | (2) Illness | (3) Consultation |
|---|---|---|---|
| CMW per capita | -0.0889 | 0.1163 | -0.0088 |
| | (0.0651) | (0.1020) | (0.2685) |
| Observations | 1,370,360 | 1,425,041 | 94,308 |

Notes: Sample consist of all adults surveyed. 'Employment' is an indicator equal to one if the individual was employed within the last one month and zero otherwise. Illness is an indicator if the individual had an illness or injury in the last 30 days. Consultation is an indicator equal to one if the individual sought medical assistance/consultation, *conditional* on being ill. All estimations have the following controls: age dummies, education of the household head, real income, number of members in the households, wealth of the household, rural/urban locality, time to nearest health facility, district fixed effects and year fixed effects. Standard errors in parentheses are clustered by district. *** p<0.001, ** p<0.01, * p<0.05

# Appendix A

## Table A1. Pakistan Social and Living Measurement Survey Sample Size

| Survey Year | HH's interviewed | Sample Size for this study |
|---|---|---|
| 2004-05 | 74,420 | 31,667 |
| 2006-07 | 73,953 | 23,413 |
| 2008-09 | 75,188 | 29,601 |
| 2010-11 | 76,546 | 28,485 |
| 2012-13 | 77,764 | 28,845 |
| 2014-15 | 78,635 | 31,692 |

Note: Each survey round was conducted in all districts of Pakistan. This study uses the rounds that were representative at the district level. HH's interviewed indicates the overall number of households surveyed in each year of PSLM. This study relates to women who had given birth recently at the time of survey and had answered the questions related to maternal health care, which is shown under "sample size for the study" column.

## Table A2. Community Midwives Deployed by District

| Punjab | | Sindh | | Balochistan | | KPK | |
|---|---|---|---|---|---|---|---|
| Islamabad | 14 | Khairpur | 65 | Quetta | 61 | Swat | 22 |
| Attock | 17 | Sukkhur | 27 | Pashin | - | Upper Dir | 34 |
| Rawalpindi | 66 | Nawabshah | 12 | Qillah Abdullah | 21 | Lower Dir | 36 |
| Jhelum | 19 | Jacobabad | 14 | Chaghi | 26 | Chitral | 28 |
| Sargodha | 27 | Shikarpur | 6 | Sibbi | 44 | Malakand | 45 |
| Mianwali | 34 | Larkana | 61 | Khuzdar | 25 | Charsada | 35 |
| Faisalabad | 14 | Dadu | 46 | Ketch/Turbat | 36 | Nowshera | 25 |
| Jhang | 73 | Hyderabad | 109 | Gwadar | 34 | Kohat | 20 |
| T.T Singh | 32 | Badin | 19 | Loralai | 13 | Karak | 41 |
| Gujranwala | 25 | Thatta | 14 | Qilla Saifullah | 14 | Hangu | 11 |
| Gujrat | 27 | Sanghar | 12 | Kohlu | - | D.I.Khan | 45 |
| Sialkot | 45 | Mirpurkhas | 46 | Dera Bugti | - | Tank | - |
| Hafizabad | 13 | Tharparkar | - | Kalat | - | Mansehra | 20 |
| Lahore | 106 | Karachi | 15 | Mastung | - | Kohistan | - |
| Kasur | 16 | | | Awaran | - | Haripur | 32 |
| Shiekhupura | 49 | | | Lasbela | - | Bannu | 21 |
| Nankana Saab | 35 | | | Panjgur | - | Lakki Marwat | 32 |
| Vehari | 63 | | | Zhob | - | | |
| Multan | 65 | | | Barkhan | - | | |
| Khanewal | 35 | | | Musa khel | - | | |
| D.G.Khan | 33 | | | Nasirabad | - | | |
| Rajanpur | 14 | | | Jafarabad | - | | |
| Layyah | 34 | | | Jhal Magsi | - | | |
| Muzafargarh | 56 | | | Bolan/kachhi | - | | |
| Bahawalpur | 58 | | | | | | |
| Bahawalnagar | 34 | | | | | | |
| R.Y.Khan | 48 | | | | | | |
| Sahiwal | 44 | | | | | | |
| Pakpattan | 62 | | | | | | |
| Okara | 33 | | | | | | |

Notes: District boundaries in Pakistan changed over the years of survey used in this study. For consistency, I reassign the number of CMWs and the population of new districts to their parent districts. The list shown in this table is the final lists of districts used after reassignment to parent districts.

**Table A3. Description of variables**

| Variable | Description |
|---|---|
| Prenatal Checkup | =1 if the individual got at least one pre-natal check-up during pregnancy, 0 otherwise |
| Skilled Attendance at birth | =1 if the individual was assisted by a skilled birth attendant at time of birth, 0 otherwise |
| Institutionalized birth | =1 if the individual gave birth at a medical facility, 0 otherwise |
| Post-natal Checkup | =1 if the individual got at post-natal checkup within 6 weeks of birth, 0 otherwise |
| CMW | Number of CMWs per 10,000 of the population |
| Region | =1 if the individual resides in an urban area, 0 otherwise |
| LHW | =1 if the household received a visit from a Lady Health Worker in last 30 days |
| Time taken to reach the nearest health facility | Dummy variable for each of the following categories: 0-14 minutes (base), 15-29, 30-44, 45-59, more than 60 minutes |
| HH head education | Education of the head of the household (in years) |
| HH Income | Total monthly income of the households (in 000s PKR) |
| HH members | Number of members in the household |
| TV ownership | =1 if the household owns a TV, 0 otherwise |
| House ownership | =1 if the household owns the house it resides in, 0 otherwise |

Notes: These variables are from the individual level micro data.

**Table A4. Descriptive Statistics for variables used to test endogeneity of the treatment variable**

| | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|
| Proportion of rural HHs in the district | 0.4788 | 0.1010 | 0.141 | 0.8401 |
| Average HH income (PKR) | 12162.31 | 2460.42 | 8013.22 | 27287.32 |
| Number of children under the age of 15 in the HH | 3.898 | 0.8892 | 0 | 6.4453 |
| Proportion of births with skilled attendance at birth | 0.3399 | 0.1666 | 0.0327 | 0.8243 |
| Proportion of women who had a post-natal check up | 0.2109 | 0.1008 | 0.0271 | 0.6481 |
| Proportion of institutional births | 0.2407 | 0.1436 | 0.0149 | 0.7257 |
| Proportion of women who had a pre-natal check up | 0.4633 | 0.1682 | 0.1006 | 0.8689 |
| Proportion of HHs that own a TV | 0.4370 | 0.1947 | 0.0585 | 0.8684 |
| Proportion of HHs that received a LHW visit within the last 30 days | 0.4430 | 0.1899 | 0.0665 | 0.7828 |

Notes: These statistics are from the district level data aggregated from the individual micro data for the pre period years.

**Table A5. Probit Estimations Results**

| | (1) Pre-natal | (2) Post-natal | (3) SBA | (4) Inst. Birth |
|---|---|---|---|---|
| CMW | 0.0957 | 0.294 | 0.557*** | 0.521*** |
| | (0.197) | (0.237) | (0.151) | (0.139) |
| Residuals | -0.128 | -0.501 | -0.455 | -0.562 |
| | (0.318) | (0.331) | (0.372) | (0.394) |
| Urban | 0.206*** | 0.160*** | 0.298*** | 0.270*** |
| | (0.0449) | (0.0281) | (0.0440) | (0.0437) |
| LHW visit | 0.0394 | 0.0269 | -0.0685 | -0.152** |
| | (0.0519) | (0.0444) | (0.0606) | (0.0632) |
| Time to nearest health facility | -0.156*** | -0.0557* | -0.206*** | -0.224*** |
| (15-29 mins.) | (0.0294) | (0.0310) | (0.0324) | (0.0275) |
| Time to nearest health facility | -0.273*** | -0.102*** | -0.323*** | -0.335*** |
| (30-44 mins.) | (0.0309) | (0.0361) | (0.0325) | (0.0302) |
| Time to nearest health facility | -0.397*** | -0.224*** | -0.424*** | -0.462*** |
| (45-59 mins.) | (0.0470) | (0.0457) | (0.0433) | (0.0434) |
| Time to nearest health facility | -0.505*** | -0.301*** | -0.478*** | -0.508*** |
| (60+ mins.) | (0.0592) | (0.0810) | (0.0451) | (0.0458) |
| HH head's education | 0.0299*** | 0.0307*** | 0.0380*** | 0.0404*** |
| | (0.00234) | (0.00197) | (0.00274) | (0.00250) |
| HH income (PKR 000s) | 0.00653*** | 0.00477*** | 0.00883*** | 0.00875*** |
| | (0.000835) | (0.000488) | (0.000925) | (0.000896) |
| No. of HH members | -0.00989** | -0.00632 | -0.0165*** | -0.0176*** |
| | (0.00446) | (0.00387) | (0.00497) | (0.00462) |
| TV ownership | 0.370*** | 0.233*** | 0.411*** | 0.430*** |
| | (0.0408) | (0.0266) | (0.0412) | (0.0457) |
| House Ownership | -0.0210 | 0.0250 | -0.105*** | -0.0933** |
| | (0.0396) | (0.0310) | (0.0387) | (0.0367) |
| Observations | 170,359 | 170,359 | 170,359 | 170,359 |

Notes: These estimations are for Equation 1 with each Column adding a new set of controls. The outcome of interest is indicator for any prenatal visit. The remaining variables are as described in Table A3. Results in Column 4 correspond to the estimate shown for prenatal visit in Table 3. Errors are clustered by district. *** p<0.01, ** p<0.05, * p<0.1

## Appendix B[18]

The CMW model includes the following functions:

- Providing individualized care to the pregnant women throughout the maternity cycle and the newborn, in her own environment and helping her in self-care.
- Monitoring the physical, social and emotional well being of the pregnant woman as needed.
- Taking appropriate action within the resources available.
- Providing guidance and counseling to the community for healthy habits, and involving the family in preparation for childbirth and for unforeseen emergencies.
- Identifying actual or anticipated conditions requiring medical attention and making timely referrals.
- Practicing midwifery within the legal framework and following the professional code of conduct provided by the relevant authority.

The objectives of the program are defined as follows:

- To strengthen the existing midwifery and LHV training schools in the country through development of linkages with DHQ and THQ hospitals for practical training, renovation of existing facilities and creation of domiciliary midwifery linkages.
- To improve the quality of midwifery training in the country through implementation of a standardized curriculum approved by the Pakistan Nursing Council, training and deployment of specific midwifery tutors and provision of standard training aids.
- To train a core group of master trainers at the National level for the training of midwifery tutors.
- To train 600 midwifery tutors all over Pakistan on the new curriculum for training of community midwives.
- To recruit, train and deploy 12,000 community midwives in the community by the end of the fourth year of the project.
- To promote birth preparedness activities through counseling.
- To strengthen the registration and accreditation system of the Pakistan Nursing Council through supporting additional staff for quality assurance and monitoring of trainings.
- Development of a computerized database of midwives at provincial MNCH directorates.

The proposed network of community midwives at the grass root level would play a pivotal role in achieving the following:

- Increasing the proportion of skilled birth attendants will have a definite impact on reducing maternal and newborn mortality and morbidity through:
- Establishing linkages, conducting normal deliveries at the household level and is able to recognize complications and takes decision of in-time referrals of complicated obstetric cases to the higher level of functional health facilities.
- Delivery of quality RH-PHC services at the community level.

[18] The information for this appendix sourced from the MNCH website for Pakistan (http://dynasoft.org/mnch/cmw.php) and the MNCH policy document (Government of Pakistan 2006).

- Established community midwifery schools with regards to human resource and equipment, thus providing a continuum of technical back stopping to the skilled birth attendants.
- LHWs Support provided through a regular contact with the SBAs would be established by the National Program for Family Planning and Primary Health Care through the LHWs supervisors.
- Including a socio-culture change in the communities by counteracting the misinformation based on taboos and negative traditional practices.
- Provide opportunities for gender development and income generation thus helping poverty alleviation.
- Gradual replacement of TBAs by trained community midwives.

**Selection Criteria**

- Female, preferably married.
- Permanent resident of the area, for which she is applying.
- Minimum qualification should be at least Matric preferably with Science subjects obtaining 45% marks
- Have experience of working in the community
- Should be 18 – 35 years of age