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**Delivery at Home Versus Delivery at a Health Care Facility – A Case Study of Bihar, India**

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**Abstract:** Improvement in maternal health care is at the center stage of policy making for many developing countries including India, which is faced with a high maternal mortality rate of 540 deaths per 100,000 live births. In India, 36% of women are underweight and an important policy question is whether maternal health care has any effect on the long-term health of mothers. In this paper, we investigate whether place of delivery (delivery at health care facility versus delivery at home) has any effect on the body mass index of women and children. This relationship is estimated in the context of Bihar, India where only one in five births take place at a health facility. Data on Bihar is taken from the third round of National Family Health Survey conducted in 2005-2006. The data set contains information on women aged between 15 to 49 years and children below the age of 5. We use the program evaluation approach to estimate the treatment effects associated with deliveries at health care institutions for women. Propensity score matching is used to estimate the average treatment effect on the treated (ATT). For underweight women, we find that ATT is positive and highly significant. This implies that there are average gains from delivering at a health facility as compared to delivering at home for underweight women. Using the propensity score results we find that education, urbanization, and higher household wealth increase the likelihood of using health institutions for child deliveries. Therefore, we recommend that *(i)* awareness should be spread about the positive health impacts of institutional deliveries through educational programs, *(ii)* there is a need for more investment in health infrastructure in Bihar, and *(iii)* maternal health care should be made accessible and affordable to poor households.

Keywords: place of child delivery, propensity score matching, program evaluation, average treatment effect on treated

JEL Codes: I10, N35, C25

## **I. Introduction**

Improvement in maternal health care is at the center stage of policy making for many developing countries including India that faces a high maternal mortality rate of 540 maternal deaths per 100,000 live births (Rao et al., 2010).<sup>1</sup> According to the National Family Health Survey (NFHS) of 2005-2006, 36 percent of women in India are underweight who are more prone to morbidity, anemia, infertility, weak immune system and lower productivity (Subramanian and Smith, 2006). A highly important policy question is whether maternal health care has any effect on the long-term weight of mothers and children. In particular, our research question involves modeling the relationship between place of delivery and long-term body mass index (BMI) of women and children.

Maternal health, which is the health of a woman during pregnancy, childbirth and postpartum period, has important long-term implications. Filippi et al. (2006) classify the long-term consequences of maternal health into four categories. First is the psychological consequence of maternity like depression and stress that cause impaired functionality in women. Second, women may undergo physical changes like damage in the pelvic structure and anemia that results in increased risk of maternal morbidity and mortality, lower work productivity and fatigue (Bentley and Griffiths, 2003). Third, households face an economic burden due to expensive maternal health care. Lastly, there are sociological consequences, which arise due to the stigmatism associated with maternity and marital discord. Note that all these factors such as stress, depression, sociological distress and

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<sup>1</sup> Improvement in maternal health has also been recognized as one of the eight Millennium Development Goals by United Nations Development Program to be achieved by the year 2015. <http://www.beta.undp.org/undp/en/home/mdgoverview.html>, accessed April 2012.

economic degradation can cause excessive weight loss in mothers that increases the risks of morbidity and reduces immunity (Subramanian and Smith, 2006). Clearly, maternal health care is important for the long-term health of mothers.

There are several aspects of maternal health care that can be analyzed. In this paper, we focus on the place of delivery and its effect on women's long-term health. Bloom, Lippeveld and Wypij (1999) argue that for a proper antenatal care system it is important to have a trained attendant at birth. According to NFHS 2005-2006 close to 60% of children in India were delivered at home, less than half of which were attended by trained health workers. Traditional birth attendants (known as '*dai*'), relatives or other untrained persons, delivered the remaining children. Thind et al. (2008) point out that home based deliveries are the cheapest option in India but they are marked with increased risks of infection and complications because of untrained health attendants and outdated equipment. Similarly, Bang et al. (2004) demonstrate that about 53% of women in rural India face a high burden of morbidity and complications such as infections, psychosis and secondary postpartum hemorrhage by delivering at home. Clearly, births at home in India are not as safe as institutional deliveries and there is need to study the long-term effect of home-based deliveries in India.

In this paper, we analyze the effect of place of delivery on woman and child's health outcomes. In particular, we use body mass index (BMI) as an indicator of long-term weight of women and children. We empirically investigate the effect of place of delivery on the BMI of women and children for Bihar, India. Household data on Bihar is taken from the third round of National Family Health Survey that was conducted in 2005-2006.

The data set contains information on women aged between 15 to 49 years and children below the age of 5.

Bihar is one of the poorest states in India with 40% of the total population below poverty line as compared to the national average of 28.6% (World Bank, 2005).

According to the NFHS report of 2009, only 9% of the households in Bihar belong to the highest wealth quintile, compared to one-fifth of households for entire India; 62% of women and 28% of men have never attended school. With only about 35% of employed married woman, women head only one in four households. The NFHS-2009 report also states that only one in five births take place in a health facility.

Using observational data for estimating relationship between place of delivery and women and children's BMI has some limitations. There are a number of demographic factors such as age and education of mother, household income and nutritional status, urban/rural residence etc. that influence both the choice of place of delivery and mother and child's BMI. Because of these empirical estimation suffers from endogeneity and self-selection bias. An alternative way is to use the program evaluation approach in which treatment effects associated with the place of delivery are estimated using counterfactual estimates. We estimate (1) the average treatment effect (ATE) that measures the average gain in BMI for women because of the treatment (delivery at a health care facility), and (2) the average treatment effect on the treated (ATT), which measure the average gain in BMI only for women who delivered at a health care facility.

Estimation of ATE and ATT using observational data is not straightforward because there is no well-defined control group and the treatment trails are not random (Dehejia

and Wahba, 2002). We use propensity score matching introduced by Rosenbaum and Rubin (1983) to estimate the treatment effects. A logistic regression model is used to estimate the propensity scores, which are further used for matching and estimating ATE and ATT. The results of this study show that there is positive ATT associated with delivery at health care institutions for underweight women in Bihar. However, no significant effects of institutional deliveries were found on child health outcomes.

There are numerous policy implications of this study. There is a need to look at institutional births in Bihar more carefully because there are positive ATT associated with delivery at health care facilities. We find that education plays an important role in determining the choice between delivery at a health facility and delivery at home. Therefore, more awareness should be spread about the positive impacts of institutional deliveries through education. Second, urban residential households show higher tendency towards institutional deliveries. This calls for more investment in health infrastructure in rural areas of Bihar. Third, wealth significantly affects the propensity of institutional deliveries. Therefore, a direct way of assuring more institutional deliveries is to make maternal health care more accessible and affordable to the poorer households.

The rest of the paper is organized as the following. Section II discusses the related literature. We explain the program evaluation approach in section III. The data and the results are summarized in section IV and section V, respectively. We end our paper by providing a brief conclusion in section VI.

## **II. Related Literature**

There are a number of factors that affect the use of maternal health care facilities such as income, education, ethnic background, birth order and number of children. While estimating the causal relationship between place of delivery and BMI of women/children, we recognize that there could be possible endogeneity between demographic characteristics, the choice of place of delivery and mother's BMI. For instance, household income influences the place of delivery as well as mother's BMI. Along with endogeneity, there could be self-selection bias in comparing a treatment group with a counterfactual control group (Dehejia and Wahba, 2002). To counter these issues, we use the program evaluation approach discussed below to estimate the treatment effects associated with place of delivery on mother's long-term BMI.

We use propensity score matching to estimate the relationship between place of delivery and long-term BMI of women and children. To estimate propensity score (conditional probability of using a health care facility for child delivery), we review the existing literature that examines the relationship between the choice of place of delivery and household demographics in India. Literature related to the program evaluation approach and matching is summarized later in this section.

### ***Literature on Delivery Location Choice***

There is sizeable research that determines the factors that explain variation in the choice of place of delivery in India. Griffiths and Stephenson (2001) investigate the factors that facilitate and act as barriers to service use such as antenatal care and health centers/hospital as place of delivery in Mumbai and Pune and surrounding rural areas in

Maharashtra, India. They find that the rural areas were characterized by reliance upon home births and safety, familiarity of the home environment, and the cultural norm to give birth in the home were important factors for delivery at home. Other factors that influenced the use pattern were distance to health facilities, health workers, service utilization, and cost of services.

In the same context Navaneethama and Dharmalingam (2002) examine the determinants of maternal health care utilization in the states of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu in India. They use NHFS (1992–93) data and focus on four maternal health care services – antenatal check-up, tetanus toxoid vaccine, place of delivery and assistance during delivery. They find that mother with first order births were more likely to deliver their babies at health care institutions than mothers with second order births. In fact birth order is found to be an important determinant for all the four services. Muslim women in some places were less likely to deliver their babies in health care institutions and women's literacy was important for all states. They also find that non-earning workingwomen were less likely to use maternal health care services compared to earning women.

Similarly Padmadas et al. (2000) investigate the factors that explain the choice for cesarean deliveries in Kerala, India. Some of the significant factors were maternal age, birth order, current age, and there were also spatial differences in these choices. Thind et al. (2008) analyze the determinants of home, private and public sector utilization for deliveries in Maharashtra. They find that maternal age, media exposure, birth order, urban vs. rural residence significantly affect these choices.

### ***Program Evaluation Approach***

Consider two groups of women - the first group used a health care facility for delivery and the current BMI of women belonging to this group is  $y_1$ . The second group delivers at home with BMI of  $y_0$ . An important question is whether place of delivery effects BMI across two groups? In other words, are there average treatment effects (ATE) or average treatment effects on the treated (ATT) associated with institutional deliveries? These effects are defined as:

$$ATE = E(y_1 - y_0 | X_i, D_i) = E(y_1 | X_i, D_i = 1) - E(y_0 | X_i, D_i = 0) \quad (1)$$

$$ATT = E(y_1 - y_0 | X_i, D_i = 1) = E(y_1 | X_i, D_i = 1) - E(y_0 | X_i, D_i = 1), \quad (2)$$

where  $X_i$  include the demographics characteristics of the individuals and  $D_i$  is a dummy variable for treatment, which takes the value “1” if a woman delivered at a health care facility and “0” if she is delivered at home. ATE measures the average gain in BMI from institutional deliveries for all the women in the data set whereas ATT measures the average gain for women who went to health care institutions for deliveries. For a random and universally available treatment assignment, estimation of ATE is reasonable.

However, in most cases this is not so. In India delivery at health care facilities are not universally accessible and affordable. Therefore, ATT is a more appropriate measure when the treatment assignment is non-random and the comparison holds only for the treated group.

Estimation of ATE and ATT is not straightforward in observational studies. Dehejia and Wahba (2002) discuss the problems associated with estimating treatment effects in observational studies. First, there is no well-defined control group in an observational

setting. In experimental settings, a control group is created in identical settings and only difference is in terms of receiving a treatment (mostly control group receives no treatment). However, in observational studies there are no systematic methods in designing a control group whereas the treatment group is well defined. Second, the treatment is often non random for example institutional and home based child deliveries are not randomly assigned, they are determined by several factors such as income, age, education etc. as discussed in the above section. In such cases, we cannot estimate the outcome for the treated in absence of treatment (the last term in equation 2). An alternative to estimate this is by matching.

The intuition behind matching is to estimate a counterfactual outcome for the treated group in the absence of the treatment. This counterfactual outcome is estimated by matching the treated group with the non-treated group using a scalar or a set of covariates. One of the most commonly used scalars is the propensity score defined as the conditional probability of getting the treatment (Rosenbaum and Rubin, 1983). In mathematical notation, it can be written as:

$$p(x) = \Pr[D_i = 1|X_i]. \tag{3}$$

A number of matching algorithms have been suggested in the literature. Rosenbaum and Rubin (1983) compared Mahalanobis metric with calipers matching and the nearest match. They find that Mahalanobis metric with calipers performs better than nearest matching. Heckman et al. (1998) used a nonparametric approach to carry out kernel based matching. Dehejia and Wahba (2002) suggested that nearest match with replacement does well when sample size places a restriction on estimation. In this paper

we use nearest one to one matching with replacement. More on how we employ this procedure is discussed in the next section.

### III. Methodology

For estimating ATT and ATE given in equation (1) and equation (2), respectively, the first step is to match the treated and untreated groups. In order to do so, we need to get a measure for the propensity score. Since the true value of propensity score is not known, we use logistic regression to estimate propensity score for each observation in the dataset. The treatment variable for our data set is defined as:

$$D_i = \begin{cases} 1 & \text{for delivery at a health facility} \\ 0 & \text{for delivery at home.} \end{cases} \quad (4)$$

Since data gives us information on who went to a health facility for delivery and who delivered at home, we use a logistic regression framework to estimate the probability of delivering at a health facility as:

$$D_i = X_i' \beta + \varepsilon_i, \quad (5)$$

where  $X_i$  contains the demographic variables that belong to one of the three categories – mother's characteristics, child's characteristics and household's characteristics. After estimating the regression in equation (5), we predict  $\hat{p}(x) = \Pr [D_i = 1|X_i]$  for all the observations.

Based on the estimated values of  $p(x)$ , women who delivered at home are matched with those who delivered at a health facility using one to one matching with

replacement. The outcomes for women and child are measured in terms of their BMI levels. After matching the groups, ATT and ATE are estimated using equations (1) and (2).

#### **IV. Data**

Data on Bihar comes from the third National Family Health Survey (NFHS-3) that was conducted in 2005-2006. This survey is extremely comprehensive. The survey presents information on a host of variables on family welfare such as maternal and child health, education, wealth index, household asset, HIV status etc.

For the state of Bihar, the data comes from a total of 3016 households with 3818 women aged between 15 to 49 years. The data set contains information on children below the age of 5. Observations used for this study after deleting missing values are 2033. Number of births at health facility were 505 (i.e. the treated observations) and births at home accounted for 1528 observations (i.e. non treated observations).

Summary statistics (mean and standard deviation) of the variables used for the current analysis are given in Table 1. Variables are divided into five groups. The first variable is the treatment variable “delivery” that describes whether the mother delivered at a health facility or at home. The outcome variables are BMI for women and child. However, for a meaningful analysis, I convert BMI into levels (discussed in the next section). The next group contains variables that define mother’s characteristics such as age of woman, education of woman, single or not and working or not.

Child's characteristics include gender, age and birth-order. Household's characteristics are defined by variables such as religion, whether head of household is a male or a female, whether household is in urban or rural settings, and how wealthy is the household. The wealth index in NFHS-3 is constructed by consolidating 33 types of household assets and based on the percentiles of this index households are characterized as being one of the five classes - poorest, poorer, middle, richer or richest.

## **V. Results**

Results for propensity score estimation are provided in Table 2. The dependent variable is  $D_i$ , the dummy variable for treatment (i.e. whether the child was delivered at a health facility or at home). Since the dependent variable is binary, logistic regression is used to estimate the coefficients for the regressors. For a logistic regression, the sign of the marginal effects is same the sign of estimated coefficients but the magnitude is different. All else constant, the coefficients measure the change in log-odds ratio as the regressor changes by one unit.

The estimated coefficients in Table 2 have the expected signs. The probability of going to a health facility for delivery is positively affected by woman's age. Older women have a greater say in the household decision making than the younger women making it easier for them to chose health facilities for child deliveries. Education, as expected has a positive effect on the probability of utilizing health institutions for deliveries. Also, the log-odds ratio increases with the level of education. Similarly, wealth and urban residence have a positive impact on institutional deliveries.

Working women are less likely to go to a health facility for deliveries. First, only about 20% of the women are working. Second, there is opportunity cost of time associated with delivering at health institutions. For instance, they may have to take days off from work to travel to the nearest health facility whereas home deliveries may save working days. Higher birth order is associated with a lower likelihood of going for institutional deliveries. This is because with more experience women become confident about delivering at home. Muslims households are less likely to go to a health facility for delivery as compared Hindu households.

Having estimated the model for propensity scores, next women who delivered at health facilities (treated) are matched with women who delivered at home (non treated) using the predicted propensity scores. We use one-to-one matching with replacement that matches 505 non-treated observations with 505 treated observations. Only 3% of the total women in Bihar are overweight. Clearly being overweight is not a concern in Bihar; therefore, we do not distinguish between normal and overweight women. The resulting BMI has only two categories – underweight and normal. For notational purposes we refer it as BMI underweight that is defined as:

$$BMI \text{ underweight} = \begin{cases} 0 & \text{if under weight i. e. } bmi < 18.50 \\ 1 & \text{if normal weight i. e. } bmi \geq 18.50, \end{cases} \quad (6)$$

where  $bmi = \frac{\text{weight in kgs}}{\text{height in meters}^2}$  and data on weight and height taken from NFHS is

recorded at the time of interview.

The estimated ATT and ATE for women's BMI are given in the third row of Table 3. The estimated ATT is 0.19 and it is highly significant. A positive ATT indicates that

there are average gains in BMI from delivering at health care facilities for women in Bihar. Since we compare underweight and normal weight women in Bihar, a positive ATT indicates that there are positive gains in BMI of underweight women if they go for institutional deliveries. As already discussed, ATT is more reliable measure because institutional deliveries are not universally affordable in Bihar.

For children, BMI is classified according to the Center for Disease Control's recommendations. BMI for children is first classified according to sex of the children, and then based on percentiles for each age category; children are classified as normal or overweight. 6% of the total children were underweight; therefore, we merge these observations with normal-weight observations. The BMI for children is defined as:

$$BMI\ overweight = \begin{cases} 0 & \text{if normal weight i. e. } bmi < 85\% \\ 1 & \text{if over weight i. e. } bmi \geq 85\%, \end{cases} \quad (7)$$

where BMI is calculated in the same way as it is calculated for adults. The ATT and ATE estimation results for children are also provided in Table 3. The treatment effect estimates are not significant; therefore, for children's BMI delivery at health care facilities shows no gain. This is not surprising as there are several other factors that affect child health and whether the child is born at a health facility or home may not have direct consequences on children's health outcomes.

There are a number of policy implications of our study. There is a need to look at institutional births in Bihar more carefully. Our analysis shows that there are average gains in BMI of women from delivering at health care facilities as compared to delivering at home. These gains are especially important for the underweight women population (as we compare treatment effects across underweight and normal women in Bihar). Our

logistic regression results for choice of place delivery shows that educated women are more likely to go child deliveries at hospitals. Therefore, more awareness should be spread about the positive impacts of institutional deliveries through education. Second, we find households residing in urban areas also prefer institutional deliveries. Hence more investment is required in health infrastructure in rural areas of Bihar. Third, our analysis also shows that wealth significantly affects the propensity of institutional deliveries. Therefore, to assure that women from poorer background use health care facilities for child deliveries, health care facilities should be made more accessible and affordable.

## **VI. Conclusion**

This paper investigates the effect of place of child delivery on women and child health outcomes in Bihar, India. The observational data was used from the third National Family Health Survey (2005-2006). Propensity score matching was used to estimate the average treatment effect (ATE) and average treatment effect on the treated (ATT). Propensity scores were estimated using a logistic regression framework and a number of factors were identified that significantly affected the probability of choosing a health facility for delivery as compared to delivering at home. Women's education, household wealth, women-age and urban residence positively affected the probability of going to a health facility for delivery vis-à-vis home delivery. Higher birth-order negatively affected this probability. The matching results showed that there are positive gains in BMI for underweight women associated with delivering at health facilities as compared to delivering at home.

Since there are average gains in women's BMI, child deliveries at health care facilities are beneficial for the long-term health of women. To facilitate use of health care facilities, we suggest the following. Our propensity score results show that education, urban residence and wealth play an important role in determining the choice between delivery at a health facility and delivery at home. Therefore, there is a need more awareness about the positive impacts of institutional deliveries on women health through education; more investment should be targeted towards health infrastructure in rural Bihar; and health services should be made more accessible and affordable to the poor households.

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## Tables

**Table 1: Summary Statistics of Variables**

<b>Category</b>	<b>Variables</b>	<b>Definition</b>	<b>Mean (S.D.)<sup>2</sup></b>
<i>Treatment</i>	Delivery	“1” delivery in health facility, “0” home	0.25 (0.43)
<i>Outcomes</i>	BMIwoman	Body mass index of mother	19.31 (2.61)
	BMIchild	Body mass index of child	14.36 (1.61)
<i>Mother’s Characteristics</i>	Age	Age of mother in years	26.73 (5.89)
	Education	“0” no education, “1” primary, “2” secondary, “3” higher	0.62 (0.92)
	Single	“1” living with husband, “0” if not	0.70 (0.46)
	Working	“1” working, “0” if not	0.20 (0.40)
<i>Child’s Characteristics</i>	Childsex	“1” female, “0” male	0.47(0.50)
	Childage	Age of child in months	29.49 (17.44)
	Birthord	Birth order of the child	3.38 (2.24)
<i>Household Characteristics</i>	Head	“1” household head male, “0” female	0.67(0.42)
	Religion	“1” Muslim, “0” Hindu/Jain	0.21 (0.40)
	Residence	“1” urban, “0” rural	0.30 (0.46)
	Wealth	“0” poorest, “1” poorer, “2” middle, “3” richer, “4” richest	1.49 (1.31)

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<sup>2</sup> S.D. refers to standard deviation

**Table 2: Propensity Score Estimation Results**

<b>Category</b>	<b>Regressors</b>	<b>Estimate</b>	<b>Std. Error</b>
	Intercept	-2.15***	0.40
<i>Mother's Characteristics</i>	Age	0.03*	0.02
<i>Education</i>	Primary	0.33*	0.19
	Secondary	0.73***	0.17
	Higher	2.14***	0.45
	Working	-0.40**	0.19
	Single	0.11	0.16
<i>Child's Characteristics</i>	Birthord	-0.26***	0.05
<i>Household Characteristics</i>	Head	0.05	0.17
	Religion	-0.64***	0.18
	Residence	0.78***	0.14
<i>Wealth</i>	Poorer	0.09	0.19
	Middle	0.40*	0.21
	Richer	0.89***	0.22
	Richest	1.61***	0.28

**Table 3: Estimated Average Treatment on the Treated and Average Treatment Effect**

<b>ATT</b>	<b>Std. Error</b>	<b>Matched Obs.<sup>3</sup></b>	<b>ATE</b>	<b>Std. Error</b>	<b>Matched Obs.</b>
<i>Outcome Variable: Women's BMI - Underweight</i>					
0.19***	0.05	505	0.07***	0.05	2033
<i>Outcome Variable: Children's BMI-Overweight</i>					
-0.02	0.04	505	0.02	0.04	2033

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<sup>3</sup> Obs. refers to observations