



Research article

Predictive behaviour of maternal health inputs and child mortality in West Bengal – An analysis based on NFHS-3[☆]Saswati Chaudhuri^a, Biswajit Mandal^{b,*}^a Department of Economics, St. Xavier's College (Autonomous), Kolkata, India^b Department of Economics & Politics, Visva-Bharati University, Santiniketan, India

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ABSTRACT

The well-being of both the mother and the child determines the health of the next generation. This in turn can predict future public health challenges that the health care system of an economy would be concerned with. Hence, we should be more concerned with antenatal and postnatal care, which are in fact complementary in nature. The birth of a child just coexists in between this transitional gap. Our paper uses NFHS-3 data for an Indian state – West Bengal - to examine the related socioeconomic factors that may have pronounced effects on the demand for maternal health inputs like pre-natal care and choice of place of delivery. Concurrently we also check the effects on child mortality. We believe that this would help the policy makers to identify the areas to stress upon in order to pave the way for the formation of good quality human capital in the long run. Another distinguishing feature of this paper is the use of joint estimation technique that solves the unobserved heterogeneity problem which is commonly present in this kind of research. In most of the cases, the usage of this technique is not resorted. The place of residence, standard of living, and women's educational level are found to have an increasing effect on the demand for prenatal care and hospital delivery. However, a more relevant analysis should never ignore the dimension of child mortality. There we find hospital delivery to be effective to reduce child mortality. Mothers' age, religion, occupation, participation in household decision making process, and child's birth order are other important predictors of child mortality.

1. Introduction and the context

Unusually high child mortality in the developing countries can be associated with underutilization of maternal health care, which is generally overlooked. However, effective health policy can be designed only when concrete and relevant information is available on the efficiency of the existing maternal healthcare and its related factors. The Millennium Development Goals had successfully focused global attention and resources to maternal and child health. Although chronic undernutrition, child and maternal mortality had declined significantly, much is yet to be accomplished. The formulation of SDG 3 – ensures healthy lives and promote well-being for all at all ages – have easily accommodated our area of concern.

This brings us to the issue of the importance of health that needs to be taken note of even before the birth of the child. The well-being of both the mother and the child determines the health of the next generation.

This in turn can predict future public health challenges that the health care system of an economy would be concerned with. Hence, we should be more concerned with antenatal and postnatal care, which are in fact complementary in nature. The birth of a child just coexists in between this transitional gap. It is usually seen that a provision for scientific delivery is desirable, but the family failed to arrange for it leading to life threatening risks for both the mother and the child. On the other hand, failure of utilizations of proper delivery care, lack of suitable post-natal care, and other health related problems can lead to child mortality. So, we tend to obtain a different result when we consider health outcome and how health inputs are utilized based on the socio-demographic profile. Again the latter might also have an impact, but in a different way, on the health outcome.

Thus, the main objective of the paper is to discover those variables that determine the demand for various maternal health inputs in West Bengal. The choice of pre-natal care and the choice of place of delivery

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are the two important health inputs that are considered as outcome variable in the first place as these two will form the basis of analysis where the final outcome variable is child mortality. We believe that this would help the policy makers to identify the areas to stress upon in order to pave the way for the formation of good quality human capital in the long run.

The paper has an 'Introduction' followed by a 'literature review' in the second section. The third section deals with the 'data source and methodology' while the fourth section outline the 'analysis'. The last section concludes the paper with some policy recommendations in place. Detailed estimated results and summary statistics are in [AppendixA](#) and [AppendixB](#), respectively.

2. Literature review

In most of the developing countries, and India not being an exception, we come across high pregnancy complication cases leading to high-risk deliveries in many instances. Thus, the developing world has yet to institutionalize ante-natal and post-natal care. Antenatal care is mainly crucial for detecting high-risk pregnancies by undergoing routine measurement of blood pressure, weight, and hemoglobin levels; abdominal examinations; and proper vaccination for diseases like tetanus. This would not only reduce the risk to maternal health from pregnancy induced factors, but at the same time would take care of birth-related complications of the child ([Mosley and Chen, 1984](#)).

Non-monetary factors like travel distance, travel time, waiting time and so on may play a crucial role also play an important role in shaping the demand for maternal health care as corroborated by [Acton \(1975\)](#). Socio-demographic variables like maternal and paternal education levels have a positive effect on the usage of maternal health care. This has been documented by a study in Nepal by [Halim et al. \(2011\)](#). Again, Ethiopia's case is discussed in [Mekonnen and Mekonnen \(2002\)](#) where he argued that the marital status of the women, their maternal education, place of residence, educational level and religion has turned out to be most important factors that have determined an increased usage of maternal health care services. [Birmeta et al. \(2013\)](#) also harped on the important bearing that community awareness can have on the health of the mother and the baby in their study which focused on a region in Ethiopia. They found that even a few years of schooling increases the probability of a mother to routinely use pre-natal care services throughout her pregnancy. Inadequate referral linkages, sub-standard quality of care, high OOP expenditures mainly for consultations and travel are additional factors that contribute to poor health care utilization in Nepal.

Some of the researchers like [Ensor and Cooper \(2004\)](#) have also shifted their attention to supply-side factors that might act as hindrances to higher demand of maternal health care. Studies suggest that high coverage and quality of essential healthcare packages could avert about 67% of neonatal and child deaths in 60 countries ([Lawn, 2005](#)). [Kerber et al. \(2007\)](#) outlines a package-based public health framework that would go a long way in ensuring a good health for the twosome - mother and the new born. The packages encompass those that are delivered through clinical care, outpatient and outreach services and through integrated family and community care.

If we now focus our attention to country-level studies, we find a myriad of them. [Becker et al. \(1993\)](#), [Celik and Hotchkiss \(2000\)](#), [Babalola and Fatusi \(2009\)](#), [Raghupathy \(1996\)](#) and [Short and Zhang \(2004\)](#) conducts in-depth study in Philippines, in Turkey, Nigeria, Thailand and China just to arrive at similar conclusions. [Agha \(2000\)](#) examined the case of gender difference in health care utilization in Pakistan. Very recently, [Makate and Makate \(2016\)](#) and [Makate \(2015\)](#) have rigorously investigated the same for Zimbabwe and used a similar technique that we have taken recourse to in this paper.

[Ensor and Ronoh \(2005\)](#) do a commendable compilation of the existing literature on financing of health care services. Though this paper holds no direct connection with the present paper, its importance is reiterated by the fact that it makes a lucid attempt at investigating the

issues of finance and how it becomes significant for prenatal care. The main causes of death below the age of five years worldwide are mainly related to preterm birth, pneumonia, intrapartum-related complications like stillbirth, complications during labour and delivery, malaria, and diarrhoea. However, the causes of child mortality vary region wise. In Sub-Saharan Africa, 1 child in 12 dies before his or her fifth birthday and the causes of mortality were mainly attributable to infectious diseases such as malaria, HIV/AIDS, pneumonia and complications of pre-term birth. In that year, South Asia accounted for approximately a third of the global burden of under-five deaths, which was largely due to complications of pre-term birth, pneumonia and intrapartum-related complications ([Liu et al., 2015](#)).

In what follows, we can comprehend that all the studies directly points to institutional or hospital delivery for the health outcome of both mother and child. There is no denying the fact that the demand for both prenatal care and hospital delivery should leave a lasting effect on child mortality. A healthy child obviously goes a long way in ensuring human capital formation, accelerating economic growth in the process.

Since this paper is based on West Bengal, an Indian state, we also need to delve into some studies based in India. Using second round data of NFHS (National Family Health Survey) in India, [Maitra \(2004\)](#) using the technique of joint estimation, had attempted to check how the status of women in the household becomes an important determining factor as they divert resources to be used in improving their health and the subsequent health of their new-borns. In another paper, [Maitra and Pal \(2007\)](#) discusses the ways by which the different health inputs are associated with child mortality in Bangladesh, a country which was once a part of undivided India and shares not only its territorial boundary with West Bengal, but also its language and culture. They also deal with the problem of unobserved heterogeneity in the above-mentioned paper. Other researchers who explored women's autonomy are [Bloom et al. \(2001\)](#) and they focus on its influence on the demand for maternal health care services in Varanasi. The Bangladesh case has been showcased by [Anderson and Eswaran \(2009\)](#) in a paper where they have shown that increasing a woman's autonomy has led to long-term reductions in fertility, higher child survival rates and proper allocation of resources within the household benefitting the children of the same. On similar grounds, the Indian story has been taken care of by [Grabowski and Self \(2013\)](#) when they examined in the Indian states of Bihar and Uttar Pradesh the case of mother's autonomy and if it can ensure high quality of child health care. They also investigated the gender biasedness prevailing in these northern states and whether the demand for child health care services is impacted due to the presence of such biasedness. Crisscrossing the country to one of its southern state, Andhra Pradesh, [Shroff et al. \(2011\)](#) tried to determine the role of mother's autonomy in feeding practice and infant growth. Results indicated that mothers with high level of financial autonomy were more likely to breastfeed their infants and mothers with higher decision-making autonomy in their households had less underweight and less wasted infants [Navaneetham and Dharmalingam \(2002\)](#) used data from NFHS (Round 2) to determine the various socioeconomic factors behind maternal health care service utilization in some southern states of India, whereas [Chakrabarti \(2012\)](#) focused the same only in rural India. [Roy and Chaudhuri \(2008\)](#) used a different survey data to explore the presence of gender difference in health care utilization in India. We could sketch some of these issues at a pan-India level with the help of the work of [Sarkar and Halder \(2014a, 2014b\)](#) help us to have a brief overview of such issues at the national level.

Thus, it is apparent that we are not aware of any study has been carried out where maternal health care utilization and its impact on child mortality based on the data of the Indian state, West Bengal was carried out. The state is steeped in history mainly from the colonial era, and has been ruled by a stable, coalition government for as long as three and half decade. This implies the state should not have suffered any policy paralysis in implementing policies targeted for lowering child and maternal mortality. West Bengal has 7.6% of the country's total population and it

has also registered a steep decline in fertility in 2001–2011 compared to its previous decade. West Bengal has been successful in considerably reducing child mortality in comparison to other Indian states. Its maternal mortality rate is also better than most of the states - it is the only state where the rate increased over the period 2004–06 and 2007–09. Thus, the state can boast of low fertility and low mortality of mothers, but maternal complications are quite high in this state, ranking third in India (just after Bihar and Jharkhand). This dwelling of opposing and compelling results makes West Bengal a curious study in this field. So this paper tries to breach this fissure by focusing on the demand for maternal health care inputs in West Bengal.

Another distinguishing feature of this paper is the use of joint estimation technique that solves the unobserved heterogeneity problem which is commonly present in this kind of research. The details of the technique and its relevance for such analysis are discussed in the paper.

3. Data and methodology

Initiated in the early 1990s, the National Family Health Surveys (NFHS) programme has emerged as a very important source of data on population, health, and nutrition for India and its states. In this paper we make use of the 2005-06 National Family Health Survey (NFHS-3), 2005, the third in the series of these national surveys. It covers all the states of India and the respondents were men of age 15–54 years and women of 15–49 years old. In this paper, it has been deemed quite irrelevant to consider the never-married group, as the pivotal issue for our discussion is maternal health. Hence, only the ever-married group of women who are in their child-bearing age has been taken up for the present study. It has already been discussed in the previous section the specific reasons for considering West Bengal as the study area.

Information on pre-natal care (PNC) and choice of place of delivery for the youngest child who is born during five years preceding the survey was noted by NFHS-3. Thus we have a sample of 1823 mothers who had a baby born during the period 2001–2005. 267 of these mothers had experienced death of a child aged less than 5 years. It should be noted that we have taken the death of any child during the mother's life span and so this should not be confused with child mortality.

A look into the socio-demographic profile of the mothers reveals that majority of the mothers are Hindus (two-third) whereas one-third are Muslims and a mere 1% of them are Christians. However, in regard to distribution of wealth we do not see any lopsidedness. The poorest group consists of only 23% of total population while middle and richest income groups are almost equally divided. This amounts to 17%.¹ 83.6% of total

¹ Note that definition of wealth index and standard of living are directly drawn from NFHS-3 or DHS (Demographic and Health Surveys) methodologies. The NFHS-3 wealth index is based on the following 33 assets and housing characteristics: household electrification; type of windows; drinking water source; type of toilet facility; type of flooring; material of exterior walls; type of roofing; cooking fuel; house ownership; number of household members per sleeping room; ownership of a bank or post-office account; and ownership of a mattress, a pressure cooker, a chair, a cot/bed, a table, an electric fan, a radio/transistor, a black and white television, a colour television, a sewing machine, a mobile telephone, any other telephone, a computer, a refrigerator, a watch or clock, a bicycle, a motorcycle or scooter, an animal-drawn cart, a car, a water pump, a thresher, and a tractor. The wealth index was constructed using household asset data and housing characteristics as mentioned above. Each household asset is assigned a weight (factor score) generated through principal components analysis, and the resulting asset scores are standardized in relation to a normal distribution with a mean of zero and standard deviation of one. Each household is then assigned a score for each asset, and the scores were summed for each household; individuals are ranked according to the score of the household in which they reside. The sample is then divided into quintiles i.e., five groups with an equal number of individuals in each. In NFHS-3, one wealth index has been developed for the whole sample and for the country as a whole (NFHS 3). The report can be accessed at <https://dhsprogram.com/pubs/pdf/FRI/ND3/FRIND3-Vol1AndVol2.pdf>.

1823 mothers are in the 15–30 years age group; 36.75% mothers are either in the category of secondary level of education or completed the level. A significant 35.87% is illiterate and the category of primary level consists of 21.23% of the population. This justifies the fact that if girls start their education, they generally move to the secondary level. In respect of employment a major share, 73.61% of total mothers are unemployed officially. They are involved only in doing own household chores. For mothers' autonomy: we construct four broad categories of indicators: access to information, household decision making, mobility, and can keep some money or own use.

A more in-depth observation reveals that 11.42% of the Hindu mothers experience child mortality while 21.42% of the Muslim mothers also experience the same. Obviously, mothers belonging to the 'poorest' segment of the wealth index have experienced child mortality (20.87%) and the 'richest' mothers are more fortunate to experience only 3.7% of child deaths. Mothers aged between 41–50 years experience 55% of child mortality while 11.75% and 27.6% of the children die for mothers in the age cohort of 15–30 years and 31–40 years respectively.²

An in-depth discussion was already done on the importance of maternal health in ensuring good health of the new-born. The role of certain socio-economic factors cannot be ignored in this connection. Thus, in line with Maitra (2004), Mandal, 2015 and Maitra and Pal (2007), we construct three probit equations viz. child mortality (CM) denoting whether the concerned mother's child had died at the age less than five or not, place of delivery (HD³) denoting whether the mother had given birth in a hospital/institutional centre or not, and prenatal care (PC) denoting whether the mother had resorted to prenatal medical care services or not. The final outcome variable in this connection is child mortality. So we estimate the following equations:

$$PC = \alpha_0 + \alpha_1 X_p + u_p + \varepsilon_p \quad (1)$$

$$HD = \beta_0 + \beta_1 X_h + u_h + \varepsilon_h \quad (2)$$

$$CM = \delta_0 + \delta_1 X_c + u_c + \varepsilon_c \quad (3)$$

Note that p , h and c subscripts are, respectively, used for equations to denote prenatal care, hospital delivery, and child mortality, and α_0 , β_0 , and δ_0 are having usual interpretations of the constant terms for those equations. α_1 , β_1 , and δ_1 signify the coefficients for different explanatory variables considered in these equations. X_p , X_h , and X_c represent possible regressors that may non-negligible effects on the demand for maternal health inputs and child mortality. Therefore, the binary outcome variables are represented as

$$PC = \begin{cases} 1 & \text{if care is taken} \\ 0 & \text{if care is not taken} \end{cases} \quad (4)$$

$$HD = \begin{cases} 1 & \text{if delivery is in hospital} \\ 0 & \text{if delivery is not in hospital} \end{cases} \quad (5)$$

² A detailed table consisting of summary statistics of the mothers especially age, religion, wealth status, educational attainments, occupation etc. is presented in Appendix B.

³ In this paper we use the joint estimation technique which is a Full Information Likelihood Method (FILM). This takes care of the problem of unobserved heterogeneity which is likely to be present in this kind of research. Some related papers have already used such technique. So this is an improvement over the regression techniques like Logit, Probit etc. where dependent variables is not continuous rather categorical in nature. It is also to be note that the Conditional Mixed Process (CMP) that we use here is also based on Probit estimation technique. But simple Probit often overestimates or underestimates (apparent from the values of coefficients of Model I and model II) the results because of the presence of heterogeneity in the structure. Fortunately, CMP takes care of this problem. We are thankful to the referee for asking us to clarify this point.

$$CM = \begin{cases} 1 & \text{if at least one child of less than 5 years age is dead} \\ 0 & \text{if no child of less than 5 years age is dead} \end{cases} \quad (6)$$

Here u_i ($i = p, h, c$) is an error term which takes care of unobserved heterogeneity due to the mother. So $u_i \sim N(0, \sigma_i^2)$; σ_i^2 is the variance of unobserved factors, if any. Again ε takes into account all other residual variation and follows $\varepsilon_i \sim IID N(0, 1)$; $i = p, h, c$.³

The source of heterogeneity in the present structure refers to certain factors or issues which can be perceived only by the mother like anticipated complications in pregnancy that might create problems during the delivery of the baby and the associated postnatal care. These information are entirely secretive to the mother but completely unobserved to the researchers. Under this situation the concerned mother will self-select herself. She would tend to use various maternal health care inputs which may be pre-natal or post-natal. So it is a case of mother specific unobserved heterogeneity where the pre-natal care (PC) is essentially endogenous in the place of delivery (HD) regression equation. Again, both PC and HD are endogenous in the CM equation. Since mothers are the first providers of care for the child, their behaviour becomes extremely important while analyzing child mortality. It is very difficult to identify whether the mothers are able to recognize potentially life-threatening conditions of the child, whether they are prompt enough to seek care for their child, and are sensible enough to persist with the treatment. We see that a mother with relatively bad health may select themselves for more prenatal care, thus leading to underestimation while a healthier and educated mother self-select for good quality maternal health care because of their knowledge about possible benefits of prenatal care lead to overestimation. Similar type of issues can also arise after the birth of the child.

Prenatal Care (PC) is a crucial covariate for determining the place of delivery (HD) decision. Similarly both PC and HD are important regressors for the CM equation. PC not only implies medical assistance but also indulges in the act of counselling during the course of the pregnancy. So it should be obvious that any PC related medical advice should guide the mothers to take a decision that should lead to a safer and successful delivery of the baby. In the same way, when the mother is delivering her baby in a hospital, she might be receiving advice from skilled medical personnel regarding the postnatal care of her child. These counselling sessions might go a long way in changing the mother's role in childcare. This implies that we would end up with a recursive system and hence should take recourse to joint estimation technique⁴, otherwise the results would signal biased estimation.

4. Results and discussions

We have estimated three binary probit equations with the three outcome variables viz. PC, HD, and CM. To start with, these are assumed as exogenous. Then we checked for unobserved heterogeneity by using random effect estimation. This helps to identify if the unobserved heterogeneity somewhat explains a sizeable percentage of variation in the outcome variable. In the presence of endogeneity one should go for jointly estimation of PC, HD, and CM equations. This is carried out here using Conditional Mixed Process (Roodman, 2009, 2013). Again, following Panis and Lillard (1994) we understand that a recursive structure may suffers from self-selection problem. This can be best handled when estimated jointly using full information maximum likelihood (FIML) method.⁵ In our set of equations mother specific unobserved heterogeneity is denoted by ε_i . However, when ε_i is not known for any specific mother, estimation should be done by formulating likelihood method conditional on ε_i , and then one has to integrate over its

distribution. This helps producing consistent estimator as the technique makes covariates x_i ($i = p, h, c$) orthogonal to ε_i . This is why all such issues are nicely taken care of in joint estimation technique, already defined above.

Now we present the effects of concerned regressors for both endogenous (Model I) and exogenous (Model II) estimations along with the marginal effects. We start with the effects on PC, and then we move to the regression equation for HD, though the final response variable is CM.

4.1. Demand for prenatal care (PC)

A careful investigation reveals that we may have confounding effects for exogenous estimations. The estimated coefficients are either underestimated or overestimated. This guarantees the presence of some kind of endogeneity. Therefore, to assess the concerned effects we should consider endogenous estimation results (see Table 1).

The results show that the city women are liable to seek 6% more prenatal care than women from villages. Pre-natal care depends mainly on availability of medical personnels, medical centres and physical proximity to the avenues that can satisfy prenatal care of the mothers which can be collectively termed as the supply-side factors. The place of residence is also a statistically strong predictor of PC. This result is an obvious one, especially in developing countries where the urbanites enjoy most of the medical related facilities we mentioned, whereas the rural women are deprived of such facilities⁶. The Muslim (4%) mothers and the Christian (20%) mothers are less likely than their Hindu counterparts to avail PC. This argument points at some religious beliefs and cultural upbringings that may have restricted these women from availing modern treatment and advice. Christians belong to lower income group in most part of West Bengal, and hence might not have the capability to avail pre-natal care. The educational level and standard of living, which are other significant covariates, are also relatively higher for urban residents. We also find the probability of seeking PC is 11% more likely for those whose standard of living is **very good** compared to those with a low standard of living. The same is 9% higher for those women who live in families having **good** standard of living (ssli).⁷ Ssli reflects the standard of living of the families the mothers belong to and so the degree of awareness of family members and their responsiveness to modern amenities can also be gauged by it. Interestingly, mothers are 5% more inclined to using PC if they have the control⁸ to keep some money aside as compared to those who do not enjoy this advantage.

Though partner's education, which implies the father's education, does not have any significant association in utilizing PC by the woman, her own education is very important. Expectedly, mothers with a secondary level of education is almost 7% more likely and those with primary education are 4% more likely to demand for PC than illiterate women. Since educated women have comparatively more freedom to go outdoor, they are relatively better placed to visit doctors or any other medical personnel and will hence demand more PC. Education also makes them more aware of the complications that might occur during pregnancy and in post-natal phase.

Conventionally birth order has a negative relation with the probability of seeking PC. Mothers acquire some experience with birth of every child. So, a mother with more children can predict some unforeseen

⁶ Literature also suggests the role of supply side variables like per capita medical professionals (including public and private). But we could not consider such variable mainly due to non availability of data. Nevertheless such analysis is more realistic as it helps policy makers to design proper plans.

⁷ There is a natural tendency to confuse between Standard of living (ssli) and wealth distribution. But Ssli covers more dimensions than wealth. For further details readers are referred to DHS reports (Rutstein, 2008).

⁸ This variable is a part of mother's autonomy indicators. Details of autonomy variables are found in the full set of covariates provided in Appendix. We have used Principal Component Analysis to find out the principal component(s) for each subgroups and then used them in the regression.

⁴ Full set of covariates and detailed coefficients are shown in Appendix A.

⁵ Other methods of estimation like OLS, 2SLS etc. give us biased estimation since $Cov(x_i, \varepsilon_i) \neq 0$, and mother level unobserved heterogeneity is actually an omitted variable in the list of regressors.

Table 1. Prenatal care (PC).

	Model-I		Model-II	
	Effect on Prenatal Care	Marginal Effects of respective covariates	Effect on Prenatal Care	Marginal Effects of respective covariates
Place of residence	0.354** (2.66)	0.0584	0.341* (2.58)	0.0580
Religion (ref. group Hindu)				
Muslim	-0.257* (-2.55)	-0.0423	-0.249* (-2.42)	-0.0424
Christian	-1.204*** (-3.41)	-0.1986	-1.201** (-2.92)	-0.2046
Standard of Living (ref. group Low)				
Good	0.562** (3.17)	0.0926	0.567** (3.20)	0.0926
Very good	0.683** (2.70)	0.1126	0.701** (2.76)	0.1195
Can keep money for own use	0.333** (3.04)	0.0550	0.328** (2.97)	0.0558
Mother's education (ref. group Illiterate)				
Primary level	0.260* (2.17)	0.0428	0.257* (2.17)	0.0438
Secondary level	0.411** (2.95)	0.0678	0.411** (2.98)	0.0700
Birth order of the child	-0.0819* (-2.10)	-0.0135	-0.0826* (-2.26)	-0.0140
Constant	0.143 (0.32)		0.141 (0.32)	

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

complications, and can protect herself. Here experience becomes a confidence augmenting factor. This is probably the reason for such negative relation between birth order and demand for prenatal care (PC). Again, on the other hand more children certainly mean resource shortage or less time available for PC.

4.2. Demand for hospital delivery (HD)

The process of child birth is not yet fully institutionalized⁹ in many developing countries, including India. Hence, the variable HD designated as 'choice of place of delivery' would obviously depend on a host of socio-economic factors. The results obtained in this case are almost similar to that of PC with the exception of mother's age which has a positive association with HD (see Table 2).

However, mother's age has not led to an increase in the probability of mothers opting for institutionalized childbirth (0.01%) to a large extent. An intuitive explanation can be that with growing age, mothers become aware of the complications and riskiness that are generally associated with a pregnancy or they also might feel that with age pregnancies become more complicated. Hence, they become more cautious and tend to seek institutional delivery with modern infrastructural set-up and under the supervision of trained medical personnel. The argument of awareness is also corroborated by the variable 'access to information' which has been defined as whether the woman reads newspaper, listens to radio and watches television at least once a week. It is observed that if a woman has access to such pathways of information, the likelihood of choosing the place of delivery as an institutional one like hospital goes up by 0.14%.

Like the demand for PC, the urbanites' probability of choosing institutional delivery (HD) rises remarkably (24%). Along with that education of women – both primary (7%) and secondary (14%) had a positive influence on HD. A good sqli (18%) and a very good sqli (12%) also increased the likelihood of women opting for HD. Again, Muslim women

are 13% less likely to go for hospital delivery, mainly due to their religious and cultural orientation of not exposing their private lives.

4.3. Child mortality

Scientific and technological innovations can potentially save the lives of the millions of children who are destined to die in the developing countries due to various factors. Inventions of various vaccines and advancements in diagnostic methods are playing the role of messiah in this context. However, emergence of effective interventions is not enough by itself unless they are able to make themselves useful and worthwhile by reaching the mothers and children who need them the most (see Table 3).

Hospital delivery translates to lower child mortality as it is evident from the regression analysis. This implies that mothers who deliver their child in hospitals are 12% less likely to be exposed to the hazards of child mortality. A quarter of all neonatal death takes place within the first twenty four hours of birth and three quarter within the first week (WHO, 2006). Thus, births in hospitals are desired as it gives mothers access to trained and skilled medical professionals who are adequately adept at recognizing and managing delivery complications and execute timely interventions whenever required.

Mothers in the higher age group have a 0.1% probability of decreasing the risk of child mortality. Once married, girls are under a great pressure to become pregnant and prove their worth in the new households. They are physically and psychologically not matured enough to accommodate such a life transformation event. Early motherhood is also associated with poor maternal health outcomes that subsequently feed through to child health.

Neither educational attainment of mothers nor their partners have any significant impact on child mortality in our analysis. Religious group to which mothers belong has an effect on child mortality. A Muslim mother is 5% less likely and a Christian mother is 19% less likely to be exposed to the hazards of child mortality compared to Hindu mothers. This finding is in consistence to previous findings by many like Bhalotra and van Soest (2008). The finding is interesting in the sense that the socio-economic status of Muslim women is considerably lower than the Hindus in India, but still they have been managing to maintain high child survival rates for decades.

⁹ Here we do not distinguish among public hospitals, private hospitals, NGO, trust or any other health institutions. Positive value of HD covers all institutions endowed with trained professionals.

Table 2. Hospital delivery (HD).

	Model-I		Model-II	
	Effect on Hospital Delivery	Marginal Effects of respective covariates	Effect on Hospital Delivery	Marginal Effects of respective covariates
Prenatal Care	0.417 (0.39)	-	0.733*** (5.38)	0.1749
Place of residence	1.053*** (9.85)	0.2441	1.049*** (10.41)	0.2501
Age of the mother	0.000496** (2.60)	0.0001	0.000496** (2.59)	0.0001
Religion (ref. group Hindu)				
Muslim	-0.580*** (-6.53)	-0.1345	-0.555*** (-6.26)	-0.1324
Standard of Living (ref. group Low)				
Good	0.759*** (4.94)	0.1758	0.688*** (5.15)	0.1642
Very good	0.508** (2.82)	0.1177	0.506** (3.14)	0.1206
Access to Information	0.00627** (3.22)	0.0014	0.00613** (3.04)	0.0014
Mother's education (ref. group Illiterate)				
Primary level	0.304** (2.80)	0.0705	0.294** (2.78)	0.0700
Secondary level	0.603*** (5.12)	0.1398	0.583*** (5.15)	0.1390
Birth order of the child	-0.191*** (-4.26)	-0.0442	-0.190*** (-5.09)	-0.0453
Constant	-1.576 (-1.72)		-1.586** (-3.14)	

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Mothers working in manual work are 6% more likely to dispose them to child loss than mothers engaged in other occupation. This might imply that manually working mothers mostly hail from families with low income and they are in no position to be irregular or absent from their work, even in periods of exigencies arising out of child's ill health. Thus, a poor working mother cannot afford to invest 'time' like breastfeeding her new born for a much lesser time leading to adverse effects on child mortality (Leslie, 1989).

Mothers with a say in household decision making is likely to have 0.2% more probability of being exposed to the hazards of child mortality. This may be primarily due to the fact that she may be in employment

whose nature is such that it curtails her time for child rearing rather than adding more to the household resources.

There is a 7% more probability of children with increasing birth order to be exposed to the hazards of child mortality. The steady increase in child mortality with the birth order might reflect competition in the resources and lower utilization of maternity services in the state (Bhalotra and van Soest, 2008). Again, in the case of children of higher birth orders, they are likely to be born of mothers who are supposedly physically weaker. They might also be receiving less care due to the presence of more children in the household. On the other hand, mothers who had already given birth before might become more complacent and banks on

Table 3. Child mortality (CM).

	Model-I		Model-II	
	Effect on Child Mortality	Marginal Effects of respective covariates	Effect on Child Mortality	Marginal Effects of respective covariates
Place of delivery	-0.693* (-2.08)	-0.1293	0.263 (1.48)	0.0445
Age of the mother	-0.000400* (-1.97)	-0.0001	-0.000533** (-2.58)	-0.0001
Religion (ref. group Hindu)				
Muslim	-0.256* (-2.48)	-0.0477	-0.102 (-0.98)	-0.0171
Christian	-1.036* (-2.19)	-0.1933	-0.893 (-1.21)	-0.1511
Mother's Occupation (ref. group No Work)				
Manual	0.320** (2.63)	0.0596	0.360** (2.72)	0.0608
Say in household decision making	0.0129* (2.56)	0.0024	0.0136* (2.08)	0.0023
Birth order of the child	0.377*** (7.13)	0.0703	0.458*** (10.96)	0.0775
Constant	-1.103 (-1.33)		-1.609** (-2.59)	

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

their prior experience leading to carelessness and increased probability of being exposed to the hazards of child mortality.

5. Conclusion

The well-being of both the mother and the child determines the health of the next generation. This in turn can predict future public health challenges that the health care system of an economy would be concerned with. Hence, we should be more concerned with antenatal and postnatal care, which are in fact complementary in nature. The birth of a child just coexists in between this transitional gap.

This paper tries to look at various socioeconomic factors that are likely to affect the demand for prenatal care and hospital delivery which are in effect also relevant for the child mortality. We believe that this would help the policy makers to identify the areas to stress upon in order to pave the way for the formation of good quality human capital in the long run. Another distinguishing feature of this paper is the use of joint estimation technique that solves the unobserved heterogeneity problem which is commonly present in this kind of research. In most of the cases, the usage of this technique is not resorted. It has been observed that the place of residence, standard of living, and educational level of women remarkably increase the demand for both the maternal health inputs. However, the analysis becomes less relevant if we fail to identify the factors responsible for the mothers and the households to be exposed to the outcome of child mortality. We find that hospital delivery translates to lower child mortality. Age group of the mother and religious groups, nature of mothers' occupation, say in the household decision making, and birth order of the child are other important predictors of child mortality.

The results obtained in this paper leads us to a general prescription that infrastructural development, supply of trained health professionals, female educational attainment must be given the maximum priority because standard of living cannot be raised in a short span of time. Thus this paper prescribes a focused plan for physical infrastructure

development. Infrastructure primarily reduces the menaces to the access of health care and education and helps in availing them. It also helps inspiring girls to continue schooling and to ensuring that the primary school drop-out rates may be brought down to the minimum. The country should institutionalise laws such that families are forced to resort to the institutional child delivery mechanism rather than relying on traditional methods, as it would go a long way in reducing child mortality.

Declarations

Author contribution statement

B. Mandal, S. Chaudhuri: Conceived and designed the analysis; Analyzed and interpreted the data; Contributed analysis tools or data; Wrote the paper.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Appendix A. List of covariates and coefficients for child mortality, hospital delivery and prenatal care regression.

	Model-I	Model-II		Model-I	Model-II
Estimated results for Prenatal Care					
Place of residence	0.354** (2.66)	0.341* (2.58)	Allowed to go	-0.00539 (-0.90)	-0.00546 (-1.00)
Age of the mother	-0.000126 (-0.62)	-0.000139 (-0.70)	Can keep money for own use	0.333** (3.04)	0.328** (2.97)
Religion (ref. group Hindu)			Complications during pregnancy	-0.0710 (-0.50)	-0.0705 (-0.52)
Muslim	-0.257* (-2.55)	-0.249* (-2.42)	Mother's education (ref. group Illiterate)		
Christian	-1.204*** (-3.41)	-1.201** (-2.92)	Primary level	0.260* (2.17)	0.257* (2.17)
Standard of Living (ref. group Low)			Secondary level	0.411** (2.95)	0.411** (2.98)
Medium	0.206 (1.83)	0.207 (1.86)	Partner's education (ref. group Illiterate)		
Good	0.562** (3.17)	0.567** (3.20)	Primary level	-0.0836 (-0.71)	-0.0803 (-0.67)
Very good	0.683** (2.70)	0.701** (2.76)	Secondary level	-0.146 (-1.20)	-0.151 (-1.14)
Partner's Occupation (ref. group No Work)			Higher level	-0.268 (-0.97)	-0.277 (-0.88)
Manual	0.710 (1.74)	0.721 (1.78)	Birth order of the child	-0.0819* (-2.10)	-0.0826* (-2.26)
	0.523	0.541	Constant	0.143 (0.32)	0.141 (0.32)
Agriculture, Household, Domestic	(1.28)	(1.33)			
Professional, Clerical, Service, Sales	0.734 (1.78)	0.750 (1.84)			
Mother's Occupation (ref. group No Work)					
Manual	0.0152 (0.09)	0.0315 (0.22)			
Agriculture, Household, Domestic	0.00445 (0.03)	0.0142 (0.09)			
Professional, Clerical, Service, sales	-0.185 (-0.85)	-0.191 (-0.86)			
Access to Information	0.00146 (0.57)	0.00158 (0.60)			
Say in household decision making	-0.00627 (-1.75)	-0.00639 (-1.13)			
Estimated results for Hospital Delivery					
Prenatal Care	0.417 (0.39)	0.733*** (5.38)	Professional, Clerical, Service, sales	0.0865 (0.46)	0.0773 (0.40)
Place of residence	1.053*** (9.85)	1.049*** (10.41)	Access to Information	0.00627** (3.22)	0.00613** (3.04)

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	Model-I	Model-II		Model-I	Model-II
Age of the mother	0.000496** (2.60)	0.000496** (2.59)	Say in household decision making	0.000513 (0.18)	0.000768 (0.22)
Religion (ref. group Hindu)			Allowed to go	0.0110 (1.78)	0.0102 (1.60)
Muslim	-0.580*** (-6.53)	-0.555*** (-6.26)	Can keep money for own use	-0.0895 (-0.90)	-0.101 (-1.14)
Christian	-0.386 (-0.65)	-0.291 (-0.56)	Complications during pregnancy	-0.244 (-1.81)	-0.256 (-1.91)
Standard of Living (ref. group Low)			Mother's education (ref. group Illiterate)		
Medium	0.0783 (0.73)	0.0617 (0.62)	Primary level	0.304** (2.80)	0.294** (2.78)
Good	0.759*** (4.94)	0.688*** (5.15)	Secondary level	0.603*** (5.12)	0.583*** (5.15)
Very good	0.508** (2.82)	0.506** (3.14)	Partner's education (ref. group Illiterate)		
Partner's Occupation (ref. group No Work)	0.737 (1.38)	0.486 (1.04)	Primary level	0.0666 (0.62)	0.0673 (0.62)
Manual			Secondary level	0.0297 (0.27)	0.0325 (0.29)
Agriculture, Household, Domestic	0.700 (1.32)	0.460 (0.98)	Higher level	0.382 (1.45)	0.415 (1.60)
Professional, Clerical, Service, sales	0.791 (1.50)	0.577 (1.23)	Birth order of the child		
Mother's Occupation (ref. group No Work)			Constant	-0.191*** (-4.26)	-0.190*** (-5.09)
Manual	-0.0524 (-0.40)	-0.0577 (-0.46)		-1.576 (-1.72)	-1.586** (-3.14)
Agriculture, Household, Domestic	-0.228 (-1.58)	-0.229 (-1.56)			
Estimated results for Child Mortality					
Place of delivery	-0.693* (-2.08)	0.263 (1.48)	Mother's occupation (ref. group No Work)		
			Manual	0.320** (2.63)	0.360** (2.72)
Prenatal Care	-0.0782 (-0.11)	0.125 (0.88)	Agriculture, Household, Domestic	-0.169 (-1.06)	-0.0964 (-0.56)
Place of residence	0.128 (0.94)	-0.149 (-1.09)	Professional, Clerical, Service, sales	0.335 (1.73)	0.335 (1.72)
Age of the mother	-0.000400* (-1.97)	-0.000533** (-2.58)	Access to Information	0.00300 (1.37)	0.00137 (0.59)
Religion (ref. group Hindu)					
Muslim	-0.256* (-2.48)	-0.102 (-0.98)	Say in household decision making	0.0129* (2.56)	0.0136* (2.08)
Christian	-1.036* (-2.19)	-0.893 (-1.21)	Allowed to go	0.00801 (1.14)	0.00681 (1.22)
Standard of Living (ref. group Low)					
Medium	0.0106 (0.09)	-0.0404 (-0.33)	Can keep money for own use	-0.181 (-1.81)	-0.184 (-1.82)
Good	0.0759 (0.45)	-0.0950 (-0.56)	Complications during pregnancy	-0.0744 (-0.52)	-0.0105 (-0.07)
Very good	0.348 (1.70)	0.136 (0.60)			
Mother's education (ref. group Illiterate)			Partner's education (ref. group Illiterate)		
Primary level	0.112 (0.93)	0.0122 (0.10)	Primary level	-0.0648 (-0.58)	-0.0891 (-0.74)
Secondary level	0.215 (1.64)	0.0549 (0.40)	Secondary level	-0.155 (-1.21)	-0.187 (-1.44)
Higher level	-0.508 (-1.27)	-0.551 (-1.16)	Higher level	-0.0417 (-0.18)	-0.0902 (-0.34)
Manual	0.320** (2.63)	0.360** (2.72)	Source of drinking water	-0.0281 (-0.40)	-0.0263 (-0.33)
Agriculture, Household, Domestic	-0.169 (-1.06)	-0.0964 (-0.56)	Type of toilet	0.0589 (1.08)	0.0499 (0.75)
Professional, Clerical, Service, sales	0.335 (1.73)	0.335 (1.72)	Birth order of the child	0.377*** (7.13)	0.458*** (10.96)
Access to Information	0.00300 (1.37)	0.00137 (0.59)			

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B. Total HH surveyed in WB is 6794. Out of this we have considered only those HH where at least one child is born in five years preceding the survey. So we ended up with 1823 HH among which 267 HH experienced death of at least one child of age less than 5 years. Baseline characteristics of the selected variables for Households (HH), Mothers (M) and Children (C) from West Bengal, India: NFHS-3 (2005–2006)

Variable	ALL				DIED				NOT DIED			
	Sample size (N)	Percentage (%)	Mean	SD	Sample size (N)	(%) in the respective category	Mean	SD	Sample size (N)	(%) in the respective category	Mean	SD
Household Characteristics												
Place of residence	1823				267	17.35			1556	82.65		
Rural	1823	58.8			267	17.35			1556	82.65		
Urban	1823	41.2			267	10.79			1556	89.21		
Religion	1823				267				1556			
Hindu	1823	65.33			267	11.42			1556	88.58		
Muslim	1823	33.3			267	21.42			1556	78.58		
Christian	1823	0.88			267	6.25			1556	93.75		
Sikh	1823	0.11			267				1556	100		
Buddhist	1823	0.05			267				1556	100		
Jain	1823	0.27			267				1556	100		
Others	1823	0.05			267				1556	100		
Standard of living	1823		2.413	1.67	267		2.03	1.6	1556		2.48	1.68
low	1823	32.2			267	21.29			1556	78.71		
medium	1823	30.77			267	15.33			1556	84.67		
good	1823	28.3			267	7.364			1556	92.64		
Very good	1823	7.95			267	10.34			1556	89.66		
Source of drinking water	1823				267				1556			
Others, primarily open	1823	13.88			267	11.86			1556	88.14		
Tube well	1823	53.81			267	17.33			1556	82.67		
Public tap	1823	18.98			267	15.03			1556	84.97		
Piped water	1823	13.33			267	6.173			1556	93.83		
Toilet	1823				267				1556			
Others including no facilities	1823	42.4			267	17.72			1556	82.28		
Pit toilet/latrine	1823	8.23			267	19.33			1556	80.67		
Flush toilet	1823	49.37			267	11.22			1556	88.78		
Partner's education	1823		1.319	1.01	267		0.83	0.92	1556		1.4	1
No	1823	28.69			267	24.28			1556	25.78		
Primary	1823	20.24			267	15.99			1556	20.18		
Secondary	1823	39.11			267	9.397			1556	42.06		
Higher	1823	10.53			267	4.167			1556	11.98		
Partner's occupation	1823				267				1556			
No work	1823	0.93			267	17.65			1556	82.35		
Others	1823	0.05			267				1556	100		
Manual	1823	38.67			267	15.74			1556	84.26		
Agriculture, hh & domestic	1823	27.21			267	17.94			1556	82.06		
Professional, Clerical, service, sales	1823	33.13			267	10.6			1556	89.4		
Mother's Characteristics												
Mother's age (in years)	1823		25.54	5.35	267		28.1	6.41	1556		25.1	5.02
15-30	1823	83.6			267	11.75			1556	88.25		

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Variable	ALL				DIED				NOT DIED			
	Sample size (N)	Percentage (%)	Mean	SD	Sample size (N)	(%) in the respective category	Mean	SD	Sample size (N)	(%) in the respective category	Mean	SD
31-40	1823	15.3			267	27.6			1556	72.4		
41-50	1823	1.1			267	55			1556	45		
Mother's education	1823		1.132	0.98	267		0.64	0.83	1556		1.22	0.98
No	1823	35.87			267	23.7			1556	76.3		
Primary	1823	21.23			267	13.95			1556	86.05		
Secondary	1823	36.75			267	8.507			1556	91.49		
Higher	1823	6.14			267	0.893			1556	99.11		
Mother's occupation	1823				267				1556			
No work	1823	73.61			267	12.59			1556	87.41		
Others	1823				267				1556			
Manual	1823	12.01			267	23.29			1556	76.71		
Agriculture, hh & domestic	1823	8.5			267	17.42			1556	82.58		
Professional, Clerical, service, sales	1823	5.87			267	18.69			1556	81.31		
Child's Characteristics												
Birth order of the child	1823		2.35	1.61	267		4.1	2.28	1556		2.05	1.23
Tetanus injection before birth	1823		0.963	0.19	267		0.89	0.32	1556		0.98	0.15
No	1823	3.73			267	44.12			1556	55.88		
At least once	1823	96.27			267	13.5			1556	86.5		
Prenatal care	1823		0.208	0.41	267		0.11	0.32	1556		0.22	0.42
No	1823	11.68			267	25.35			1556	74.65		
Yes	1823	88.32			267	13.23			1556	86.77		
Place of delivery	1823		0.546	0.5	267		0.36	0.48	1556		0.58	0.49
Others	1823	45.42			267	20.65			1556	79.35		
Hospital	1823	54.58			267	9.648			1556	90.35		
Size at birth	1823		2.048	0.78	267		1.98	0.83	1556		2.06	0.77
Don't know/missing	1823	2.08			267	26.32			1556	73.68		
Below average	1823	21.83			267	16.08			1556	83.92		
Average	1823	45.26			267	13.94			1556	86.06		
Above average	1823	30.83			267	13.88			1556	86.12		
Weight at birth (in gm)	1823		2.242	0.78	267		2.51	0.74	1556		2.2	0.78
≤2500,	1823	21.34			267	10.28			1556	89.72		
2500<*<7500,	1823	33.13			267	8.278			1556	91.72		
7500<*<9998 includes notweighed and don't know	1823	45.53			267	21.33			1556	78.67		
Postnatal care	1823		0.46	0.64	267		0.63	0.61	1556		0.43	0.64
Don't know or missing	1823	62.26			267	10.4			1556	89.6		
No	1823	29.51			267	24.16			1556	75.84		
Yes	1823	8.23			267	12.67			1556	87.33		
Autonomy (Mother Level Variables)												
Access to information	1823				267				1556			
Reading news paper	1823		0.154	0.36	267		0.06	0.24	1556		0.17	0.38
Listening to radio	1823		0.304	0.46	267		0.22	0.42	1556		0.32	0.47
Watching TV	1823		0.511	0.5	267		0.36	0.48	1556		0.54	0.5
Decision making within the household	1823				267				1556			

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Variable	ALL			DIED			NOT DIED			
	Sample size (N)	Percentage (%)	Mean	SD	Sample size (N)	Mean	SD	Sample size (N)	Mean	SD
	(% in the respective category)									
Respondent's health care	1823	4.393	1.39	267	4.47	1.36	1556	4.38	1.39	
HH large purchase	1823	3.541	1.32	267	3.63	1.25	1556	3.53	1.33	
HH daily purchase	1823	3.882	1.58	267	4.09	1.5	1556	3.85	1.59	
Visit to ntl family	1823	3.888	1.39	267	4.05	1.33	1556	3.86	1.39	
Spending partner's income	1823	5.023	1.39	267	5.12	1.36	1556	5.01	1.39	
Mobility	1823			267			1556			
Allowed to go to market	1823	2.171	0.8	267	2.16	0.83	1556	2.17	0.8	
Allowed to go to the health facility	1823	2.455	0.57	267	2.45	0.59	1556	2.46	0.57	
Allowed to go outside the village/community	1823	2.25	0.64	267	2.27	0.65	1556	2.25	0.64	
Money set aside for own use	1823	1.386	0.49	267	1.29	0.45	1556	1.4	0.49	

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