THE EFFECT OF THE LADY HEALTH WORKER PROGRAM ON MATERNAL HEALTH AND FAMILY PLANNING SERVICES IN RURAL PAKISTAN

Layla M. Lavasani

A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Gillings School of Global Public Health (Maternal and Child Health).

Chapel Hill
2012

Approved by:

Kavita Singh, Ph.D.

Siân Curtis, Ph.D.

Herbert Peterson, M.D.

Chirayath Suchindran, Ph.D.

Dean M. Harris, J.D.

ABSTRACT

LAYLA M. LAVASANI: The Effect of the Lady Health Worker Program on Maternal Health and Family Planning Services in Rural Pakistan
(Under the direction of Dr. Kavita Singh)

The Lady Health Worker Program (LHWP) is a national program introduced in 1994 by the Pakistani Ministry of Health with the aim of improving access to Maternal and Child Health (MCH) and family planning services in urban slums and rural areas. Utilizing the 2006-2007 Pakistan Demographic Health Survey and the 2006 Pakistan Community-level Rural Survey, this dissertation examines the effect of the LHWP on use of reversible contraceptives and MCH services (tetanus toxoid immunizations/antenatal care) in rural Pakistan. In order to control for non-random program placement, this study uses an instrumental variable approach with a novel set of valid geographic exclusion restrictions; availability of a middle school and telephone lines in a community.

The first paper in this dissertation examines the effect of the LHWP on the use of reversible contraceptive methods among rural ever-married woman 15-49 years while examining determinants of LHW placement in rural communities. Results from a logistic regression indicate that communities with developed infrastructures are more likely to have a LHW. In the bivariate probit model which takes into account non-random program placement, access to a LHW increases the probability of utilizing reversible contraceptives by 9.9 percentage points. The naïve probit marginal effect estimates were 7.7 percentage points lower than the bivariate estimations. This suggests that LHWs

significantly increase access to reversible contraceptives in rural communities despite being located in more advantaged areas. In terms of methodology, naïve estimation procedures which ignore non-random program placement would substantially underestimate the impact of the program.

The second paper examines the effect of the LHWP on the use maternal health services among rural ever-married woman. Results from the bivariate probit model indicate that LHWs increase the probability of receipt of tetanus toxoid injections by 42 percentage points. However, the LHW program does not have a statistically significant effect on the uptake of antenatal care services. Programmatically, these results suggest that in rural areas of Pakistan, LHWs are effective at providing a service for which they are directly responsible but ineffective in increasing use of antenatal care services through a referral mechanism to local health facilities and skilled birth attendants.

To Mohamad and Vera Lavasani

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my adviser, Dr. Kavita Singh, for her continual support and guidance throughout the dissertation process. I would also like to acknowledge my committee members, Drs Siân Curtis, Herbert Peterson, Chirayath Suchindran, and Dean Harris, for their thoughtful comments and feedback which has only helped to strengthen this work.

I am thankful to my dear friends and family who have tirelessly supported me in my academic pursuits. Without all of you – this dissertation would not have been possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANC	Antenatal Care
BHU	Basic Health Unit
CHWs	Community Health Workers
DHS	Demographic and Health Survey
FANA	Federally Administered Northern Areas
FATA	Federally Administered Tribal Areas
GoP	Government of Pakistan
IV	Instrumental Variable
LHWs	Lady Health Workers
LHWP	Lady Health Worker Program
MDGs	Millennium Development Goals
MCH	Maternal and Child Health
NIPS	National Institute of Population Studies
NGOs	Nongovernmental organizations
PDHS	Pakistan Demographic and Health Survey
PHC	Primary Health Care
TT	Tetanus Toxoid
RHU	Rural Health Centers
SBAs	Skilled Birth Attendants
TFR	Total Fertility Rate

CHAPTER 1: INTRODUCTION

Pakistan's maternal and child health indicators are among the worst in the world (USAID 2008). In 2007, the Pakistan Demographic and Health Survey showed little change in morality over time with a maternal mortality ratio of 276 per 100,000 and an under-five mortality rate of 94 per 1000 live births (USAID 2008; National Institute of Population Studies 2008). Furthermore, the low contraceptive prevalence rate (22%) and high fertility rates (4.5 children per woman) in rural areas constrain the attainment of the Millennium Development Goals (MDGs) (Shadoul 2010; USAID 2008). Therefore, improving the health of mothers and children in Pakistan is an immense priority. Recent evidence in other developing countries has shown that maternal deaths can be reduced by promoting the availability and use of maternal care services (Kerber et al. 2007). However, these services are often underutilized by those in greatest in need.

In order to improve access to and utilization of maternal health and family planning services, the Government of Pakistan (GoP) launched the Lady Health Worker Program in 1994 (Ministry of Health Pakistan 2011). Key objectives of the LHW program were to improve uptake of Maternal and Child Health (MCH) services in urban slum/rural communities and provide information concerning the adoption and continuation of family planning methods, including the distribution of some forms of contraceptives. Although previous evaluations have found a positive impact of the

program on the receipt of tetanus toxoid injections and contraceptive use, selective program placement of LHWs in communities has been ignored. Targeting programs to specific communities will not complicate evaluation efforts when characteristics are observed and controlled for in statistical models (Frankenberg et al. 2005; Angeles et al. 1998). However, a growing body of literature suggests that when purposive program placement is based on unobserved characteristics (social capital, cultural norms, decision maker's preferences etc.) and those characteristics are correlated to the outcome of interest, the effect of the program will be biased (Frankenberg and Duncan 2001; Angeles et al. 1998; Gertler and Molyneaux 1994; Rosenzweig et al. 1986). The effects of the program may be overestimated or underestimated when potential sources of confounding are not controlled (Rosenzweig 1986; Gertler and Molyneaux 1994; Angeles et al. 1998; Guilkey and Hutchinson 2011).

Therefore, the purpose of this dissertation is to examine the impact of the LHW program in rural areas on maternal service and family planning use, while examining potential selective program placement concerns. An instrumental Variable (IV) technique was used to test and correct for endogeneity with a novel set of geographic instruments (availability of a middle school and telephone lines). These geographic characteristics are reflective of factors that may influence program placement due to recruiting and placement requirements, while not affecting health outcomes directly. Data from the 2006-2007 Pakistan Demographic and Health Survey and Community-level Rural Survey was used in order to address the following:

SPECIFIC AIMS

Aim 1: Examine determinants of community level placement of Lady Health Workers

Hypothesis 1A: Rural communities that are more structurally developed will be more likely to have a Lady Health Worker.

Aim 2: To estimate the effects of living in a community with a Lady Health Worker on reversible contraceptive use

Hypothesis 2 A: Women living in communities with a Lady Health Worker will be more likely to utilize contraceptives.

Aim 3: To estimate the effects of living in a community with a Lady Health Worker on use of maternal health services (antenatal care and receipt of tetanus toxoid injections)

Hypothesis 3 A: Women living in communities with a Lady Health Worker will be more likely to utilize maternal health services.

BACKGROUND

Maternal health indicators in Pakistan are among the worst in the world:

Despite progress towards meeting the Millennium Development Goals (MDG), Pakistan's maternal health indicators are some of the worst in the world (USAID 2008; National Institute of Population Studies 2008). Globally, over 7.6 million children under five die annually (UN Inter-agency Group 2011). Pakistan in particular, has one of the highest maternal mortality ratios (MMR) in South Asia at 276 per 100,000 live births and is only exceeded by countries like Afghanistan and Nepal (Khan et al. 2009). Under five mortality is 87 deaths per 1,000 live births, with rates significantly higher in rural areas (UN Inter-agency Group 2011). According to the 2007 Pakistan Demographic and

Health Survey (PDHS), only one-third of women had an antenatal visit by their fourth month of pregnancy as recommended by WHO while over 35% received no prenatal care at all. The most commonly cited reason for the lack of a visit was due to the fact that women believed it was not necessary. Skilled Birth Attendants (SBAs) assisted only 39% of births, with significant disparities by urban-rural residence. Approximately 34% of births took place within a facility and 66% were home based. Of the home based deliveries, only 7.6% were assisted by a skilled birth attendant a (National Institute of Population Studies 2008).

Fertility levels remain high in Pakistan:

In 2009, Pakistan had an estimated population of 170 million and is continuing to grow at a rate of 1.9 percent per year (Ministry of Finance Pakistan 2009). Based on UN projections, Pakistan will be the third most populous country by the year 2050 (Pakistan Ministry of Finance 2009). The rapid increase in population is mainly due to consistently high fertility levels, which have seen little change in the past decade (World Bank 2010). Pakistan's Total Fertility Rate (TFR) of 4.1 children per women is one of the highest in South Asia (National Institute of Population Studies 2008). Fertility is considerably higher in rural areas (4.5 children per woman) compared to urban areas (3.3 children per woman) (National Institute of Population Studies 2008). The urban-rural fertility rate disparity also increases with women's age. Theses differentials between urban and rural women have been attributed to factors associated with urbanization, higher levels of education, status of women, improved access to health and family planning services, and later marriage (National Institute of Population Studies 2008; Hardy and Leahy 2008).

Modern contraceptive use in Pakistan lags behind its neighbors:

In Pakistan, only 22% of currently married women are using a modern method compared to India (49%) and Bangladesh (47%) where the rates are much higher (National Institute of Population Studies 2008). According to the 2007 PDHS, approximately three-fourths of current users are using a modern method while one-fourth is using traditional methods. The most commonly used method is female sterilization (8%), condoms (7%), withdrawal (4%), and the rhythm method (4%). The use of IUDs, injectibles and pills are each around 2% for married women (National Institute of Population Studies 2008). Although there has been a substantial increase in contraceptive use since the 80's, modern contraceptive use has reached a plateau in recent years. The lack of progress on increasing contraceptive use may be due to a number of factors including: decentralization of the family planning program from central control leading to a lack of ownership of the program at district levels, the lack of support from within the health sector, and the disconnect between community and facility level services ((National Institute of Population Studies 2008; Ali et al. 2008; Casterline et al. 2001; Harel 1997).

Access to and utilization of maternal health and family planning services is essential for maternal survival and health:

Most maternal deaths can be prevented by reducing the delays in decision-making to seek medical care (often due to the lack of awareness of obstetric danger signs), utilizing a skilled attendant at labor and delivery, ensuring availability of emergency obstetric care, and referral to quality health services (Campbell et al. 2006; Goodburn et al. 2001). During the antepartum period, focused antenatal care (ANC) provides an opportunity to identify and manage conditions that may threaten the health of a mother or

infant, although research suggests that the effect of ANC on maternal mortality is limited (Corroli et al. 2001; Bergsjø 2001; Rooney 1992; McDonagh 1996). Nonetheless, routine ANC exposes women to key information about birth preparedness, dangers signs, and where to seek care for pregnancy complications which is particularly important in rural areas where there are low levels of education (WHO and UNICEF 2003). ANC has been found to be an important determinant of safe delivery (Bloom et al. 1999) and is positively associated with the uptake of postnatal health care services (Chakraborty et al. 2002) potentially contributing indirectly to maternal mortality reduction. Antenatal care visits also provide opportunities for the provision of other preventative health services that can improve maternal health and perinatal survival including: immunizations against neonatal tetanus, prophylactic treatment of malaria, and HIV counseling and testing (WHO and UNICEF 2003). In particular, immunizing pregnant women against tetanus is one of the most effective methods of reducing neonatal tetanus mortality rates and the incidence of maternal tetanus (Blencowe et al. 2010, Gay et al. 2003). In 2008, approximately 59,000 newborns died worldwide due to neonatal tetanus with 508 cases reported in Pakistan alone (Black et al. 2010, WHO 2011).

Likewise, family planning services are a key component to the continuum of care to improve the health and wellbeing of mothers and children (Kerber et al. 2007). By reducing unintended pregnancies, improving reproductive behaviors of men and women, family planning interventions can help to reduce child mortality and improve maternal health (Family Health International 2011). However, the lack of access to family planning clinics and contraceptives remain a significant issue in Pakistan (World Bank 2010).

Factors affecting family planning and maternal service use:

There are multiple levels which can influence health service use, including individual and community-level effects. Many studies of maternal health service utilization have focused primarily on individual level factors, with little attention to community influences (Adamu and Salihu 2002; Bloom et al. 2001; Van den Broek et al. 2003). However in countries such as Pakistan where mobility and security are limited, contextual level factors are an essential component in understanding the influences on family planning and maternal service use. The following variables are common factors which may influence uptake of maternal health and family planning services.

Socio-cultural factors

A review of the literature suggests at the individual-level, there are a number of factors which use of maternal health and family planning services including socio-cultural factors such as maternal age, husband's attitudes, and mother's education (Gabrysch and Campbell 2009; Gage 2007; Elo 1992; Mekonnen and Mekonnen 2003). These factors are especially relevant to the Pakistani context where female autonomy and decision making are severely limited (Shaikh 2004). Younger Pakistani women often lack the autonomy to leave their home without permission from a male caregiver, limiting access and use of health care and family planning methods (Mumtaz and Salway 2005; Khan 1999). Women who are older may potentially be more confident and influential in decision-making compared to younger women in Pakistan (Shaikh 2004; Mumtaz and Salway 2005; Khan 1999). Husband's opposition to health service use and family planning methods has been shown to be a significant factor in a wide variety of places including Egypt, Guatemala, India and Pakistan (Jejeebhoy 1995; Mumtaz et al. 2003;

Sathar and Kazi 1997). In many cases, husband's disapproval may reflect fertility preferences or cultural beliefs concerning the use of health facilities (Mumtaz and Salway 2005).

Furthermore, maternal education and literacy have also been shown to be positively correlated with utilization of maternity care services (Gabrysch and Campbell 2009). Increased knowledge of the benefits of preventive health care and awareness of health services may explain the ability to demand and use services (Mekonnen and Mekonnen 2003). Low levels of female literacy and education in Pakistan may serve as barriers to recognizing birth-related complications, utilizing modern contraceptives as well as seeking appropriate health care (Shaikh and Hatcher 2007; Shaikh et al. 2008). Furthermore, the widespread restrictions on education and employment of women can limit the number of trained female health providers and reduce women's resources to access care (Shaikh 2004).In Pakistan, where there are considerable cultural restrictions within communities; this can drastically affect health service use and the recruitment of LHWs (Shaikh 2004). Such beliefs and cultural practices may lead women to self-care, utilize home remedies, and consult with traditional healers in rural communities (Shaikh 2004). In other cases, gender discrimination can affect health seeking behavior and use of contraceptives (Casterline et al. 2001; Mahmood and Ringheim 1996). In Pakistan, often the early contraceptive adopters are generally those with relatively high parity and already have a sufficient number of sons (Mahmood and Ringheim 1996).

Women's mobility and autonomy

Women's mobility and autonomy in decision making regarding health service use is severely hampered in Pakistan (Khan 1999). Men are generally in charge of resources

and decide when and if women should seek care. Women are generally not allowed to visit a health facility alone and often encouraged to remain secluded from public places to maintain family honor (*izzat*) and to ensure separation of the sexes (*purdah*) (Khan 1999; Fikree et al. 2001). In particular, pregnancy an obvious product of sexual activity, may be associated with notions of shame (*sharam*), therefore women may be more likely to avoid leaving the home to access services (Mumtaz and Salway 2005). One study in rural Punjab found only 23% of mothers were able to travel unescorted to a health facility (Sathar and Kazi 1997). A separate study in Pakistan found that women who were accompanied outside of the home by an adult were more likely to access antenatal services (Mumtaz and Salway 2005).

Community-level

A number of community level characteristics have been found to exert an influence on women's decision to utilize reproductive services in developing countries including: presence of a community health worker, poor road conditions, high mean number of children per woman in the community, distance to medical care, and lack of access to a main road (Glei et al. 2003; Stephenson et al. 2006; Gabrysch and Campbell 2009). In Pakistan, with over 65% of the population living in rural areas, the lack of infrastructure, poor road conditions, absence of railways, and mountainous terrain may reduce women's access to services (National Institute of Population Studies 2008; Government of Pakistan 2000).

Health Care Delivery in Pakistan:

Health care is primarily provided by the provincial governments, except in the federally administered territories (Shaikh 2004). The federal government is responsible

for planning and formulating national health policies with the Ministry of Health responsible for the implementation of a number of vertical program including: Lady Health Worker Program, Malaria Control Program, Tuberculosis and HIV/AIDS Control Program, National Maternal and Child Health Program, the Expanded Program on Immunization, Cancer Treatment Program, and Food and Nutrition Program (Government of Pakistan 1993).

Overall, the healthcare system is comprised of public and private health facilities. The public sector has more than 10,000 health facilities ranging from Basic Health Units (BHUs) to tertiary centers (Government of Pakistan 2001). The BHUs serve between 10,000-20,000 people and rural health centers (RHUs) serve approximately 30,000-45,000 people (Ghaffer et al. 2000). The Primary Health Care (PHC) units comprise of both the BHUs and RHCs. The next level of health facilities are the lauka/tehsil hospitals which serve 500,000-1,000,000 people, and the tertiary level which serves 1-2 million (Ghaffer et al. 2000). There are approximately 22 tertiary care facilities which are mostly located in the larger cities (EMRO 2003).

Although healthcare provision is comprised of a relatively large network of facilities, approximately 30% of the population utilizes PHC facilities. In addition, some studies suggest that on average an individual utilizes the PHC facility less than once a year (Government of Pakistan 1993). Underutilization of health facilities in Pakistan is often due to the lack of health care professionals who are women, the high rates of absenteeism, poor quality of services, and often inconvenient location of PHC units (Government of Pakistan 2000). Basic level facilities often have restricted hours of

operation and approximately only 25% of BHUs and RHCs have qualified female health providers (Islam and Tahir 2002).

In the private sector accredited hospitals are available, but also many unregulated hospitals, general practitioners, healers, bonesetters, and quacks (Shaikh 2004). Non-Governmental Organizations (NGOs) provide health care in a number of regions. In Pakistan most people initially seek curative care in the private sector. For example, approximately 50% of diarrhea cases are initially seen by private practitioners and about 70% of the private sector services are based in urban areas (Federal Bureau of Statistics 2002). In urban areas, a number of public-private partnerships exist within private health facilities (Nishtar and Amjad 2009). Many of these initiatives are successful in raising the level of awareness of positive health behaviors among the population (Nishtar and Amjad 2009). However, improvements in health practices within rural areas have not been as successful (Bile 2009).

Provision of Family Planning and Maternal Health Care Services in Pakistan: Lady Health Workers

In order to improve access to maternal and family planning services to rural and poor communities, the Government of Pakistan (GOP) launched the National Program for Family Planning and Primary Health Care, also known as The Lady Health Worker Program (LHWP) in 1994 (Ministry of Public Health Pakistan 2011). The goals of the program included (Development Fund 2011):

- Achieve universal health coverage by addressing primary health care problems in the community
- Provide preventative, curative, rehabilitative services

- Bring about community participation through creation of awareness, changing of attitude, organization and mobilization support
- Improve the utilization of health facilities by bridging the communication gap between the community and health services
- Serve in un-served and underserved areas of Pakistan where access is limited

Scope of Work

In this program, LHW's are expected to provide a range of services to communities including: delivery of family planning services, immunizations, treatment of common diseases, health promotion and education. They also provide referrals for women to obtain safe motherhood services including referrals for antenatal care, safe delivery, and postnatal care (Gupta et al. 2007). LHWs work closely with the nearest primary health care facility, traditional birth attendant or other skilled health workers. In terms of family planning services, the program relies on the LHW as a change agent, to encourage married couples to utilize family planning methods by providing education, access to condoms, oral pills, and referrals for IUD insertions, contraceptive surgery, and injectables (Hafeez et al. 2011).

Recruitment and Training

In order to serve as a LHW, women must be a resident of the area to which she is recruited, preferably married between 18-45 years, and have a minimum of a middle school education (Ministry of Health Pakistan 2011). Training of LHWs is conducted in two phases totaling 15 months, coupled with continued training and refresher courses. The first phase of training includes 3 months of structured class room work and the second phase includes 12 months of field work with a supervisor. During the second

phase, LHWs return every four weeks for a one week formal training session. The training is conducted at the health facility with a medical officer, a Lady Health Visitor (who is considered a skilled birth attendant) and a health technician (Ministry of Health Pakistan 2011).

Coverage

LHWs are considered contract workers and are associated with a government health facility where they are trained and receive medical supplies. They receive a small stipend each month and are paid during training. LHWs are assigned to health facility catchment areas and each worker serves approximately 1,000 residents. In areas where the population is scattered, LHWs may serve less individuals. LHWs serve in clusters which consist of approximately 100 to 200 households, and should be able to reach the farthest household within one hour of walking. Generally the LHW makes on average 5-7 home-visits a day. In addition, the LHW residence is considered a health house, where the community may go to access services in emergencies. The working hours of the LHW are relatively flexible and they do not actually report to duty. They are expected to visit the local health facility once a month to collect supplies, continued educational sessions, and to submit monthly reports. The services and supplies provided to the community are free of cost (Ministry of Health Pakistan 2011).

Phase 1 of the implementation strategy, only 37,838 LHWs were trained, less than 50% of the original 100,000 planned during this period (Oxford Policy Management 2002). By July 2002, Pakistan launched a new population policy with goals to increase access to family planning and health services and expand the LHW program (Douthwaite

2005). At the end of 2010, there were approximately 90,000 LHWs nationwide serving rural and urban slum areas (Oxford Policy Management 2009).

Evaluations of maternal health and family planning programs:

Methodological concerns arise in the evaluation of health programs when programs are selectively assigned to areas where health outcomes are poor, or where programs can easily be rolled out through the existing health infrastructure. Targeting programs to specific communities will not complicate evaluation efforts when characteristics are observed and controlled for in statistical models (Frankenberg et al. 2005; Angeles et al. 1998). A growing body of literature suggests that when purposive program placement is based on unobserved characteristics (social capital, cultural norms, decision maker's preferences etc.) and those characteristics are correlated to the outcome of interest, the effect of the program will be biased (Frankenberg and Duncan 2001; Angeles et al. 1998; Gertler and Molyneaux 1994; Rosenzweig et al. 1986). The effects of the program may be overestimated or underestimated when potential sources of endogeneity (unobserved factors) are not controlled (Rosenzweig et al. 1986; Gertler and Molyneaux 1994; Angeles et al. 1998; Guilkey and Hutchinson 2011).

Angeles, Guilkey and Mroz provide a basic example of this point. Suppose a government focuses on reduction of fertility in high fertility areas by opening clinics in these locations. After the implementation of the program, the high level of fertility declines. It is possible that the fertility levels of where the clinic was placed may potentially still be above the level of fertility in places where the clinic was not placed (Angeles et al. 1998). This may be due to the shear fact the places where the clinics have been placed had such a high fertility level in the first place. Therefore it may appear that

the program was less effective than it actually had been. Thus, without taking into account that the program was purposively placed, impact estimates may be biased (Angeles et al. 1998).

Prior Evaluations of the LHWP and limitations in estimation methods:

Prior evaluations have examined the impact of the LHWP on health outcomes. In 2008, a nationally representative population based survey was commissioned by the Ministry of Health in Pakistan to gather information on clinical knowledge/support of LHWs, work patterns, health indictors of populations served by LHW, and overall impact of the program for a wide variety of indicators (Oxford Policy Management 2009). The survey covered 5,278 households in both urban slums and rural areas and 554 LHWs. The survey found that households served by LHWs tend to be more advantaged than national populations; LHW households are more likely to be salaried, own their own home, have better facilities at home, and are literate. A propensity score matching approach was used to compare outcomes for served and un-served households. The results of the analysis found that the LHWP had a positive impact on family planning and antenatal care. Women living in served areas were 11 percentage points more likely to be using modern family planning methods and 5.4 percentage points more likely to use reversible contraceptives. Women who had a birth in the 3 years before the survey were 13 percentage points more likely to have had tetanus toxoid during their pregnancy, and neo-natal check-ups are 15 percentage points more likely to have occurred (Oxford Policy Management 2009). However, one of the key limitations of the propensity score method is that it can only adjust for observed covariates and is unable to adjust for unobservable factors that may affect placement (Rosenbaum 1983; Rubin and Thomas

1997; Yanovitzky 2005). In addition, this method does not allow for a test of endogeneity (examining whether unobservable factors affect both exposure and program placement) (Hutchinson and Wheeler 2006). If selective program placement is an issue, naïve and matching estimators will produce biased estimates of the impact of the program (Hutchinson and Wheeler 2006). Finally, this study did not estimate the effects of the program on contraceptive use separately for urban slum and rural areas.

An earlier evaluation conducted in 2000-2001 which was funded by the Department of International Development United Kingdom examined program management systems and the impact of the program on a number of health outcomes between LHW areas and comparison areas. The survey covered a total of 5,161 households and interviewed all ever-married women between 15-49 years (Oxford Policy Management 2002). A sub-sample of women was used to examine the impact of the program on use of reversible contraceptives in rural areas among currently married women (Douthwaite 2005). A total of 4,277 women were included in the analysis, 931 in comparison areas and 3346 in LHW areas. Bivariate results found that LHW areas were more advantaged than comparison areas on many socio-economic indicators including literacy, mobility, and wealth. Logistic regression results indicate that current use of reversible modern methods was 1.5 times higher in rural program areas compared to comparison areas (Douthwaite 2005). However, there are several limitations to this study including the lack of community and health facility characteristics controlled for within the model. Likewise, this evaluation occurred prior to the expansion of the program in 2002 and no statistical method was used to control for non-random program placement despite the significant differences between served and comparison areas.

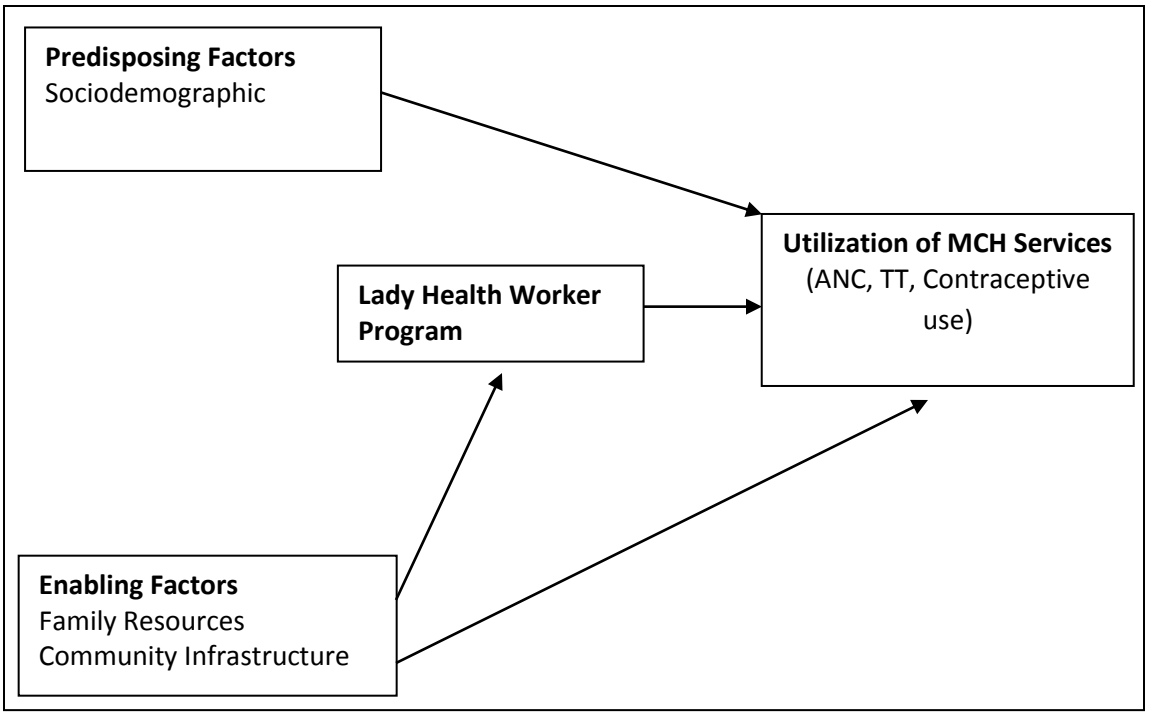
Finally, a separate study conducted by the World Bank using nationally representative data from the Pakistan Integrated Household Survey 2001-02 examined determinants of LHW placement and the impact of the program on reproductive and child health outcomes (Gupta et al. 2007). A total of 7,850 women were included in the analysis, 2,276 in LHW areas and 5,574 in comparison areas. The results from probit estimations indicate that women living in areas with a LHW were 3 percentage points more likely to utilize contraceptives compared to women living in comparison areas. In addition, women living in a community with a LHW were 6 percentage points more likely have tetanus toxoid injections compared to their counterparts in comparison areas. This study also found that more developed areas with a girl's middle school and a basic health unit in the community were more likely to have a LHW (Gupta et al. 2007). Similar to the prior studies cited, this study did not take into account non-random program placement which may significantly bias estimated effects. In addition, the study results presented occurred prior to the expansion of the program in 2002.

CONCEPTUAL FRAMEWORK

Figure 1 depicts the conceptual model used in this study. The Anderson behavioral model and its modifications are commonly used to examine health service utilization in a number of developing countries (Anderson 1968; Fosu 1994; Amin et al. 2010). The model supposes that the use of health services is a function of three key sets of characteristics: predisposing, enabling, and need (Anderson and Newman 1973). For the purposes of this study, the behavioral model has been slightly modified to incorporate the relationship between LHW and health service utilization. The model further suggests that health service utilization is based on a process where predisposing factors are

exogenous, and where some enabling resources are necessary but may not be sufficient to the use of services. Predisposing factors include demographic/social factors such as age, province, women's highest level of education, number of living children, fertility preference, knowledge of contraception, literacy, heard family planning messages on radio, heard family planning messages on TV, and partner's education. These factors underscore the idea that some individuals have a greater propensity to utilize services than others based on demographic and attitudinal factors. Health beliefs and women's autonomy are also considered a part of predisposing factors which may influence health service use; however questions related to empowerment were not available in the PDHS. Enabling factors incorporate family/community level factors which may include family resources or other sources which help to use or receive health services. Enabling factors in this dissertation include; wealth, type of road, availability of basic health unit/family planning center/maternal health center and private provider with 5km, private. These factors reflect the fact that some factors may promote or hinder the used of services. The presence of predisposing and enabling factors may not be enough to seek care. According to Anderson and Newman, the need factor reflects the perceived health status by the severity of the morbidity conditions or the number of the morbidities (Anderson and Newman 1973). For the purpose of this study the need component is integrated by the fact that the sample are women who are ever-married 15-49 years of age who have already given birth. In this model, it is hypothesized that community level factors may have affected the placement of lady health worker in communities. Therefore, exposure to a lady health worker may be endogenous. An instrumental variable method described in chapter 2 will be used to test and control for endogeneity.

Figure 1: Conceptual Model



Given the gap in the existing literature, this dissertation makes three key contributions. To the author's knowledge, this is the first study to test and control for non-random placement of LHW's in communities due to unobserved confounding using a novel set of geographic exclusion criteria. Second, this study focuses on the effect of the LHW program on maternal health and family planning services specifically in rural areas of Pakistan where there are high levels of unmet need and a lack of adequate service provision. Third, this study will provide greater insight into the determinants of LHW program placement in rural areas of Pakistan.

CHAPTER 2: THE EFFECT OF THE LADY HEALTH WORKER PROGRAM ON REVERSIBLE CONTRACEPTIVE USE IN RURAL PAKISTAN

INTRODUCTION

Family planning programs have been implemented widely in developing countries in order to increase contraceptive use, lower fertility, and reduce population growth rates. The benefits of such programs on the health of mothers and children are widely documented. Family planning allows for women to prevent unintended pregnancies and reduce the number of unsafe abortions thereby reducing maternal deaths (PRB 2009; Cleland et al. 2006). Likewise, the use of family planning also results in wider intervals between births resulting in a reduced risk of fetal death, low birth weight, and infant mortality (Cleland et al. 2006; Rutstein 2005; PRB 2009).

One of the most commonly used approaches to family planning has been community-based programs which attempt to improve access and demand for services often in rural areas (Prata et al. 2005). This strategy utilizes village-level volunteer workers to provide contraceptives and information on family planning. The Lady Health Worker Program (LHWP) in Pakistan is one such example of a successful community health worker program tasked with providing access to maternal health and family planning services. However, these community health workers and programs are often assigned to areas with high fertility rates, where health outcomes are poor, or where programs can easily be rolled out through the existing health infrastructure (Frankenberg

et al. 2005; Angeles et al. 1998). Targeting programs to specific communities will not complicate evaluation efforts when characteristics are observed and controlled for in statistical models (Frankenberg et al. 2005; Angeles et al. 1998). A growing body of literature suggests that when purposive program placement is based on unobserved characteristics (social capital, cultural norms, decision maker's preferences etc.) and those characteristics are correlated to the outcome of interest, the effect of the program will be biased (Frankenberg and Duncan 2001; Angeles et al. 1998; Gertler and Molyneaux 1994; Rosenzweig et al. 1986). The effects of the program may be overestimated or underestimated when potential sources of confounding are not controlled (Rosenzweig et al. 1986; Gerler and Molyneaux 1994; Angeles et al. 1998; Guilkey and Hutchinson 2011).

A number of family planning evaluations have attempted to take into account the non-random program placement problem using advanced statistical techniques including instrumental variables and fixed effects estimators. Angeles (1998) utilized a two-stage least squares model to examine fertility levels by using variables that influenced program placement but that were unrelated to individual fertility. This study found that in Tanzania the effect of access to family planning hospitals on births was overstated while the impact of access to health centers was underestimated when non-random program placement is ignored. Gertler and Molyneaux (1994) used a fixed effect estimation procedure to examine the impact of family planning programs on fertility in Indonesia while controlling for endogenous program placement. Results indicate that the effects of the program on fertility were marginal and naïve estimation procedures would lead to misleading results. Frankenberg (2005) also utilized Indonesian data and a fixed-effects

approach to examine the impact of a village midwife program on children's health status. Results indicate that that the nutritional status of a child exposed to a midwife was better compared to children in communities without a midwife after controlling for non-random program placement. Thomas and Maluccio (1996) found that mobile family planning clinics resulted in a significant increase in contraceptive use in Zimbabwe while accounting for endogeneity. A separate study by Schwartz (2000) utilized an instrumental variable (IV) approach to examine the effects of health expenditures on contraceptive use and immunizations in the Philippines. Results suggested the municipal-level expenditures were endogenous and naive estimation procedures would underestimate their impact on health outcomes. Finally, an evaluation of a family planning media campaign on modern contraceptive use found that naïve estimation procedures underestimated the effect of the program by 49% compared to models that account for endogeneity (Guilkey and Hutchinson 2011).

Given that non-random placement of family planning programs can significantly bias program effect estimates, this study utilizes an instrumental variable approach to examine the effectiveness of a national family planning program, the Lady Health Worker Program (LHWP) in rural Pakistan on the use of reversible contraceptive methods among ever-married woman 15-49 years. In addition, this study will also explore determinants of LHW placement in rural Pakistani communities.

BACKGROUND

Although Pakistan was one of the first countries in South Asia to introduce a national family planning policy, progress over the last four decades has been slow. Fertility rates have declined from 6.5 in 1980 to 4.1 in 2006 but remain one of the highest

in South Asia (National Institute of Population Studies 2008; Carton and Agha 2011). In 2009, Pakistan had an estimated population of 170 million and is continuing to grow at a rate of 1.9 percent per year (Pakistan Ministry of Finance 2009). Based on UN projections, Pakistan will be the third most populous country by the year 2050 (Pakistan Ministry of Finance 2009). Modern contraceptive use has increased in the last decade from 12% in 1990 to 22% in 2006, however high levels of unmet need remain, especially in rural areas (National Institute of Population Studies 2008; Carton and Agha 2011). In 2006, 25% of women wanted to limit or space their births but were not using contraception (National Institute of Population Studies 2008).

In order to improve quality and access to primary health care services the Government of Pakistan launched The National Program for Family Planning and Primary Health Care, also known as The Lady Health Worker Program (LHWP) in 1994 (Ministry of Health Pakistan 2011). These community health workers provide a range of services to urban slums and rural areas including: delivery of family planning services, antenatal care, childhood immunizations, treatment of common diseases, health promotion and education. In terms of family planning, the program relies on the LHW as a change agent, to encourage married couples to utilize family planning methods by providing education, access to condoms, oral pills, injectables and referrals for IUD insertions, and surgery (Hafeez et al. 2011). In Phase 1 of the implementation strategy, only 37,838 LHWs were trained, less than 50% of the original 100,000 planned during this period (Oxford Policy Management 2002). By July 2002, Pakistan launched a new population policy with goals to increase access to family planning and health services and expand the LHW program (Douthwaite 2005) At the end of 2010, there were

approximately 90,000 LHWs nationwide serving rural and urban slum areas (Oxford Policy Management 2009).

In order to serve as a LHW, women must be a resident of the area to which she is recruited, preferably married between 18-45 years, and have minimum of a middle school education (Ministry of Health Pakistan 2011). Training of LHWs is conducted in two phases totaling 15 months, coupled with continued training and refresher courses. LHWs are considered contract workers and are associated with a functioning health facility where they are trained and receive medical supplies. They receive a small stipend each month and are paid during training. LHWs are assigned to health facility catchment areas and each worker serves approximately 1,000 residents. In areas where the population is scattered, LHWs may serve less individuals. LHWs serve in clusters which consist of approximately 100 to 200 households, and should be able to reach the farthest household within one hour of walking. Generally the LHW makes on average 5-7 home-visits a day. In addition, the LHW residence is considered a health house, where the community may go to access services in emergencies. The working hours of the LHW are relatively flexible and they do not actually report to duty. They are expected to visit the local health facility once a month to collect supplies, continued educational sessions, and to submit monthly reports. The services and supplies provided to the community are free of cost (Ministry of Health Pakistan 2011).

Prior evaluations have examined the impact of the LHWP on health outcomes. In 2008, a nationally representative population based survey was commissioned by the Ministry of Health in Pakistan to gather information on clinical knowledge/support of LHWs, work patterns, health indictors of populations served by LHW, and overall impact

of the program for a wide variety of indicators (Oxford Policy Management 2009). The survey covered 5,278 households in both urban slums and rural areas and 554 LHWs. The survey found that households served by LHWs tend to be more advantaged than national populations; LHW households are more likely to be salaried, own their own home, have better facilities at home and to be literate. A propensity score matching approach was used to compare outcomes for served and un-served households. The results of the analysis found that the LHWP had a positive impact on family planning and antenatal care. Women living in served areas were 11 percentage points more likely to be using modern family planning methods and 5.4 percentage points more likely to use reversible contraceptives. Women who had a birth in the 3 years before the survey were 13 percentage points more likely to have had tetanus toxoid during their pregnancy, and neo-natal check-ups are 15 percentage points more likely to have occurred (Oxford Policy Management 2009). However, one of the key limitations of the propensity score method is that it can only adjust for observed covariates and is unable to adjust for unobservable factors that may affect placement (Rosenbaum 1983; Rubin and Thomas 1997; Yanovitzky 2005). In addition, this method does not allow for a test of endogeneity examining whether unobservable factors affect both exposure and program placement (Hutchinson and Wheeler 2006). If endogeneity is an issue, naïve and matching estimators will produce biased estimates of the impact of the program (Hutchinson and Wheeler 2006). Finally, this study did not estimate the effects of the program on contraceptive use separately for urban slum and rural areas.

An earlier evaluation conducted in 2000-2001 which was funded by the Department of International Development examined program management systems and

the impact of the program on a number of health outcomes between LHW areas and comparison areas. The survey covered a total of 5,161 households and interviewed all ever-married women between 15-49 years (Oxford Policy Management 2002). A sub-sample of women was used to examine the impact of the program on use of reversible contraceptives in rural areas among currently married women (Douthwaite 2005). A total of 4,277 women were included in the analysis, 931 in comparison areas and 3346 in LHW areas. Bivariate results found that LHW areas were more advantaged than comparison areas on many socio-economic indicators including literacy, mobility, and wealth. Logistic regression results indicate that current use of reversible modern methods was 1.5 times higher in rural program areas compared to comparison areas (Douthwaite 2005). However, there are several limitations to this study including the lack of lack community and health facility characteristics controlled for within the model. Likewise, this evaluation occurred prior to the expansion of the program in 2002 and no statistical method was used to control for non-random program placement despite the significant differences between served and comparison areas.

Finally, a separate study conducted by the World Bank using nationally representative data from the Pakistan Integrated Household Survey 2001-02 examined determinants of LHW placement and the impact of the program on reproductive and child health outcomes (Gupta et al. 2007). A total of 7,850 women were included in the analysis, 2,276 in LHW areas and 5,574 in comparison areas. The results from probit estimations indicate that women living in areas with a LHW were 3 percentage points more likely to utilize contraceptives compared to women living in comparison areas. In addition, women living in a community with a LHW were 6 percentage points more

likely have tetanus toxoid injections compared to their counterparts in comparison areas. This study also found that more developed areas with a girl's middle school and a basic health unit in the community were more likely to have a LHW (Gupta et al. 2007). Similar to the prior studies cited, this study did not take into account non-random program placement which may significantly bias estimated effects. In addition, the study results presented occurred prior to the expansion of the program in 2002.

DATA

This study utilizes two sources of data to examine the impact of LHW program on reversible contraceptive use and determinants of program placement in rural Pakistan: the 2006-2007 Pakistan Demographic and Health Survey (PDHS) and the 2006 Pakistan Community-level Rural Survey (National Institute of Population Studies 2008). The PDHS was executed under the Ministry of Population Welfare and implemented through the National Institute of Population Studies (NIPS). This is the largest household survey conducted in Pakistan and the second-ever DHS undertaken. This survey gathered information on household background statistics, family planning, prenatal/postnatal care, immunizations, HIV/Aids, and breastfeeding practices. The sample for the PDHS is representative of the population of Pakistan excluding restricted military areas and the Federally Administered Northern Areas (FANA). The Federally Administered Tribal Areas (FATA) was also excluded from the survey due to security and political concerns. The survey utilized a two-stage random sample design. In the first stage of sampling, 1,000 clusters were selected using the probability proportional to size method, with 390 clusters in urban areas and 610 in rural areas. However, only 972 clusters were covered because of political resistance. The second stage of sampling focused on household

selection. In each cluster, 105 households were selected by systematic random sampling technique. Out of 105 sampled households, ten households in each cluster were selected using a systematic random sampling procedure to conduct interviews for the Long Household and the Women's Questionnaires. Any ever-married woman aged 15-49 years who was a usual resident of the household was eligible for interview. In rural areas a total of 5,569 households and 6,193 women were interviewed.

The Community-level Rural Survey was designed to gather information on the following: availability/distance of various health/family planning services, infrastructure development, and education (National Institute of Population Studies 2008). In each rural cluster, a key informant who was representative of the community was selected to answer the community-level questionnaire. Informants were often selected based on their participation in community council groups who are keenly aware of activities occurring within their localities. 582 rural clusters of the Pakistan Demographic and Health Survey were sampled. A total of 4 of the clusters were not visited at all, data for 3 clusters were missing, and 5 clusters were not completed. Of these 570 community questionnaires completed, only 540 had complete information on distances to health facilities and availability of services within villages. Household and community-level datasets are linked through the cluster ID number present in both surveys. A total of 5,699 women had complete community-level information.

This analysis focuses on the impact of the LHW program on reversible contraceptive use in rural areas of Pakistan and examines the determinants of community level placement of the program. The outcome measure of whether women are currently using reversible contraceptive methods was constructed using as a dichotomous variable

as defined by 1= oral pill, IUD, injectable, implants, condom, and diaphragm[1]. The explanatory variable of interest was a binary variable capturing whether a village has a LHW present. The study sample was reduced to 4,594 who answered the question concerning contraceptive use and who had complete information on community level factors. In particular women (n=326) who were sterilized were excluded due to collinearity with fertility preference and due to the fact that many sterilizations pre-date the initiation of the LHW program (Douthwaite 2005). However, there is a possibility that some of these women received referrals for sterilization from a LHW. In addition, 778 women were excluded because they were not asked questions regarding contraceptive use given they were not currently married.

The control characteristics selected for inclusion in this analysis were based on key factors affecting contraceptive choice. Basic demographic factors included number of living children (0-1, 2-3, 4+), age (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49), and province (Punjab, Sindh, NWFP, Baluchistan). Socioeconomic factors included women's highest level of education (no education, primary, secondary, higher), partners highest level of education (no education, primary, secondary, higher), current work status (yes working/not working), literate (yes/no), and quintiles for socioeconomic status (poorest, poorer, middle, richer, richest). Community level variables included paved road to main district (yes/no), availability of a basic health unit within 5km (yes/no), maternal health center within 5km (yes/no), family planning center within 5km (yes/no), private provider with 5km (yes/no), motorized public transport present in the village (yes/no), middle school present in village (yes/no), presence of a post office and availability of telephone line service in village. These factors were included in the model to capture

[1] Although reversible contraceptive use includes diaphragm, there were no users in the PDHS

accessibility of services and the level of development of rural communities. Additional factors included in the models included exposure to family planning on television (yes/no), exposure to family planning messages on the radio (yes/no), and desire for more children (more, no more, undecided). Health facility and educational variables were examined for collinearity. Given the low degree of correlation between the variables, all were included in the final model.

ESTIMATION STRATEGY

In order to estimate the effect of the LHW program on reversible contraceptive use, a bivariate probit model was used because of the dichotomous dependent and independent variable of interest (Manddala 1983). This strategy utilizes simultaneous equations to address and test the problem of endogeneity of program placement. An individual's underlying propensity to use contraceptives, Y_{ij}*, is given by the Eq.(1) where *i* represents the individual and *j* represents the community:

$$Y_{ij}^* = \alpha_0 + \sum_k \alpha_k X_{k(ij)} + \alpha_2 P_1 + \varepsilon_{1i} \quad (1)$$

$$Y_{ij} = \begin{cases} 1 \; if \; Y_{ij}^* \geq 0 \\ 0 \; if \; Y_{ij}^* < 0 \end{cases}$$

A woman *i* utilizes contraception (Y_{ij}=1) when $Y_{ij}^* \geq 0$, and does not utilize contraception (Y_{ij}=0) when $Y_{ij}^* < 0$. The vector X_k represents exogenous individual and community-level factors, including age, province, highest level of education, number of living children, fertility preference, literacy, currently working, heard family planning messages on radio, heard family planning messages on TV, partner's highest level of education, wealth, type of road, availability of basic health unit with 5km, maternal health center within 5km, family planning center within 5km, private health care provider within 5km, and motorized public transport in the village. The main parameter of interest is α_2, which

represents the effect of the LHW program on contraceptive use, controlling for all other factors. P_1 represents the LHW program, and is equal to 1 if an LHW is present in a community and 0 if an LHW is not present. In Eq. (2), the LHW program is present when $P_{1i}^{*}>0$ program, and is given by the following:

$$P_{1i}^{*} = \beta_0 + \sum_j \beta_j X_{ij} + \sum_{k=1}^{2} \Upsilon_k Z_{ki} + \varepsilon_{2i} \qquad (2)$$

where the vector X_{ji} represents the *j*th exogenous factor in community *i* mentioned above, and Z_{ki} represents the instrumental variables including whether a community *i* has telephone service, and the presence of a middle school for girls. The issue of selective program placement arises when the error term of Eq. (1), ε_{1i} is correlated with the unobserved determinants in Eq.(2) ε_{2i}, because of targeted program placement (Bollen 1995). The bivariate model tests the correlation ρ: $E\{[\varepsilon_{1i},\varepsilon_{2i}]\}=0$. If ρ is equal to zero, then the error terms are not correlated and endogeneity is not an issue (Bollen 1995). In that case, a single-equation probit model can be used to examine the effectiveness of the LHW on reversible contraceptive use without biasing estimates. If ρ is significantly different from zero, then one can conclude that the placement of a LHW is endogenous in Eq. 2. Thus, the bivariate probit maximum likelihood model will provide unbiased estimates of the effectiveness of the program on reversible contraceptive use.

Instruments

As noted above, one method to solve non-random program placement is through an instrumental variable (IV) approach. The instrumental variable method requires two key assumptions: 1) that the variable is highly correlated to the treatment variable (communities with a LHW in this case), 2) the variable cannot directly affect the outcome

(contraceptive use) (Cameron and Trivedi 2005; Wooldridge 2002; Newhouse and McClellan 1998). The idea is that these instruments can be used to "simulate" random assignment (Newhouse et al 1998). The two instruments used in this analysis include the availability of telephone service within a community and whether a community has a girl's middle school. Infrastructure (individual/community-level) and geographic variables are common sources of instruments and have been used within the literature as valid methods to deal with endogeneity concerns (Ravallion and Wodon 1999; Portner and Beegle 2011; Hutchinson et al. 2006). The availability of telephone service within a community and whether a community has a girl's middle school were both constructed based on the rural community level questionnaire. These particular variables were selected with the intention to measure LHW placement using an indicator not directly related to the dependent variables of interest. The theoretical rationale behind use of these instruments is that selection and recruitment of an LHW require they have a middle school education, be from the community they intend to work in, and be placed in an area with a functioning health facility (Ministry of Health Pakistan 2011). Thus, areas with a middle school present may be more likely to have an LHW placed in the community because of the ease in meeting recruitment requirements. Rural communities which have telephone-line services (inevitably electricity) may be more likely to have an LHW because it may make it easier to contact community-level staff within functioning facility catchment areas. This is supported by prior evidence from a World Bank study that found the most significant predictor of LHW program placement were communities with a middle school (Gupta et al. 2007). This study also found that communities that were more developed were more likely to have a LHW, although presence of a telephone line

was not specifically used in the analysis (Gupta et al. 2007). In addition to the instrumental variable results, naïve probit estimations are also presented for comparison purposes. All regressions take into account the multi-stage sampling design by using the 'cluster' command in Stata version 10.0.

RESULTS

Sample Characteristics

Table 1 provides weighted descriptive statistics for the population served by LHWs and comparison areas. Overall, women who live in communities with a LHW tend to be more educated, literate, and wealthier than those not exposed to LHW. The age distribution of women was relatively similar between women exposed to LHW and those who were not. There were small differences in the number of living children between served and comparison areas for women with 0-1 living children. A greater portion of women served by LHWs live in the most developed province of Punjab (67.4%) and have higher levels of education compared to their counterparts. Nonetheless both populations have very high proportions of women who have no education (70.0% vs. 82.1%). However, women in LHW areas were significantly more literate than women in comparison areas. In the LHW area, women's partners are significantly more educated at secondary and higher-levels compared to the comparison areas. Likewise, a greater portion of women living in served areas are located closer to family planning centers, private providers, maternal health centers and basic health units compared to comparison areas. There are also significant differences in structural characteristics of communities in both areas. A greater portion of populations in LHWs areas compared to comparison areas have access to motorized transport (71.3% vs. 53.3%), a girls middle schools

located in the village (26.7% vs. 7.4%), telephone line service (71.6% vs. 44.8%), post office (42.0% vs. 10.0%) and paved roads (82.0% vs. 78.3%).

Table 2 describes family planning characteristics for ever-married women who live in program and comparison areas. Approximately 12.8% of women living in program areas were using modern reversible conceptive methods compared to 8.0% of women in comparison areas. A large proportion of women in both the LHW (79.4%) and comparison (86.8%) areas are not using contraceptives. When asked if women wanted more children about one-half of women (50.6%) in LHW areas did not want more compared to 45.2% in comparison areas. Knowledge of modern contraceptives was relatively high in the served (96.5%) and comparison (91.8%) populations. Finally a significantly larger proportion of women were exposed to family planning messages on the radio and television in LHW areas compared to comparison areas.

Factors associated with placement of LHWs

Given that women who were exposed to LHWs appear to be significantly better off compared their counterparts, a closer examination of the determinants of program placement through a community-level regression is essential. Table 3 presents odds ratios from the logistic regression of factors associated with the presence of a LHW in 540 communities. The dependent variable is defined as equal to 1 when a LHW is present in a community and 0 when an LHW is not present. Data suggests that women living in Sindh, NWFP, and Baluchistan were significantly less likely to have a LHW present in a rural community compared to villages in Punjab province. This isn't terribly surprising given that Punjab province is much more secure, developed, and wealthier than

extremely remote province of Baluchistan and NWFP (National Institute of Population 2008). Areas with a relatively developed community infrastructures were significantly more likely to have access to a LHW in their community. The availability of a basic health unit, maternal and child health center and private provider within 5km were not statistically significant predictors of placement of the program. However, communities with an available family planning center within 5km were almost 2 times more likely to have a LHW present. The most significant predictor of placement of a LHW in rural communities were the availability of girl's middle school (OR: 3.11) and a post office (OR: 3.56). Villages with telephone lines were almost twice (OR: 1.90) as likely to have access to a LHW as villages without. Although, the two instruments suggested for this analysis, availability of telephone lines and a middle school within a community are predictors of the placement of the program, tests for the validity of the instruments can only be conducted using a simultaneous equation (bivariate probit model).

Testing for Non-random Program Placement

In order examine whether non-random program placement is a significant issue, the correlation between error terms of Eq.1 and Eq.2 were tested: ρ: E{[ε_{1i},ε_{2i}]}=0. Results of this test indicated, ρ was statistically significant, with a p=0.01, therefore we would strongly reject the null hypothesis of exogeneity (ρ = 0.00) and conclude there is endogeneity within the model. Thus, utilizing a naïve estimation procedure such as single-equation regression model or propensity score matching estimators will produce biased estimates of the effect of the LHW program.

Identification tests

The validity of the bivariate maximum likelihood estimations hinge upon the validity of the instrument variables used, telephone line and availability of a girl's middle school in a village. The specification tests located at the bottom of Table 4 validate the instruments. In order for the bivariate probit model to be correctly identified, the strength of the instruments in predicting program placement was first tested using both equations. A joint test of the null hypothesis that these two instruments have no effect on predicting program placement yielded a p-value of zero, indicating strong joint significance. An over-identification test was then conducted to determine if the instruments were validly excluded from the main outcome equation (Eq.1). Based on a p-value of .467, we accept the null hypothesis that the instruments have no effect on the outcome. The exclusions restrictions are valid both as predictors of program placement and are validly excluded from the contraceptive equation. Therefore, the bivariate probit maximum likelihood estimation model will produce unbiased estimates of the program effect.

Estimation results

Table 4 presents the naïve probit and bivariate coefficient estimations of the effect of the LHWP on the use of reversible contraceptive methods among rural ever-married woman. Given that non-random program placement was a significant issue, results focus primarily on the bivariate model. The sign and significance for most coefficients are as expected. Results indicated that the effect of exposure to LHW on reversible contraceptive use is positive and statistically significant in both the naïve and the IV estimations. As expected, women with a 0-1 and 2-3 children were less likely to utilize contraceptives compared to women with 4 or more. Similarly, wealthier households are

more likely to utilize contraceptives, an effect that appears to increase with each additional wealth quintile. Interaction terms were created to examine the differential effect of the program between wealth quintiles; however findings indicate that all of the terms were insignificant and therefore left out of the final model. This suggests that LHWs services had the same effect between poorer and wealthier families on reversible contraceptive use in rural areas. Other key findings suggest that husbands education (higher or primary compared to none), is a statistically significant predictor of contraceptive use, although women's education did not appear to have a statistically significant effect. Within both the naïve probit and IV model the facility level variables did not have any statistically significant effects on contraceptive use.

In order to quantify the overall effect of the program on reversible contraceptive use, simulations were conducted using predicted probabilities where the LHW variable was set to 1 then 0 with all the other variables set to their sample value. Based on the marginal effects (difference between predicted probabilities) in Figure 2, the probit model indicated that access to a LHW increase the probability of utilizing contraceptives by 2.22 percentage points. After taking into account endogeneity with the bivariate probit model, the effect of the program is substantially larger with a 9.93 percentage point increase in reversible contraceptive use. The bivariate probit estimations are almost 4.5 times higher than the basic probit model.

DISCUSSION

This study utilized a nationally representative cross-sectional survey and a rural community-level survey to examine the impact of the National Lady Health Worker Program on the likelihood that women between 15-49 years use reversible contraceptives

in rural areas of Pakistan. For the purposes of this analysis, non-random program placement is tested and controlled for using an IV approach with a novel set of geographic instruments (availability of a middle school and telephone lines). The geographic characteristics are reflective of factors that influence program placement due to recruiting and placement requirements, while not affecting reversible contraceptive use directly. Based on the specification tests, both instruments are strong predictors of program placement and are validly excluded from the contraceptive equation providing strong support for their use.

In accordance with previous studies, basic bivariate comparisons in Table 1 and Table 2 reveal that women who live in communities with a LHW tend to be more educated, literate, and wealthier than those not exposed to LHW (Douthwaite 2005; Gupta et al. 2007; Oxford Policy Management 2009). Results from the community-level logistic regression on determinants of LHW placement indicate that communities with developed infrastructures including access to telephone lines, a post office, and a middle school are more likely to have a LHW. These findings are supported by a previous study conducted by the World Bank in 2002 that found LHWs were more likely to be placed in more developed areas with access to a girl's middle school being the most significant predictors of placement (Gupta et al. 2007). The World Bank study also found access to basic health unit as a major determinant of the placement of the program however, in this study the only health facility factor that was a strong predictor of LHW placement was the availability of a family planning center within 5km of the village. The placement of the program in villages with stronger community and health infrastructures may make it easier to initiate and roll out the program given the ease in meeting recruiting

requirements. As the program continues to expand to increasingly more rural communities and given that remote rural areas of Pakistan have the lowest levels of contraceptive use (National Institute of Population Studies 2008) – it will be important that the LHW program adapt recruiting mechanisms to more fully reach these areas. One potential avenue could include the recruitment of women with basic literacy skills to be LHWs. This approach was utilized in Afghanistan and was proven to be effective in improving ANC and contraceptive use at the community-level (Viswanathan et al. 2011).

The results from the bivariate probit and naïve probit models suggest that women living in a rural community with LHW are more likely to use reversible contraceptives compared to comparison areas. However, ignoring non-random program placement in the reversible contraceptive equation can lead to a significant underestimation of the program effect. Specifically, after taking into account selective program placement, access to a LHW increased the probability of utilizing reversible contraceptives by over 4-fold compared to naïve estimation procedures. In other words, there would appear to be far fewer users of reversible contraceptives predicted with naive estimation and matching procedures than with methods that take into account non-random program placement. Therefore in the case of the LHWP, testing and controlling for program placement is clearly essential to estimating accurate impact estimates. Moreover, these findings have significant cost-effective implications because calculations require robust estimates of program effect. The LHWP would appear to be less cost-effective than it actually was when non-random program placement is taken into account. Given that the Government of Pakistan is the largest funder of the LHWP (Oxford Management 2009) and decision

makers often utilize cost effective analyses to make informed decisions with limited resources – inaccurate estimations could lead to less funding for the program.

Why is there such a drastic underestimation of the results using a naïve probit model? Based on the direction of the bias, it appears that unobservable characteristics that decrease the probability of contraceptive use are correlated with unobservable characteristics that increase the probability of the placement of the program. Given that there are a number of unobservables which can influence the direction of the bias, one may only hypothesize as to the source. A number of studies have noted a similar bias between naïve models and IV estimates (Rosenzweig et al. 1986; Portner and Beegle 2011; Guilkey and Hutchinson 2011). In particular, these studies found that naïve estimates underestimated the impact of family planning programs on fertility and contraceptive use when compared to models that take into account selective program placement. Such a bias may be due to a compensatory approach towards the allocation of programs, where resources are placed in high fertility areas or where there is a high unmet need for contraceptives (Rosenzweig et al. 1986; Guilkey and Hutchinson 2011). This may very well be possible in rural areas of Pakistan. Despite the fact that the program is located in more developed rural areas, decision makers may have placed LHWs where overall fertility rates and late demand for family planning is high. Low levels of unmeasured prior contraceptive use may also decrease the probability of current contraceptive use and potentially increase the probability of placement of the program.

These findings have several implications for both policy and future research. It has already been demonstrated that the poor and rural populations in Pakistan have the lowest level of contraceptive use and the most difficulty in accessing services

(Douthwaite 2005; Sathar and Kazi 1997). The LHW program sought to target this gap, by providing basic health and family planning services throughout the country. Results from this analysis clearly suggest that access to reversible contraceptives is substantially improved in rural communities with a LHW. However, the placement of LHWs in more developed communities is a significant issue in examining the effect of the program and will lead to biased estimates if ignored. However, given that one cannot predict a priori whether endogenous program placement is a problem, future research on the effectiveness of the LHWP and similar programs should test and control for it where it is an issue. The geographic exclusion restrictions tested and utilized in this analysis may serve as valid predictors of program placement in future work.

This study may suffer from a number of limitations. The use of cross-sectional data limits the analysis of the role of selective program placement. Longitudinal data would allow for changes in health outcomes to be explored when communities introduce a LHW over time. Likewise, the trends in the bias introduced by unobservable factors affecting program placement could be more fully examined with longitudinal data. The two instrumental variables, availability of telephone service and presence of a girl's middle school in communities may be measured with error. Key informants were used to answer the community rural questionnaire to gain insight on the availability of services. If this information does not represent the true infrastructure within communities the instrument will provide biased estimates of the impact of the program. Additionally, there may be a number of unobserved individual and community level characteristics which may influence contraceptive use including: number of LHW's within communities, length of time the LHW has been active in the community, cultural norms,

and restrictions on women's autonomy and movement. Consequently, the simulation estimates may provide inconsistent and inefficient estimates of the effect of the LHW on contraceptive use. Nevertheless, the findings of this study emphasize the importance of controlling for non-random program placement and provide a useful model for future research.

Table 1: Weighted descriptive statistics of ever-married women by area

	LHW n= 2959	**Comparison** n=1636
*5-year age groups**		
15-19	6.36	10.34
20-24	18.11	18.39
25-29	22.80	20.80
30-34	17.19	20.04
35-39	16.06	12.43
40-44	10.40	10.52
45-49	9.08	7.49
*Number of living children**		
0-1	28.94	33.21
2-3	29.45	26.95
4+	41.61	39.85
*Province****		
Baluchistan	3.34	9.84
NWFP	14.00	20.52
Sindh	15.25	27.58
Punjab	67.41	42.06
*Highest education level (Female)****		
No education	70.03	82.08
Primary	15.63	11.59

Secondary	11.28	5.30
Higher	3.06	1.03
*Partners education level****		
No education	36.10	45.22
Primary	18.46	17.43
Secondary	34.30	29.44
Higher	11.50	7.91
*Wealth Quintiles****		
Poorest	22.98	39.30
Poorer	26.26	28.11
Middle	24.24	16.80
Richer	18.68	11.16
Richest	7.83	4.64
Currently working	29.88	30.43
*Literate****	23.00	13.04
Health facility access within 5 km		
Family Planning Center***	47.45	20.00
Private Provider***	55.05	31.51
Maternal Health Center***	25.04	10.71
Basic Health Unit***	65.78	35.92
Availability of structural characteristics with a village		
Motorized transport***	71.28	53.33
Middle school***	26.73	7.43

Telephone-line***	71.58	44.80
Paved roads	82.03	78.29
Post office***	42.00	10.01

Reported significance refer to tests with a null of equality of proportions across the two groups
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Family Planning Characteristics for ever-married women by area

	LHW n=2959	**Comparison** n=1635
*Current Contraceptive use****		
Modern Reversible Contraception	12.77	7.96
Using Traditional /folk	7.80	5.23
No contraceptive use	79.43	86.81
*Fertility Preference****		
Does not want more	50.56	45.18
Wants more children	46.92	52.64
Undecided	2.52	2.18
*Knowledge of Contraceptive methods****		
Knows modern methods	96.54	91.75
Media Messages		
Heard FP messages on radio***	13.45	6.63
Heard FP messages on television***	39.47	22.15

Reported significance refer to tests with a null of equality of proportions across the two groups
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Logit estimates of determinants of LHW placement in rural communities

Measure n=540	Odds Ratio	Std. Error
Province		
(Punjab Referent group)		
Sindh	0.557*	(0.162)
NWFP	0.281***	(0.087)
Baluchistan	0.353**	(0.124)
Community characteristics		
Paved road to main district	0.527*	(0.140)
Telephone lines in community	1.902**	(0.454)
Middle school for girls in community	3.114**	(1.165)
Post Office	3.559***	(1.084)
Motorized vehicle	1.384	(0.329)
Health Facilities within 5km		
Basic Health Unit	1.472	(0.354)
Maternal Health Center	1.349	(0.472)
Private provider	1.681	(0.457)
Family planning	1.901*	(0.534)
Pseudo R2 = .233		
LR chi2 = 162.65		

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Bivariate and naïve probit coefficient estimates of the effect of the LHWP on the use of reversible contraceptive methods

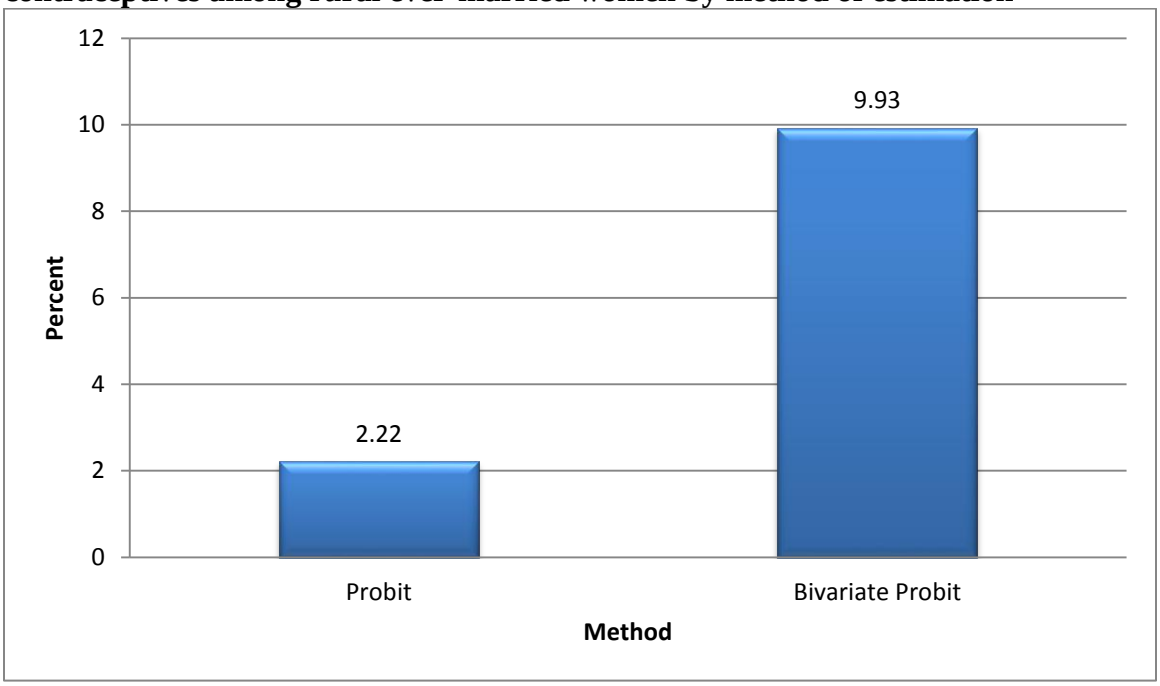
(n=4594)	**Naïve Probit**	**Bivariate Probit**
LHW present	0.148*	0.692***
	(0.067)	(0.210)
Age		
15-19	0.127	0.135
	(0.188)	(0.183)
20-24	0.087	0.085
	(0.098)	(0.095)
25-29 (r)	-	-
30-34	0.228**	0.231**
	(0.085)	(0.083)
35-39	-0.028	-0.045
	(0.095)	(0.093)
40-44	-0.103	-0.094
	(0.108)	(0.106)
45-49	-0.470***	-0.465***
	(0.125)	(0.123)
Province		
Punjab (r)	-	-
Sindh	-0.194*	-0.109
	(0.084)	(0.090)
NWFP	0.158*	0.260**
	(0.073)	(0.081)
Baluchistan	0.051	0.143
	(0.106)	(0.109)
Highest educational level (Female)		
No education (r)	-	-
Primary	0.126	0.104
	(0.096)	(0.095)
Secondary	0.117	0.052
	(0.133)	(0.133)
Higher	0.161	0.056
	(0.190)	(0.192)
Partners highest educational level		
No education (r)	-	-
Primary	0.211**	0.195*
	(0.080)	(0.079)
Secondary	0.085	0.083

	(0.075)	(0.073)
Higher	0.257**	0.221*
	(0.099)	(0.099)
Wealth		
Poorest (r)	-	-
Poorer	0.276**	0.227**
	(0.087)	(0.087)
Middle	0.365***	0.299**
	(0.093)	(0.096)
Richer	0.377***	0.319**
	(0.108)	(0.108)
Richest	0.501***	0.476***
	(0.136)	(0.134)
Currently working	0.120	0.123
	(0.064)	(0.063)
Literate	0.185	0.204
	(0.107)	(0.105)
Fertility preferences		
Wants more children (r)	-	-
Does not want more	0.164*	0.145*
	(0.074)	(0.073)
Undecided	-0.436	-0.459
	(0.247)	(0.241)
Number of living children		
0-1	-1.165***	-1.132***
	(0.120)	(0.120)
2-3	-0.241**	-0.240**
	(0.075)	(0.074)
4+ (r)	-	-
Media Messages		
Heard FP messages on radio	-0.011	-0.035
	(0.086)	(0.085)
Heard FP messages on television	0.220***	0.184**
	(0.065)	(0.066)
Availability of Health Services within 5km		
Basic Health Unit	-0.016	-0.089
	(0.064)	(0.068)
Maternal Health Center	0.010	0.017
	(0.075)	(0.074)
Family Planning Center	0.055	-0.022
	(0.069)	(0.074)
Private provider	0.019	-0.052

	(0.068)	(0.072)
Community variables		
Paved road to main district	0.064	0.097
	(0.073)	(0.072)
Motorized public transport in village	-0.031	-0.079
	(0.062)	(0.064)
Constant	-1.787***	-1.980***
	(0.143)	(0.148)
Instrument variables		
Middle school for girls in community	-	0.711***
		(0.068)
Telephone lines in community	-	0.301***
		(0.049)
Identification Tests		
Test ρ=0		5.79
p-value		0.01
Instrument power (p-value)		0.00
Over-identification test (p-value)		0.467
Log-Likelihood		-3671

Estimated standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 2: Magnitude of effects of exposure to LHWs on the use of reversible contraceptives among rural ever-married women by method of estimation



CHAPTER 3: THE EFFECT OF THE LADY HEALTH WORKER PROGRAM ON USE OF MATERNAL HEALTH SERVICES IN RURAL PAKISTAN

INTRODUCTION

Despite the renewed interests by the global community to improve maternal health and reduce maternal mortality, few countries are on track to meet the Millennium Development Goal 5 which calls for a 75% reduction in maternal mortality by 2015 (WHO 2010). In 2008, approximately 358,000 maternal deaths occurred worldwide, with 99% of the fatalities taking place in developing countries mostly due to complications during labor and delivery (WHO 2010). Pakistan in particular, has one of the highest maternal mortality ratios (MMR) in South Asia at 276 per 100,000 live births and is only exceeded by countries like Afghanistan and Nepal (Khan 2009). The major causes of maternal deaths in Pakistan include postpartum hemorrhage (27%), sepsis (14%), and eclampsia (10%) (National Institute of Population Studies 2008). According to the 2007 Pakistan Demographic and Health Survey (PDHS), only one-third of women had a antenatal visit by their fourth month of pregnancy as recommended by WHO and only 39% of births were assisted by a skilled birth attendant, with significant disparities by urban-rural residence (National Institute of Population Studies 2008).

Most maternal deaths can be prevented by reducing the delays in decision-making to seek medical care (often due to the lack of awareness of obstetric danger signs),

utilizing a skilled attendant at labor and delivery, ensuring availability of emergency obstetric care, and referral to quality health services (Campbell et al. 2006; Goodburn et al. 2001). During the antepartum period, focused antenatal care (ANC) provides an opportunity to identify and manage conditions that may threaten the health of a mother or infant, although research suggests that the effect of ANC on maternal mortality is limited (Corroli et al. 2001; Bergsjø 2001; Rooney 1992; McDonagh, 1996). Nonetheless, routine ANC exposes women to key information about birth preparedness, dangers signs, and where to seek care for pregnancy complications which is particularly important in rural areas where there are low levels of education (WHO AND UNICEF 2003). ANC has been found to be an important determinant of safe delivery (Bloom 1999) and is positively associated with the uptake of postnatal health care services (Chakraborty 2002) potentially contributing indirectly to maternal mortality reduction. Antenatal care visits also provide opportunities for the provision of other preventative health services that can improve maternal health and perinatal survival including: immunizations against neonatal tetanus, prophylactic treatment of malaria, and HIV counseling and testing (WHO AND UNICEF 2003). In particular, immunizing pregnant women against tetanus is one of the most effective methods of reducing neonatal tetanus mortality rates and the incidence of maternal tetanus (Blencowe et al, Gay et al. 2003). In 2008, approximately 59,000 newborns died worldwide due to neonatal tetanus with 508 cases reported in Pakistan alone (Black et al. 2010, WHO 2011).

Community-based programs particularly community health workers (CHWs) are one of the most commonly used approaches to improving maternal and child health outcomes. The World Health Organization defines CHWs as "members of the particular

community where they work, selected by the community, supported by the health system but not necessarily part of its organization, and have shorter trainings than professional workers" (WHO 1989). These health workers often act as extensions of the health system to provide care to rural and underserved areas. CHWs have been found to improve uptake of maternal health services as well as to reduce child morbidity and mortality (Haines et al. 2007; Lewin et al. 2010). A study in Bangladesh found a significant reduction in neonatal morality where CHWs were effective in following mothers through the postnatal period by providing antenatal and postnatal home visits, and promoting birth preparedness and referral for sick neonates (Baqui et al. 2008). Viswanathan et al. (2011) found that CHWs were effective in increasing uptake of contraceptives, antenatal care, and skilled birth attendance in Afghanistan. Kidane and Morrow (2000) results suggest that training volunteer coordinators in Tigray Ethiopia to provide antimalarial drugs reduced under 5 mortality by 40%. A separate study conducted in Tanzania found that village health workers increased women's knowledge of danger signs during pregnancy and increased use of skilled birth attendants (Ahluwalia et al. 2003).

In Pakistan, the Ministry of Health established the Lady Health Worker Program (LHWP) to expand access to health services in urban slum and rural areas. These female community health workers provide a range of services including: delivery of family planning services, tetanus toxoid injection, childhood immunizations, treatment of common diseases, and health promotion/education (Ministry of Health Pakistan 2011). In terms of safe motherhood services (antenatal/postnatal care, safe delivery), LHWs are expected to motivate and refer women to the basic health unit or a skilled birth attendant (Gupta et al. 2007).

In Phase 1 of the implementation strategy, only 37,838 LHWs were trained, less than 50% of the original 100,000 planned during this period (Oxford Policy Management 2002). By July 2002, Pakistan launched a new population policy with goals to increase access to family planning and health services and expand the LHW program (Douthwaite 2005). At the end of 2010, there were approximately 90,000 LHWs nationwide serving rural and urban slum areas (Oxford Policy Management 2009).

In order to serve as a LHW, a woman must be a resident of the area to which she is recruited, preferably married, between 18-45 years, and have minimum of a middle school education (Ministry of Health Pakistan 2011). Training of LHWs is conducted in two phases totaling 15 months, coupled with continued training and refresher courses. LHWs are considered contract workers and are associated with a functioning health facility where they are trained and receive medical supplies. They receive a small stipend each month and are paid during training. LHWs are assigned to health facility catchment areas and each worker serves approximately 1,000 residents. However, in areas where the population is scattered, LHWs may serve less individuals. LHWs serve in clusters which consist of approximately 100 to 200 households, and should be able to reach the farthest household within one hour of walking. Generally the LHW makes on average 5-7 home-visits a day. In addition, the LHW residence is considered a health house, where the community may go to access services in emergencies. The working hours of the LHW are relatively flexible and they do not actually report to duty. They are expected to visit the local health facility once a month to collect supplies, continue educational sessions, and to submit monthly reports. The services and supplies provided to the community are free of cost (Ministry of Health Pakistan 2011).

Prior research has found a positive impact of the LHWP on health outcomes. In 2008, a nationally representative population based survey was commissioned by the Ministry of Health in Pakistan to gather information on clinical knowledge/support of LHWs, work patterns, health indictors of populations served by LHW, and overall impact of the program for a wide variety of indicators (Oxford Policy Management 2009). The survey covered 5,278 households in both urban slums and rural areas and 554 LHWs. The survey found that households served by LHWs tend to be more advantaged than national populations; LHW households are more likely to be salaried, own their own home, have better facilities at home, and to be literate. A propensity score matching approach was used to compare outcomes for served and un-served households. The results of the analysis found that the LHWP had a positive impact on receipt of two tetanus toxoid injections and no effect on receipt of at least one antenatal consultation. A separate study conducted by the World Bank prior to the expansion of the LHW program used nationally representative data from the Pakistan Integrated Household Survey 2001-02 to examine determinants of LHW placement and the impact of the program on reproductive and child health outcomes (Gupta et al. 2007). A total of 7,850 women were included in the analysis, 2,276 in LHW areas and 5,574 in comparison areas. The results from probit estimations indicate that women living in a community with a LHW were 6 percentage points more likely have tetanus toxoid injections compared to their counterparts in comparison areas. This study also found that more developed areas with a girl's middle school and a basic health unit in the community were more likely to have a LHW (Gupta et al. 2007).

However, methodological concerns arise in the evaluation of CHW programs when programs are selectively assigned to areas where health outcomes are poor, or where programs can easily be rolled out through the existing health infrastructure. Targeting programs to specific communities will not complicate evaluation efforts when characteristics are observed and controlled for in statistical models (Frankenberg et al. 2005; Angeles et al. 1998). A growing body of literature suggests that when purposive program placement is based on unobserved characteristics (social capital, cultural norms, decision maker's preferences etc.) and those characteristics are correlated to the outcome of interest, the effect of the program will be biased (Frankenberg and Duncan 2001; Angeles et al. 1998; Gertler and Molyneaux 1994; Rosenzweig et al. 1986). The effects of the program may be overestimated or underestimated when potential sources of endogeneity are not controlled (Rosenzweig et al. 1986; Gertler and Molyneaux 1994; Angeles et al. 1998; Guilkey and Hutchinson 2011). In the case of the LHW program, given that prior evaluations have found substantial differences between served and non-served areas, selective program placement will be tested and addressed with a method described in the next section.

The overall objective of this study is to determine the impact of the LHW program on use of antenatal care and receipt of tetanus toxoid injections in rural areas of Pakistan while taking into account selective program placement concerns.

DATA

This study utilizes two sources of data to examine the impact of the LHW program on use of maternal health services in rural Pakistan: the 2006-2007 Pakistan Demographic and Health Survey (PDHS) and the 2006 Pakistan Community-level Rural

Survey (National Institute of Population Studies 2008). The PDHS was executed under the Ministry of Population Welfare and implemented through the National Institute of Population Studies (NIPS). This is the largest household survey conducted in Pakistan and the second-ever DHS undertaken. This survey gathered information on household background statistics, family planning, prenatal/postnatal care, immunizations, HIV/AIDS, and breastfeeding practices. The sample for the PDHS is representative of the population of Pakistan excluding restricted military areas and the Federally Administered Northern Areas (FANA) which were excluded from the survey due to security and political concerns. The survey utilized a two-stage random sample design. In the first stage of sampling, 1,000 clusters were selected using the probability proportional to size method, with 390 clusters in urban areas and 610 in rural areas. However, only 972 clusters were covered because of insecurity. The second stage of sampling focused on household selection. In each cluster, 105 households were selected by systematic random sampling technique. Out of 105 sampled households, ten households in each cluster were selected using a systematic random sampling procedure to conduct interviews for the Long Household and the Women's Questionnaires. Any ever-married woman aged 15-49 years who was a usual resident of the household was eligible for interview. In rural areas a total of 5,569 households and 6,193 women were interviewed.

The Community-level Rural Survey was designed to gather information on the following: availability/distance of various health/family planning services, infrastructure development, and education (National Institute of Population Studies 2008). In each rural cluster, a key informant who was representative of the community was selected to

answer the community-level questionnaire. Informants were often selected based on their participation in community council groups who are keenly aware of activities occurring within their localities. 582 rural clusters of the Pakistan Demographic and Health Survey were sampled. A total of 4 of the clusters were not visited at all, data for 3 clusters were missing, and 5 clusters were not completed. Of these 570 community questionnaires completed, only 540 had complete information on distances to health facilities and availability of services within villages. Household and community-level datasets are linked through the cluster ID number present in both surveys. A total of 5,699 women had complete information on community-level factors.

Dependent variables

This analysis focuses on the impact of the LHW program on use of maternal health services in rural areas of Pakistan. The two health outcomes modeled include: use of antenatal care (ANC) and receipt of tetanus toxoid (TT) vaccinations among ever-married women aged 15-49 years who delivered a live birth in the last 5 years. ANC is defined as having received at least one or more visits during the mother's last pregnancy. TT is defined as having received two or more vaccinations during the mother's last pregnancy or having received five of more shots before the last pregnancy. The study sample was reduced to 3,031 who had child in the last 5 years and answered the question concerning use of ANC and TT.

Independent variables

The explanatory variable of interest is a binary variable capturing whether a village has a LHW present. The control characteristics selected for inclusion in this analysis were based on key factors affecting use of health services. Basic demographic

factors included number of living children (0-1, 2-3, 4+), age (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49), and province (Punjab, Sindh, NWFP, Baluchistan). Socioeconomic factors included women's highest level of education (no education, primary, secondary, higher), partners highest level of education (no education, primary, secondary, higher), current work status (yes working/not working), literate (yes/no), and quintiles for socioeconomic status (poorest, poorer, middle, richer, richest). Community level variables included paved road to main town (yes/no), availability of a basic health unit within 5km (yes/no), maternal health center within 5km (yes/no), private provider with 5km (yes/no), motorized public transport present in the village (yes/no), middle school present in village (yes/no), and availability of telephone line service in village. These factors were included in the model to capture accessibility of services and the level of development of rural communities. Additional factors included in the models included exposure to family planning on television (yes/no), and exposure to family planning messages on the radio (yes/no). These variables were included because they may have made women more aware of other MCH services including ANC and TT vaccinations. Health facility and educational variables were examined for collinearity. Given the low degree of correlation between the variables, all were included in the final model.

MODEL

In order to estimate the effect of the LHW program on use of maternal health services, a bivariate probit model was used because of the dichotomous dependent and independent variable of interest (Manddala 1983). This strategy utilizes simultaneous equations to address and test the problem of selective program placement. Therefore, an

individual's underlying propensity to use maternal health services (ANC and TT), Y_{ij}* is given by the Eq.(1) where *i* represents the individual and *j* represents the community:

$$Y_{ij}^* = \alpha_0 + \sum_k \alpha_k X_{k(ij)} + \alpha_2 P_1 + \varepsilon_{1i} \quad (1)$$

$$Y_{ij} = \begin{cases} 1 \; if \; Y_{ij}^* \geq 0 \\ 0 \; if \; Y_{ij}^* < 0 \end{cases}$$

A woman *i* utilizes contraception (Y_{ij}=1) when $Y_{ij}^* \geq 0$, and does not utilize contraception (Y_{ij}=0)when $Y_{ij}^* < 0$. The vector X_k represents exogenous individual and community level factors, including age, province, highest level of education, number of living children, literacy, currently working, heard family planning messages on radio, heard family planning messages on TV, partner's highest level of education, wealth, type of road, availability of basic health unit with 5km, maternal health center within 5km, private health care provider within 5km, and motorized public transport in the village. The main parameter of interest is α_2, which represents the effect of the LHW program on use of maternal health services, controlling for all other factors. P_1 represents the LHW program, and is equal to 1 if an LHW is present in a community and 0 if an LHW is not present. In Eq. (2), the LHW program is present when $P_{1i}^* > 0$ program, and is given by the following:

$$P_{1i}^* = \beta_0 + \sum_j \beta_j X_{ji} + \sum_{k=1}^{2} \Upsilon_k Z_{ki} + \varepsilon_{2i} \quad (2)$$

where the vector X_{ji} represents the *j*th exogenous factor in community *i* mentioned above, and Z_{ki} represents the instrumental variables including whether a community *i* has telephone service, and the presence of a middle school for girls. The issue of selective program placement arises when the error term of Eq. (1), ε_{1i} is correlated with the unobserved determinants in Eq.(2) ε_{2i}, because of targeted program placement (Bollen

1995). The bivariate model tests the correlation ρ: E{[ε_{1i},ε_{2i}]}=0. If ρ is equal to zero, then the error terms are not correlated and endogeneity is not an issue (Bollen 1995). In that case, a single-equation probit model can be used to examine the effectiveness of the LHW on use of maternal health services without biasing estimates. If ρ is significantly different from zero, then one can conclude that the placement of a LHW is endogenous in Eq. 2. Thus, the bivariate probit maximum likelihood model will provide unbiased estimates of the effectiveness of the program.

Instruments

As noted above, one method to solve non-random program placement is through an instrumental variable approach. The instrumental variable method requires two key assumptions: 1) that the variable is highly correlated to the treatment variable (communities with a LHW in this case), 2) the variable cannot directly affect the outcome (ANC and TT injections) (Cameron and Trivedi 2005; Wooldridge 2002; Newhouse and McClellan 1998). The idea is that these instruments can be used to "simulate" random assignment (Newhouse et al 1998). The two instruments used in this analysis include the availability of telephone service within a community and whether a community has a girl's middle school. Infrastructure (individual/community-level) and geographic variables are common sources of instruments and have been used within the literature as valid methods to deal with endogeneity concerns (Ravallion and Wodon 1999; Portner and Beegle 2011; Hutchinson et al. 2006). The availability of telephone service within a community and whether a community has a girl's middle school were both constructed based on the rural community level questionnaire. These particular variables were selected with the intention to measure LHW placement using an indicator not directly

related to the dependent variables of interest. The theoretical rationale behind use of these instruments is that selection and recruitment of an LHW require they have a middle school education, be from the community they intend to work in, and be placed in an area with a functioning health facility (Ministry of Health Pakistan 2011). Thus, areas with a middle school present may be more likely to have an LHW placed in the community because of the ease in meeting recruitment requirements. Rural communities which have telephone-line services (inevitably electricity) may be more likely to have an LHW because it may make it easier to contact community-level staff within functioning facility catchment areas. This is supported by prior evidence from a World Bank study that found the most significant predictor of LHW program placement were communities with a middle school (Gupta et al. 2007). This study also found that communities that were more developed were more likely to have a LHW, although presence of a telephone line was not specifically used in the analysis (Gupta et al. 2007). In addition to the instrumental variable results, naïve probit estimations are also presented for comparison purposes. All regressions take into account the multi-stage sampling design by using the 'cluster' command in Stata version 10.0

RESULTS

Sample Characteristics

Table 5 provides weighted descriptive statistics for the population served by LHWs and comparison areas. Women who live in communities with a LHW tend to be wealthier, more educated, and living in more structurally developed areas compared to those not exposed to LHW. In addition, LHW areas are more likely to have one or more ANC visit (63.2% vs. 50.0%) and more likely to have received the appropriate number of injections to protect against tetanus. The age distribution of women was relatively

similar between women exposed to LHW and those who were not. There were no differences between areas in terms of the number of living children. A greater portion of women served by LHWs live in the most developed province of Punjab (66.2%) and have higher levels of education compared to their counterparts. Nonetheless both populations have very high proportions of women who have no education (69.1% vs. 81.1%). However, women in LHW areas were significantly more literate than women in comparison areas. In the LHW area, women's partners are significantly more educated at secondary and higher-levels compared to the comparison areas. Likewise, a greater portion of women living in served areas are located close to private providers, maternal health centers and basic health units compared to comparison areas. There are also significant differences in structural characteristics of communities in both areas. A greater portion of populations in LHWs areas compared to comparison areas have access to motorized transport (70.0% vs. 52.0%), a girls middle schools located in the village (26.7% vs. 6.6%), telephone line service (72.3% vs. 42.3%), and paved roads (81.5% vs. 80.0%).

Estimation results

Table 6 presents the naïve probit and bivariate coefficient estimations of the effect of the LHWP on the use of maternal health services among rural ever-married woman. Based on the exogeneity tests at the bottom of the table, non-random program placement appears to be an issue for both antenatal care ($p<0.05$) and tetanus toxoid equations ($p<0.001$). The strength of the instruments in predicting program placement was also tested for both outcomes. A joint test of the null hypothesis that the instruments have no effect on predicting program placement yielded a p-value of zero for both outcomes,

indicating strong joint significance. Given that LHW variable is endogenous in the antenatal care and tetanus toxoid equations, results focus primarily on the bivariate probit model.

In both the naïve probit and bivariate probit estimations, results indicate that the effect of exposure to LHW on receipt of tetanus toxoid is positive and statistically significant. In contrast, after taking into account endogeneity concerns with the bivariate probit model, the effect of the program on use of antenatal care services was not significant. Household wealth status was associated with a positive use of health services, an effect that generally increases with each additional wealth quintile. Interaction terms were created to examine the differential effect of the program on use of health services between wealth quintiles; however findings indicate that all of the terms were insignificant and therefore left out of the final model suggesting no differential effect between poorer and wealthier families on antenatal care and receipt of tetanus toxoid injections in rural areas. Within both models the facility level variables did not have strong statistically significant effects on use of services except for the unexpected findings of availability of private provider and motorized transport within 5km which were negatively associated with use of services.

In order to quantify the overall effect of the program on receipt of tetanus toxoid injection, simulations were conducted using predicted probabilities where the LHW variable was set to 1 then 0 with all the other variables set to their sample value. Based on the marginal effects (the difference in the predicted probabilities) in Figure 3, the probit model indicated that access to a LHW increases the probability of receipt of tetanus toxoid injections by 8.2 percentage points. After taking into account selective

program placement with the bivariate probit model, the effect of the program is substantially larger with a 42.0 percentage point increase in receipt of tetanus toxoid injections.

DISCUSSION

This study builds on earlier research from Pakistan and other settings through use of an instrumental variable approach to examine the impact of the National Lady Health Worker Program on the likelihood that ever-married women between 15-49 years use maternal health services. The issue of non-random program placement is tested and controlled for using a set of geographic instruments (availability of a middle school and telephone lines) to more accurately estimate the effect of the program in rural areas of Pakistan.

This study found significant differences between LHW and comparison areas. Women served by LHWs tend to better off and residing in more well developed communities. After controlling for selective program placement, results indicate that access to a LHW increases the probability of receipt of tetanus toxoid injections by over 5-fold compared to naïve estimation procedures. Although the effect estimate appears to be very large, women in rural area generally receive TT injections either from LHWs or from routine ANC visits. Given that ANC use is very low in rural Pakistani communities, areas without LHWs are inevitably less likely to receive the vaccine. The large differences between the naïve probit and bivariate probit may be due to the compensatory approach to the allocation of the program, where LHWs are located in areas with high latent demand for maternal health services. However, it is impossible to know which unobservable factors contribute to the large effect noted in this study.

The LHW program appears to have no significant effect on the use of antenatal care services using the bivariate probit model. However, this relationship was statistically significant in probit model. Methodologically, this suggests failure to take into account non-random program placement of LHWs would lead to a significant underestimate of the program effect on the receipt of tetanus toxoid injections and an overestimate of the program on use of antenatal care services. Therefore in the case of the LHW program, testing and controlling for program placement appears to be essential to estimating accurate impact estimates.

Overall the sign and significance of the estimates found in this study are consistent with a prior World Bank study which used a naïve estimation procedure and identified a positive and statistically significant effect of the program on receipt of tetanus toxoid injections (6.4 percentage point) and no effect on antenatal care use in rural areas prior to the expansion of the program in 2002 (Gupta et al. 2007). More recently, an evaluation covering urban slum and rural areas found a 13 percentage point increase in the receipt of at least two tetanus toxoid injections and no effect on antenatal care use (Oxford Policy Management 2009). The effect estimates found in this study do vary considerably from previous studies, suggesting that nonrandom program placement is a significant issue in evaluation the LHWP. As a practical matter- these differences in program effect have significant implications on the cost-effectiveness of the LHW program. Inaccurate effect estimations may make the LHWP appear less cost effective than it truly is- potentially leading to less funding allocated to the program.

Programmatically, these results suggest that LHWs are effective at providing services for which they are directly responsible (tetanus toxoid injections) but ineffective

in increasing demand and use of antenatal care in rural areas. This may not be terribly surprising given LHWs are expected to refer mothers directly to local health facilities (basic health units) and skilled birth attendants/midwives for antenatal care checkups. LHWs are responsible for reporting on a monthly basis the number of antenatal care referrals provided to women in the community but receive no incentives to ensure that mothers actually attend their visits at local health posts –suggesting a poor linkage between referrals and the wider health system (Gupta et al. 2007). Evidence from this study found the availability of a basic health unit or maternal health center within 5-kilometers had no statistically significant effect on the uptake of ANC services. Thus, even in the case where LHWs refer mothers, women are not utilizing services at the health facility level - potentially supporting Gupta's hypothesis of the lack of synergy between lower levels of the health system.

Alternatively, the lack of utilization of antenatal care services despite the availability of LHWs within communities may be due social and cultural barriers. In rural areas of Pakistan, women's mobility and autonomy in decision-making regarding health service use are severely hampered (Khan 1999). Women are generally not allowed to visit a health facility alone and often encouraged to remain secluded from public places to maintain family honor (*izzat*) and to ensure separation of the sexes (*purdah*) (Khan 1999; Fikree et al. 2001). In particular, pregnancy an obvious product of sexual activity, may be associated with notions of shame (*sharam*), therefore women may be more likely to avoid leaving the home to access services (Mumtaz and Salway 2005). One study in rural Punjab found only 23% of mothers were able to travel unescorted to a health facility (Sathar and Kazi 1997). A separate study in Pakistan found that women who were

accompanied outside of the home by an adult were more likely to access antenatal services (Mumtaz and Salway 2005). Unfortunately, women's autonomy and mobility factors were not controlled for in this study due to the lack of available data in the 2007 PDHS.

Other evidence from this study suggests that male figures play a key role in the uptake of maternal health services. In particular, men who were educated at secondary and higher levels were more likely to have wives who received antenatal care and tetanus toxoid immunizations. This is consistent with findings from a study in Pakistan which noted that providing information to husbands on safe motherhood and family planning improved women's use of antenatal care and the likelihood of reaching a hospital during obstetric complications (Midhet and Becker 2010). A separate study in India found the estimated risk of maternal death to be three times higher among women whose husbands were uneducated compared to women whose husbands were college educated (Ganatra 1998).

These results have significant programmatic and policy implications. Given that LHWs are an effective means of providing direct services at the community level and that non-utilization of antenatal care may result in significant missed opportunities in identifying conditions which threaten the life of the mother and child – the LHW program should consider methods to strengthen the referral mechanism between communities and health facilities which may include incentives for LHWs to ensure mothers reach local health posts/skilled birth attendants. Monetary and in-kind incentives have been shown to improve the retention and quality of services provided at the community-level (Bhattacharyya et al. 2001). Pilot tests could be conducted in a small number of rural

Pakistani communities to identify which incentives work best given the context. In order to increase demand and use of antenatal care services, community-based programs including the LHWP should improve awareness concerning safe motherhood strategies and target key male decision-makers within the family to be a part of such discussions. Future research investigating the barriers to the use of maternal health services including antenatal care in rural areas may help to identify opportunities for future intervention.

This study does suffer from a number of limitations. The use of cross-sectional data limits the analysis of the role of selective program placement. Longitudinal data would allow for changes in health outcomes to be explored when communities introduce a LHW over time. Likewise, the trends in the bias introduced by unobservable factors affecting program placement could be more fully examined with longitudinal data. In addition, the confidence interval surrounding the marginal effect estimates for receipt of tetanus toxoid injection in Figure 3 may be relatively large given the large standard error on the LHW variable (.174). Unfortunately, confidence intervals were not calculated given the nature of the simulations. Another limitation is the use of key informants to obtain information on the availability of services in the community questionnaire which was not independently verified. If this information does not represent the true infrastructure within communities the instrument will provide biased estimates of the impact of the program. Additionally, there may be a number of unobserved individual and community level characteristics which may influence contraceptive use including: number of LHW's within communities, length of time the LHW has been active in the community, cultural norms, and restrictions on women's autonomy and movement. Despite these limitations, this study contributes key evidence to the importance of

community based programs on the provision and use of maternal health services. The overall findings are consistent with prior studies which used different data sets and analytical methods to examine the effect of the LHW program – although the point estimations vary considerably. After controlling for selective program placement, LHWs substantially improve the uptake of tetanus toxoid injections but have no statistically significant effect on ANC use in rural Pakistani communities.

Table 5: Weighted descriptive statistics of ever-married women by area

N=3031	**LHW** n= 1,941	**Comparison** n=1,090
*At least 1 ANC visit****	63.16	50.01
*Receipt of TT injections****	57.52	39.51
*5-year age groups**		
15-19	3.93	5.06
20-24	20.13	21.18
25-29	29.69	26.73
30-34	20.76	24.29
35-39	16.31	12.12
40-44	6.79	8.03
45-49	2.42	2.60
Number of living children		
0-1	20.51	20.91
2-3	35.24	33.58
4+	44.26	44.52
*Province****		
Baluchistan	2.94	9.27
NWFP	13.97	20.34
Sindh	16.36	30.00
Punjab	66.72	40.40
*Highest education level (Female)****		

No education	69.05	81.14
Primary	16.60	11.87
Secondary	11.45	5.82
Higher	2.90	1.17
*Partners education level****		
No education	37.06	46.36
Primary	17.59	17.09
Secondary	33.74	27.29
Higher	11.55	8.93
*Wealth Quintiles****		
Poorest	24.65	43.60
Poorer	26.27	26.92
Middle	24.65	14.39
Richer	16.74	10.43
Richest	7.70	4.67
Currently working	29.40	30.50
*Literate****	24.12	13.52
Media Messages		
Heard FP messages on radio***	13.83	7.38
Heard FP messages on tv***	40.03	21.21
Health facility access within 5 km		
Private Provider***	56.44	30.80
Maternal Health Center***	24.64	10.19
Basic Health Unit***	66.47	35.72
Availability of structural		

characteristics with a village		
Motorized transport	70.00	57.00
Middle school ***	26.70	6.60
Telephone-line***	72.27	42.30
Paved roads	81.48	80.01

Reported significance refer to tests with a null of equality of proportions across the two groups
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Bivariate and naïve probit coefficient estimates of the effect of the LHWP on use of maternal health services

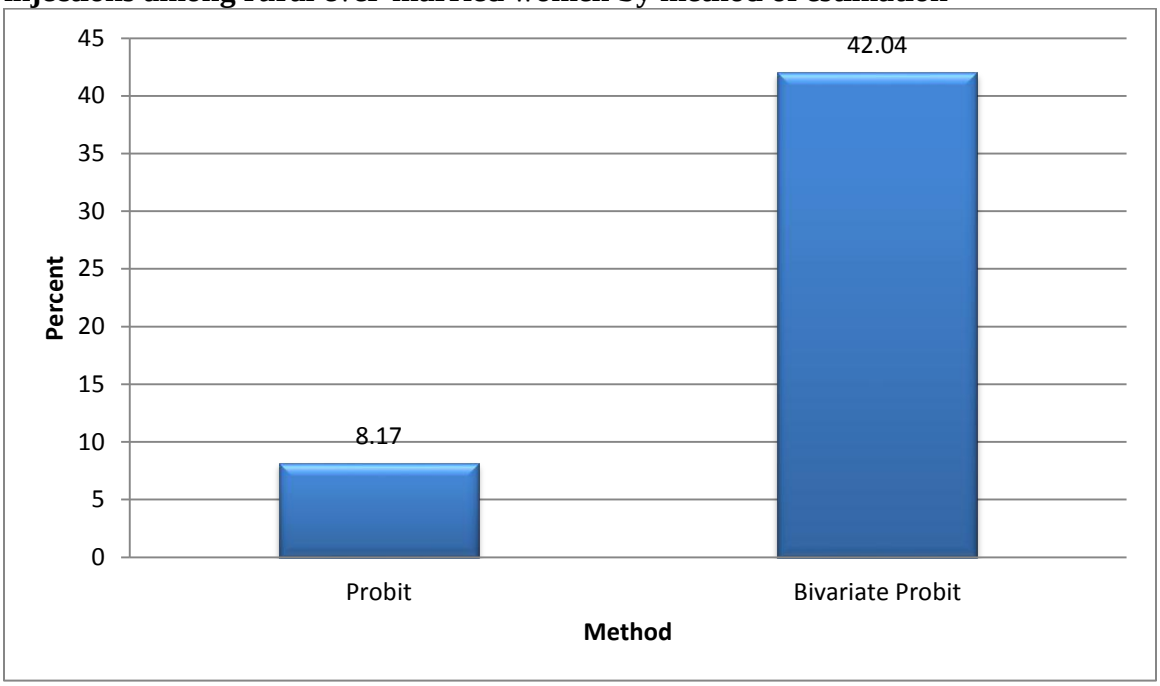
	Use of ANC		Receipt of TT	
N=3031	**Naïve Probit**	**Bivariate Probit**	**Naïve Probit**	**Bivariate Probit**
LHW present	0.130*	-0.327	0.250***	1.272***
	(0.057)	(0.219)	(0.058)	(0.174)
Age				
15-19	-0.027	-0.010	-0.255	-0.264*
	(0.134)	(0.133)	(0.132)	(0.127)
20-24	-0.169*	-0.175*	-0.082	-0.049
	(0.074)	(0.074)	(0.073)	(0.071)
25-29 (r)	-	-	-	-
30-34	0.062	0.045	0.028	0.065
	(0.074)	(0.073)	(0.073)	(0.070)
35-39	-0.111	-0.096	-0.022	-0.035
	(0.085)	(0.085)	(0.085)	(0.082)
40-44	-0.274*	-0.277**	-0.002	0.021
	(0.107)	(0.106)	(0.108)	(0.103)
45-49	0.158	0.158	0.194	0.164
	(0.151)	(0.150)	(0.154)	(0.148)
Province				
Punjab (r)	-	-	-	-
Sindh	0.418***	0.335***	-0.048	0.106
	(0.070)	(0.082)	(0.068)	(0.071)
NWFP	-0.011	-0.106	-0.212**	0.024
	(0.072)	(0.084)	(0.071)	(0.082)
Baluchistan	-0.306***	-0.388***	-0.709***	-0.422***
	(0.088)	(0.094)	(0.093)	(0.109)
Highest educational level (Female)				
No education (r)	-	-	-	-
Primary	0.077	0.089	0.373***	0.315***
	(0.092)	(0.092)	(0.090)	(0.089)
Secondary	0.145	0.174	0.331*	0.238
	(0.139)	(0.138)	(0.133)	(0.129)
Higher	0.431	0.487	0.848***	0.721**
	(0.257)	(0.255)	(0.240)	(0.233)
Partners highest				

educational level				
No education (r)	-	-	-	-
Primary	0.058	0.058	0.041	0.039
	(0.071)	(0.070)	(0.071)	(0.068)
Secondary	0.169**	0.165**	0.179**	0.154*
	(0.064)	(0.064)	(0.064)	(0.062)
Higher	0.183	0.203*	0.315***	0.231*
	(0.095)	(0.094)	(0.092)	(0.090)
Wealth				
Poorest (r)	-	-	-	-
Poorer	0.309***	0.342***	0.237***	0.127
	(0.066)	(0.066)	(0.067)	(0.068)
Middle	0.552***	0.599***	0.428***	0.267**
	(0.078)	(0.079)	(0.078)	(0.083)
Richer	0.833***	0.863***	0.570***	0.426***
	(0.099)	(0.098)	(0.095)	(0.098)
Richest	1.118***	1.113***	0.517***	0.454***
	(0.154)	(0.152)	(0.136)	(0.132)
Currently working	0.067	0.062	-0.131*	-0.115*
	(0.057)	(0.057)	(0.057)	(0.055)
Literate	0.195	0.177	0.064	0.090
	(0.111)	(0.110)	(0.108)	(0.103)
Number of living children				
0-1	0.391***	0.381***	0.224**	0.208**
	(0.085)	(0.085)	(0.084)	(0.080)
2-3	0.062	0.060	0.115	0.107
	(0.066)	(0.066)	(0.066)	(0.064)
4+ (r)	-	-	-	-
Media Messages				
Heard FP messages on radio	0.054	0.069	0.240**	0.167*
	(0.085)	(0.084)	(0.082)	(0.081)
Heard FP messages on television	0.234***	0.262***	0.170**	0.079
	(0.064)	(0.064)	(0.062)	(0.063)
Availability of Health Services within 5km				
Basic Health Unit	0.048	0.115	0.036	-0.105
	(0.058)	(0.065)	(0.057)	(0.060)
Maternal Health Center	-0.053	-0.044	-0.006	-0.008

	(0.070)	(0.070)	(0.068)	(0.065)
Private provider	0.004	0.087	0.021	-0.158*
	(0.060)	(0.071)	(0.059)	(0.065)
Community variables				
Paved road to main district	0.028	-0.014	-0.043	0.064
	(0.062)	(0.064)	(0.062)	(0.062)
Motorized public transport in village	0.025	0.073	-0.118*	-0.200***
	(0.055)	(0.059)	(0.056)	(0.055)
Constant	-0.652***	-0.416**	-0.558***	-1.018***
	(0.110)	(0.159)	(0.110)	(0.123)
Instrument variables				
Middle school for girls in community	-	0.799***	-	0.724***
		(0.084)		(0.084)
Telephone lines in community	-	0.320***	-	0.369***
		(0.061)		(0.057)
Identification Tests				
Test ρ=0		4.19		14.96
Exogenity p-value		0.04		0.00
Instrument power (p-value)		0.00		0.00
Over-identification test (p-value)		0.22		0.19
Log-Likelihood		-3340		-3351

Estimated standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 3: Magnitude of effects of exposure to LHWs on the receipt of tetanus toxoid injections among rural ever-married women by method of estimation



CHAPTER 4: CONCLUSION

Since 1994, the Lady Health Worker Program has sought to improve access to maternal health and family planning services in Pakistan through the doorstep provision of services. This dissertation provides the first rigorous evaluation of the program in rural Pakistan communities utilizing an instrumental variable approach to test and control for unobserved confounding. Results primarily focus on the impact of the LHWP on use of ANC, TT, and reversible contraceptives – key health indicators the program intended to improve. Findings from this dissertation will better inform researchers and programmatic stakeholders on the impact of the LHW program and methods to generate credible estimates with non-randomized designs. This final chapter summarizes the programmatic and methodological implications.

PROGRAMMATIC IMPLICATIONS

Overall from a policy and programmatic standpoint, there are several key findings. First, despite the goals of the Government of Pakistan to increase coverage of primary health services to underserved communities, results from both papers suggest that that the program places LHWs in rural communities with more developed infrastructures and the populations they serve tend to be better off. This may be due in part to the recruiting requirements of the program which necessitate LHWs to have a middle school education, be from the communities in which they will work, and to be

placed within a functioning health facility catchment area. Such requirements inevitably preselect placement of LHWs in areas where the community infrastructure is readily available. As the program continues to expand services to increasingly disadvantaged areas, alternative mechanisms for recruitment will need to be explored. One potential avenue could include the recruitment of women with basic literacy skills to be LHWs. This approach was utilized in Afghanistan and was proven to be effective in improving ANC and contraceptive use at the community-level (Viswanathan et al. 2011). Pilot tests could be conducted in more rural Pakistani communities to determine the quality and effectiveness of LHWs with low levels of education in the provision of health services.

Secondly, despite the placement in more developed communities – results from both papers suggest LHWs play a significant role in providing doorstep services to rural communities with large estimated effects for the provision of contraceptives and tetanus toxoid immunizations for which they are directly responsible. However, evidence from the second paper suggests that the program is not having the intended impact on ANC. This may be due to due to the fact that LHWs are responsible for encouraging and referring mothers to attend ANC visits at local health facilities or with skilled birth attendants/midwives within the community and are not expected to provide such checkups – suggesting a poor linkage between rural communities and the wider health system. Given the decentralized health system in Pakistan and the weak referral mechanisms to local health facilities- the LHW program should consider methods to increase collaboration between LHWs, and other skilled providers including midwives. Examples may include routine community rounds with skilled birth attendants and LHWs to ensure mothers receive the appropriate number of ANC visits. Additional training or

refresher courses for LHWs should reemphasize the importance of safe motherhood strategies and allow for role playing activities to ensure LHWs have the appropriate knowledge to motivate mothers to seek care. Financial or material incentives for LHWs could also be explored and pilot-tested to ensure mothers reach local providers.

Given the social and cultural barriers regarding the use of health services in Pakistan, information and education for empowerment and change (IEEC) campaigns should target key male decision makers in order to improve awareness around safe motherhood strategies. Further research investigating the barriers to the use of maternal health services including ANC may help to identify opportunities for future intervention.

METHODOLOGICAL IMPLICATIONS

Methodologically, there are several salient lessons that emerge from this dissertation. First, evidence from this dissertation suggests that utilizing naïve estimation procedures which treat differences between exposed and unexposed individuals equivalently for the LHWP will lead to biased program estimates. Thus future research on this and other similar programs should test and control for selective program placement where it is an issue.

Second, the magnitude and direction of the bias introduced by selective program placement vary across health outcomes and may not be estimated a priori. In both papers, use of contraceptives and receipt of tetanus toxoid injections were drastically underestimated with the naïve probit model. However in the second paper, use of ANC appears to be overestimated when comparing the naïve model to the bivariate probit – although this was not statistically significant. This potentially suggests that the

underlying unmeasured factors and processes affecting placement may not be consistent and generalizable across outcomes. Thus evaluators may not know beforehand the directional bias when using instrumental variable methods in comparison to naïve models.

Third, this study identified two novel instruments based on LHW recruiting requirements that were predictors of program placement. However, in many cases identifying valid exclusion restrictions that affect program placement but do not directly affect health outcomes can be a difficult task. Such exclusion restrictions though theoretically valid, may inevitably fail identification tests. Moreover, when potential instruments are identified and found to be weak determinants of program placement, effect estimates may be more biased than if naïve estimation procedures were used. Thus care must be taken when identifying and selecting appropriate exclusion restrictions. Although instruments used in this dissertation may prove to be valid predictors for other similar programs, future work should explore and identify additional factors that explain program placement but are unrelated to maternal health and family planning outcomes.

Fourth, the instruments utilized for this dissertation were constructed from data collected in a community-level questionnaire. Unfortunately this level of information is often unavailable in many routinely collected national-level surveys including DHS. Thus, when designing cross-sectional surveys in the future, evaluators may need to incorporate a number of additional questions that have little programmatic value on the outset but may serve as potential instruments during the analysis phase.

Results from both papers demonstrate that rigorous program effect estimates can be obtained utilizing cross-sectional data and an instrumental variable approach contributing to the on-going debate regarding the use of randomized experiments versus quasi-experimental designs (instrumental variables/regression discontinuity). Randomized controlled trials are often thought of as the 'gold standard' of evaluations in the medical literature. In recent years - developmental economists have also stressed the importance of randomization as a robust approach to obtaining effect estimates (Duflo et al. 2008). Duflo (2004), a vocal proponent, argues that the best way to estimate the impact of programs is through randomized impact evaluations and such evaluations should play can key role in the scaling up of programs. However in many settings, experimental evaluations are not feasible due to ethical concerns, cost constraints, and where the coverage of programs are national in scope or targeted to particular areas. In those cases, alternative approaches are needed to generate reliable effect estimates – especially for large scale programs. Imbens (2009) argues that instrumental variables, despite being 'second best compared to experimental designs' – are a useful alternative for the evaluation of such programs. This technique has been used in the econometric literature for decades and is now gaining popularity in the statistical literature (Angrist et al. 1996; Rosenzweig et al. 1986; Portner and Beegle 2011; Guilkey and Hutchinson 2011; Hutchinson et al 2006). Thus the methodologies utilized in this dissertation are illustrative of a real-world effectiveness evaluation making optimal use of already available data to ascertain national impact estimates where experimental designs may not be viable.

Taken together, results from this dissertation provide greater insight into the impact of the LHW program on maternal health and family planning outcomes utilizing a novel approach to correct for nonrandom program placement with observational data. Although the LHWs are placed in more structurally developed rural areas, the door-step delivery approach has been successful in improving access and utilization of contraceptives and TT injections.

REFERENCES

Adamu YM., Salihu, HM. Barriers to the use of antenatal and obstetric care services in rural Kano, Nigeria. Journal of Obstetrics and Gynaecology, 22(6), 600–603. 2002.

Ahluwalia IB, Schmid T, Kouletio M, Kanenda O. An evaluation of a community-based approach to safe motherhood in northwestern Tanzania. Int J Gynaecol Obstet 2003 Aug;82(2):231-240.

Ali M, Bhatti M, Kuroiwa C. Challenges in access to and utilization of reproductive health care in Pakistan. J Ayub Med Coll Abbottabad 2008 Oct-Dec;20(4):3-7.

Amin R, Shah N, Becker S. Socioeconomic factors differentiating maternal and child health-seeking behavior in rural Bangladesh: A cross-sectional analysis. Int J Equity Health. 2010; 9: 9.

Andersen RM. A behavioural model of families' use of health services. Chicago, Illinois, USA: Center for Health Administration Studies, University of Chicago;1968.

Andersen RM, Newman JF. Societal and individual determinants of medical care utilization in the United States. Milbank Memorial Fund Quarterly. 1973;51:95–124.

Angeles G, Guilkey D, Mroz T. Purposive Program Placement and the Estimation of Family Planning Program Effects in Tanzania. Journal of the American Statistical Association. Sep.;93(443):pp. 884-899. 1998.

Angrist J, Imbens G, Rubin D. 1996. Identification of causal effects using instrumental variables. Journal of the American Statistical Association.. 91:444–55. 1996.

Bhattacharyya K, Winch P, LeBan K, Tien M. Community Health Worker Incentives and Disincentives: How They Affect Motivation, Retention, and Sustainability. Basic Support for Institutionalizing Child Survival Project (BASICS II) for the United States Agency for International Development. Arlington, Virginia, Oct 2001.

Baqui AH, El-Arifeen S, Darmstadt GL, Ahmed S, Williams EK, Seraji HR, et al. Effect of community-based newborn-care intervention package implemented through two service-delivery strategies in Sylhet district, Bangladesh: a cluster-randomised controlled trial. Lancet 2008 Jun 7;371(9628):1936-1944.

Bergsjø, P. What is the evidence for the role of antenatal care strategies in the reduction of maternal mortality and morbidity? In De Brouwere, V. & Lerberghe, W. V. (eds) *Safe Motherhood Strategies: A Review of the Evidence*. Studies in Health Services Organisation and Policy No. 17. ITG Press, Antwerp. 2001.

Bile K. The imperative of functional integration for achievement of MDGs. Journal of Pakistan Medical Association, 2009, 59(9 Suppl. 3):S34–38.

Black RE, Cousens S, Johnson HL, Lawn JE, Rudan I, Bassani DG, et al. Global, regional, and national causes of child mortality in 2008: a systematic analysis. Lancet 2010 Jun 5;375(9730):1969-1987.

Blencowe H, Lawn J, Vandelaer J, Roper M, Cousens S. Tetanus toxoid immunization to reduce mortality from neonatal tetanus. Int J Epidemiol 2010 Apr;39 Suppl 1:i102-9.

Bloom, S. S., Lipperveld, T. & Wypig, D. (1999) Does antenatal care makes a difference to safedelivery? A study in urban Uttar Pradesh, India. Health Policy and Planning 1999 14 (1), 38–48.

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

Cameron AC, Trivedi, PK. Microeconometrics: Methods and Applications. New York, NY: Cambridge University Press; 2005.

Campbell OM, Graham WJ. Strategies for reducing maternal mortality: getting on with what works. The Lancet 2006 10/7–13;368(9543):1284-1299.

Carroli G, Rooney C, Villar J. How effective is antenatal care in preventing maternal mortality and serious morbidity? An overview of the evidence. Paediatr Perinat Epidemiol 2001 Jan;15 Suppl 1:1-42.

Carton TW, Agha S. Changes in contraceptive use and method mix in Pakistan: 1990-91 to 2006-07. Health Policy Plan 2011 Mar 26.

Casterline J, Sathar Z, ul Haque M. Obstacles to contraceptive use in Pakistan: a study in Punjab. Stud Fam Plann 2001 Jun;32(2):95-110.

Castro M. Women's education and fertility: results from 26 Demographic and Health Surveys. Stud Fam Plann 1995 Jul-Aug;26(4):187-202.

Chakraborty N., Islam M.A., Chowdhury R.I. & Bari W. Utilization of postnatal care in Bangladesh: evidence from a longitudinal study. Health & Social Care in the Community 10(6), 492–502. 2002.

Cleland J, Bernstein S, Ezeh A, Faundes A, Glasier A, Innis J. Family planning: the unfinished agenda. The Lancet 2006 11/24;368(9549):1810-1827.

Development Fund. Lady Health Worker. (2011). Retrieved on Jan 20, 2011 from http://www.gsmworld.com/documents/lady_health_worker_pakistan.pdf

Douthwaite M. Increasing use in rural Pakistan: an evaluation of the Lady Health Worker Programme. Health Policy and Plan 2005; 20(2):117-123.

Duflo, E. Scaling up and evaluation, Annual World Bank Conference on Development Economics 2004, Washington, DC. The World Bank.2004.

Duflo, E., Glennerster R,. Kremer M. Using Randomization in Development Economics Research: A Toolkit,"Handbook of Development Economics, (T. P.Schultz and J. Strauss eds.), 3895-3962. 2008.

Elo IT. Utilization of maternal health-care services in Peru: the role of women's education. Health Transit.Rev. 1992 Apr;2(1):49-69.

EMRO. Health Systems Profile Pakistan. (2003) Retrieved on Jan 15, 2011 from http://gis.emro.who.int/HealthSystemObservatory/PDF/Pakistan/Health%20system%20organization.pdf

Family Health International. The importance of family planning in reducing maternal mortality. (2011). Retrieved on Jan 21, 2011 from: http://www.fhi.org/en/RH/Pubs/Briefs/MCH/factsheet11.htm

Federal Bureau of Statistics. Pakistan integrated household survey 2001-2002. Islamabad, 2002.

Fikree F, Khan A, Kadir MM, Sajan F, Rahbar M. What influences contraceptive use among young women in urban squatter settlements of Karachi Pakistan? International Family Planning Perspectives 27: 130–6. 2001.

Fosu GB. Childhood morbidity and health services utilization: Cross-national comparisons of user-related factors from DHS data. Social Science and Medicine. 1994;38:1209–1220.

Frankenberg E, Duncan T. Women's health and pregnancy outcomes: do services make a difference?. Demography 2001 38(2):253-265.

Frankenberg E, Suriastini W, Thomas D. Can expanding access to basic healthcare improve children's health status? Lessons from Indonesia's 'midwife in the village' programme. Popul Stud (Camb) 2005 Mar;59(1):5-19.

Gabrysch S, Campbell OM. Still too far to walk: Literature review of the determinants of delivery service use. BMC Pregnancy Childbirth 2009 Aug 11;9(1):34.

Gage AJ. Barriers to the utilization of maternal health care in rural Mali. Soc.Sci.Med. 2007 Oct;65(8):1666-1682.

Ganatra BR, Coyaji KJ, Rao VN. Too far, too little, too late: a community-based case-control study of maternal mortality in rural west Maharashtra, India. Bull World Health Organ 1998;76(6):591-598.

Gay J, Hardee K, Judice N, Agarwal K, Fleming K, Hariston A, Walker B, Wood M. What Works: A policy and program guide to the evidence of family planning and safe motherhood, and STI/HIV/AIDs interventions: Module 1. Policy Project. 2003.

Gertler P, Molyneaux J. How Economic Development and Family Planning Programs Combined to Reduce Indonesian Fertility. Demography 1994 Feb.;31(1):pp. 33-63.

Ghaffar A, Kazi BM, Salman M. Health care systems in transition III. Pakistan, Part I. An overview of the health care system in Pakistan. J Public Health Med 2000 Mar;22(1):38-42.

Glei DA, Goldman N, Rodriguez G. Utilization of care during pregnancy in rural Guatemala: does obstetrical need matter? Soc.Sci.Med. 2003 Dec;57(12):2447-2463.

Goodburn E, Campbell O. Reducing maternal mortality in the developing world: sector-wide approaches may be the key. BMJ 2001 Apr 14;322(7291):917-920.

Government of Pakistan. Utilization of public health facilities in Pakistan. Islamabad: National Health Management Information System, 2000.

Government of Pakistan. Ministry of Health & Ministry of Population Welfare. Prime Minister's programme for family planning & primary health care. Islamabad, 1993.

Government of Pakistan. Ministry of Health. An overview of the health sector: the way forward. Islamabad: Multi Donor Support Unit, 2001.

Guilkey D, Hutchinson P. Overcoming methodological challenges in evaluating health communication campaigns: evidence from rural Bangladesh. Stud Fam Plann 2011 Jun;42(2):93-106.

Gupta M, Mansuri G, Sinha N. Overcoming Gender-based Constraints to Utilization of Maternal and Child Health in Pakistan: The roll of the doorstep delivery system. World Bank 2007.

Hafeez A, Mohamud B, Shiekh M, Shah S, Jooma R. Lady health workers programme in Pakistan: challenges, achievements and the way forward. J Pak Med Assoc 2011 Mar;61(3):210-215.

Haines A, Sanders D, Lehmann U, Rowe AK, Lawn JE, Jan S, et al. Achieving child survival goals: potential contribution of community health workers. The Lancet 2007 6/23–29;369(9579):2121-2131.

Harel K. Barriers to contraceptive use among Pakistani couples. Popul Briefs 1997 Summer;3(3):2.

Hutchinson P, Wheeler J. Advanced methods for evaluating the impact of family planning communication programs: evidence from Tanzania and Nepal. Stud Fam Plann 2006 09/01;37(3):169(18).

Hutchinson P, Lance P, Guilkey D, Shahjahan M, Haque S. Measuring the cost-effectiveness of a national health communication program in rural Bangladesh. J Health Commun 2006;11 Suppl 2:91-121.

Imbens, Guido. Better LATE than Nothing: Some comments on Deaton (2009) and Heckmand and Urzua (2009) NBER Working Papers 14896, National Bureau of Economic Research, Inc. 2009.

Islam A, Tahir MZ. Health sector reform in South Asia: new challenges and constraints. Health Policy. 2002: 60**:** 151–169.

Jejeebhoy S. Women's education, autonomy and reproductive behaviour: experiences from developing countries. Clarendon Press. Oxford 1995.

Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. The Lancet 2007 10/13;370(9595):1358-1369.

Kidane G, Morrow RH. Teaching mothers to provide home treatment of malaria in Tigray, Ethiopia: a randomised trial. Lancet 2000 Aug 12;356(9229):550-555.

Khan YP, Bhutta SZ, Munim S, Bhutta ZA. Maternal health and survival in Pakistan: issues and options. J Obstet Gynaecol Can 2009 Oct;31(10):920-929.

Khan A. Mobility of women and access to health and family planning services in Pakistan. Reproductive Health Matters. 1999: 7(14), 39-48.

Lewin S, Munabi-Babigumira S, Glenton C, Daniels K, Bosch-Capblanch X, van Wyk BE, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. Cochrane Database Syst Rev 2010 Mar 17;(3)(3):CD004015.

Mahmood N, Ringheim K. Factors affecting contraceptive use in Pakistan. Pakistan Dev. Review 1996 March;35(1):1-22.

Manddala, G. Limited Dependent and Qualitative Variables in Economics. Cambridge University Press, 1983.

McDonagh, M. Is antenatal care effective in reducing maternal morbidity and mortality? Health Policy and Planning 11(1), 1–15.1996.

Mekonnen Y, Mekonnen A. Factors influencing the use of maternal healthcare services in Ethiopia. J.Health Popul.Nutr. 2003 Dec;21(4):374-382.

Midhet F, Becker S. Impact of community-based interventions on maternal and neonatal health indicators: Results from a community randomized trial in rural Balochistan, Pakistan. Reprod Health 2010 Nov 5;7:30.

Ministry of Health Pakistan (2011). National Program for family Planning and Primary Health Care. Retrieved on Jan 10, 2011 from: http://www.phc.gov.pk/site/component/content/article/48-the-national-programme-for-family-planning-a-primary-health-care-an-overview.html

Ministry of Finance Pakistan. (2009). Pakistan Economic Survey 2009-2010. Retrieved on Jan 11, 2011 from: http://www.finance.gov.pk/survey/chapter_10/16_Population.pdf

Mumtaz Z, Salway S. 'I never go anywhere': extricating the links between women's mobility and uptake of reproductive health services in Pakistan. Soc Sci Med 2005 4;60(8):1751-1765.

Mumtaz, Salway, Waseem, Usman Z. Mumtaz, S. Gender-based barriers to primary health care provision in Pakistan: understanding the experience of female providers. Health Policy and Planning 2003: 18:261–269.

National Institute of Population Studies and Macro International Inc. Pakistan Demographic and Health Survey 2006-2007. Islamabad. 2008.

Newhouse JP, McClellan M. Econometrics in outcomes research: the use of instrumental variables. Annu Rev Public Health 1998;19:17-34.

Nishtar S, Amjad S. Synergizing health and population in Pakistan. Journal of Pakistan Medical Association, 2009 (Suppl.3):S3–S20.

Oxford Policy Management. External Evaluation of the National Program for Family Planning and Primary Health Care. Lady Health Worker Programme. 2002.

Oxford Policy Management. External Evaluation of the National Program for Family Planning and Primary Health Care. Lady Health Worker Programme. 2009.

Population Reference Bureau (PRB). Family Planning Saves Lives. Washington D.C. 2009.

Portner C, Beegle K. Family Planning and Fertility: Estimating Program Effects using Cross-sectional Data. The World Bank. Population English Edition. 2011.

Prata N, Vahidnia F, Potts M, Dries-Daffner I. Revisiting community-based distribution programs: are they still needed? Contraception 2005 Dec;72(6):402-407.

Ravallion M, Wodon Q. Evaluating a Targeted Social Program When Placement is Decentralized. World Bank Policy Research Working Paper No. 1945. 1999.

Rooney, G. Antenatal Care and Maternal Health: How Effective Is It? Document WHO/MSM/92·4. World Health Organization, Geneva. 1992.

Rosenbaum P. The central role of the propensity score in observational studies for causal effects. Biometrika 1983;70(1):41-55.

Rosenzweig M. Evaluating the effects of optimally distributed public programs: Child health and family planning interventions. Am Econ Rev 1986;76(3):470.

Rubin D, Thomas N. Matching using estimated propensity scores: relating theory to practice. Biometrics 1996 Mar;52(1):249-264.

Rutstein S. Effects of preceding birth intervals on neonatal infant and under-five years mortality and nutritional status in developing countries: evidence from the demographic and health surveys. Int J Gynaecol Obstet 2005, 89 (Suppl 1): S7-S24.

Sathar Z, Kazi S. Women's Autonomy, Livelihood, and Fertility: A Study of Rural Punjab. Islamabad: Pakistan Institute of Development Economics.1997.

Schwartz J, Racelis R, Guilkey D. Decentralization and local government health expenditures in the Philippines. MEASURE Evaluation. Chapel Hill: University of North Carolina. 2000.

Shadoul, A.F. Maternal, neonatal, and child health in Pakistan: towards the MDGs by moving from desire to reality. EMHJ. Vol 16: 2010.

Shaikh B, Haran D, Hatcher J. Women's social position and health-seeking behaviors: is the health care system accessible and responsive in Pakistan? Health Care Women Int 2008 Sep;29(8):945-959.

Shaikh B, Hatcher J. Health seeking behaviour and health services utilization trends in national health survey of Pakistan: what needs to be done? J Pak Med Assoc 2007 Aug;57(8):411-414.

Shaikh, B. Health seeking behavior and health service utilization in Pakistan: challenging the policy makers. J. Public Health. 2004 Dec; 27(1):49-54.

Stephenson R, Baschieri A, Clements S, Hannink M, Madise N. Contextual influences on the use of health facilities for childbirth in Africa, American Journal of Public Health. 2006:96 (1):84–93.

Thomas D, Maluccio J. Fertility, contraceptive choice, and public policy in Zimbabwe. The World Bank economic review 1996;10(1):189.

UN Inter-Agency Group for Child Morality (2011). Levels & Trends in Child Mortality. Retrieved April 4, 2012 from: http://www.unicef.org/media/files/Child_Mortality_Report_2011_Final.pdf

USAID. Pakistan MCH Program Description (2008). Retrieved on Nov 10, 2010 from: http://pdf.usaid.gov/pdf_docs/PDACN952.pdf

Van den Broek NR, White SA, Ntonya C, Ngwale M, Cullinan T R, Molyneux M E, Reproductive health in rural Malawi: A population-based survey. British Journal of Gynaecology, 110(10), 902–908. 2003.

Viswanathan K, Hansen PM, Rahman MH, Steinhardt L, Edward A, Arwal SH, et al. Can community health workers increase coverage of reproductive health services? J Epidemiol Community Health 2011 Nov 7.

WHO and UNICEF. Antenatal Care in Developing Countries: Promises, Achievements and Missed Opportunities: An Analysis of Trends, Levels, and Differentials: 1990–2001. Geneva, New York. 2003.

WHO. Strengthening the performance of community health workers in primary health care. Report of a WHO Study Group. Geneva, World Health Organization (WHO Technical Report Series, No. 780). 1989.

WHO. Trends in Maternal Mortality 1990-2008: estimates developed by WHO, UNICEF, UNFPA, and the World Bank Geneva, WHO; 2010.

WHO (2011). Immunization profile: Pakistan. Retried on January 10, 2012 from: http://apps.who.int/immunization_monitoring/en/globalsummary/countryprofileresult.cfm?C=pak

Wooldridge, J. Econmetric Analysis of Cross Section and Panel Data. Cambridge, MA: MIT Press; 2002.

World Bank. Fertility decline in Pakistan 1980-2006: case study. (2010) Retrieved on Jan 10, 2011 from http://siteresources.worldbank.org/INTPRH/Resources/376374-1278599377733/Pakistan62810PRINT.pdf.

Yanovitzky I. Estimating causal effects of public health education campaigns using propensity score methodology. Eval Program Plann 2005;28(2):209.