Research article

Predictive behaviour of maternal health inputs and child mortality in West Bengal – An analysis based on NFHS-3☆

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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 Millenium 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 Appendix A and Appendix B, 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 played 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 Enser 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 23% of maternal mortality (Mosley and Chen, 1984). West Bengal has 7.6% of the country’s total population and it is the second largest state and the inland state of India. It has a rich cultural and social heritage. West Bengal has a unique blend of culture and tradition, which has been preserved till today. It has been ruled by a stable, coalition government for as long as three and half decades. This implies the state should not have suffered any policy paralysis. The state is steeped in history mainly from the colonial era, and has strong socio-economic linkages with the rest of the world. The state is 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 Dhamalingam (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 Chakraborti (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 the richest 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.

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 (HD) 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:

\[ PC = \alpha_0 + \alpha_1X_p + u_p + \epsilon_p \]  
\[ HD = \delta_0 + \delta_1X_d + u_d + \epsilon_d \]  
\[ CM = \gamma_0 + \gamma_1X_m + u_m + \epsilon_m \]

Note that p, h and c subscripts are, respectively, used for equations to denote prenatal care, hospital delivery, and child mortality, and \( \alpha_0, \beta_0, \) and \( \gamma_0 \) are having usual interpretations of the constant terms for those equations. \( \alpha_1, \beta_1, \) and \( \gamma_1 \) signify the coefficients for different explanatory variables considered in these equations. \( X_p, X_d, \) and \( X_m \) 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

\[ PC = \begin{cases} 1 & \text{if care is taken} \\ 0 & \text{if care is not taken} \end{cases} \]

\[ HD = \begin{cases} 1 & \text{if delivery is in hospital} \\ 0 & \text{if delivery is not in hospital} \end{cases} \]

1 Note that definition of wealth index and standard of living are directly drawn from NFHS-3 or DHS (Demographic and Health Survey) 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 thrasher, 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/PF/NFDX/FRI/NDSVol1AndVol2.pdf.

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.
Here \( u_i (i = p, h, c) \) is an error term which takes care of unobserved heterogeneity due to the mother. So \( u_i \sim N(0, \sigma^2_\epsilon); \sigma^2_\epsilon \) is the variance of unobserved factors, if any. Again \( \epsilon \) takes into account all other residual variation and follows \( \epsilon_i \sim \text{IID } N(0,1) \) for \( i = p, h, c \).

The source of heterogeneity in the present structure refers to certain factors or issues 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 technique\(^6\), 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 \( \epsilon_i \). However, when \( \epsilon_i \) is not known for any specific mother, estimation should be done by formulating likelihood method conditional on \( \epsilon_i \), 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 \( \epsilon_i \). 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 facilities.\(^6\) 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 upbringing 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(sisi).\(^7\) Sisi 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 control\(^8\) 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

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\(^6\) 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 (sisi) and wealth distribution. But Sisi 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.
Table 1. Prenatal care (PC).

| Model-I | Effect on Prenatal Care | Marginal Effects of respective covariates | Model-II | 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 institutionalized 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 sssi (18%) and a very good sssi (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.

* 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.
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 newborn 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 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) | -0.580*** (4.53) | -0.1345 | -0.555*** (-6.26) | -0.1324 |
| Standard of Living (ref. group Low) | 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) | 0.304** (2.80) | 0.0705 | 0.294** (2.78) | 0.0700 |
| Primary level           | 0.603*** (5.12) | 0.1998 | 0.585*** (5.15) | 0.1390 |
| Secondary level         | -0.191*** (-4.26) | -0.0442 | -0.190*** (-5.09) | -0.0453 |
| Constant                | -1.576 (-1.72) | -1.586** (-3.14) | -1.586** (-3.14) | -1.586** (-3.14) |

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

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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) | -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) | 0.320** (2.63) | 0.0596 | 0.360** (2.72) | 0.0608 |
| Manual                   | 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                 | -1.163 (-1.33) | -1.609** (-2.59) | -1.609** (-2.59) | -1.609** (-2.59) |

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).

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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.

| Covariate                                | Model-I        | Model-II       | Model-I        | Model-II       |
|------------------------------------------|----------------|----------------|----------------|----------------|
| Place of residence                       | 0.354**        | 0.341*         | -0.00539       | -0.00546       |
|                                          | (2.66)         | (2.58)         | (-0.90)        | (-1.00)        |
| Age of the mother                        | -0.000126 (-0.62) | -0.000139 (-0.70) | 0.333** (3.04) | 0.328** (2.97) |
| Religion (ref. group Hindu)              | -0.257* (-2.55) | -0.249* (-2.42) | -0.0710 (-0.50) | -0.0705 (-0.52) |
| Muslim                                   | -1.204*** (-3.41) | -1.201*** (-2.92) | 0.260* (2.17)  | 0.257* (2.17)  |
| Standard of Living (ref. group Low)      | 0.206 (1.83)   | 0.207 (1.86)   | 0.411** (2.95) | 0.411** (2.98) |
| Medium                                   | 0.562** (3.17) | 0.567** (3.20) | 0.0865 (0.46)  | 0.0773 (0.40)  |
| Very good                                | 0.683** (2.70) | 0.701** (2.76) | -0.0836 (-0.71) | -0.0803 (-0.67) |
| Partner’s Occupation (ref. group No Work) | 0.710 (1.74)   | 0.721 (1.78)   | -0.146 (-1.26) | -0.151 (-1.14) |
| Manual                                   | 0.0152 (0.09)  | 0.0315 (0.22)  | 0.0819* (2.10) | 0.0826* (2.26) |
| Agriculture, Household, Domestic         | 0.00146 (0.57) | 0.00158 (0.60) | 0.143 (0.32)   | 0.141 (0.32)   |
| Professional, Clerical, Service, Sales   | 0.734 (1.78)   | 0.750 (1.84)   | 0.733** (5.38) | 0.733** (5.38) |
| Access to Information                    | 0.000146 (0.57) | 0.00158 (0.60) | 0.0865 (0.46)  | 0.0773 (0.40)  |
| Say in household decision making         | -0.00627 (-1.75) | -0.00639 (-1.13) | 0.00627** (3.22) | 0.00613** (3.04) |

(continued on next page)
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)

|                      | Model-I                          | Model-II                         | Model-I                  | Model-II               |
|----------------------|----------------------------------|----------------------------------|--------------------------|------------------------|
| Age of the mother    | 0.000496** (2.60)                | 0.000496** (2.59)                | 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)               | -0.0895 (-0.90)          | -0.101 (-1.14)         |
| Christian            | -0.386 (-0.65)                  | -0.291 (-0.56)                  | -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)                   | 0.304** (2.80)           | 0.294** (2.78)         |
| Good                 | 0.759*** (4.94)                 | 0.688*** (5.15)                 | 0.603*** (5.12)          | 0.583*** (5.15)        |
| Very good            | 0.508** (2.82)                  | 0.506** (3.14)                  |                           |                        |
| Partner's Occupation (ref. group No Work) | 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)                   |                           |                        |
| Professional, Clerical, Service, sales | 0.791 (1.50)                  | 0.577 (1.23)                   | 0.382 (1.45)            | 0.415 (1.60)          |
| Mother's Occupation (ref. group No Work) | Birth order of the child       | -0.191*** (-4.26)              | -0.190*** (-5.09)        |                        |
| Manual               | -0.0524 (-0.40)                 | -0.0577 (-0.46)                |                           |                        |
| 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) | -0.000400* (-1.97) | -0.000533** (-2.58) |
| Place of residence      | -0.0782 (-0.11) | 0.125 (0.88) | 0.128 (0.94)       | -0.149 (-1.09)      |
| Age of the mother       | -0.000400* (-1.97) | -0.000533** (-2.58) |                           |                        |
| 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) | -0.000400* (-1.97) | -0.000533** (-2.58) |
| 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) | -0.0744 (-0.52) | -0.0105 (-0.07)      |
| Very good             | 0.348 (1.70) | 0.136 (0.60) | -0.0417 (-0.18) | -0.0920 (-0.34)      |

r statistics in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.
| Variable                          | ALL Sample size (N) | Percentage (%) | Mean | SD | NOT DIED Sample size (N) | (%) in the respective category | Mean | SD |
|----------------------------------|---------------------|----------------|------|----|--------------------------|--------------------------------|------|----|
| **Household Characteristics**    |                     |                |      |    |                          |                                |      |    |
| Place of residence               | 1823                |                |      |    |                          |                                |      |    |
| Rural                            | 1823                | 58.8           | 267  | 17.35 | 1556                     | 82.65                          | 1556 | 89.21 |
| Urban                            | 1823                | 41.2           | 267  | 10.79 | 1556                     | 89.21                          | 1556 | 82.65 |
| **Religion**                     | 1823                |                |      |    |                          |                                |      |    |
| Hindu                            | 1823                | 65.3            | 267  | 11.42 | 1556                     | 88.58                          | 1556 | 93.75 |
| Muslim                           | 1823                | 33.3            | 267  | 21.42 | 1556                     | 78.58                          | 1556 | 93.75 |
| Christian                        | 1823                | 0.88            | 267  | 6.25  | 1556                     | 93.75                          | 1556 | 93.75 |
| Sikh                             | 1823                | 0.11            | 267  |      | 1556                     | 100                            | 1556 | 100  |
| Buddhist                         | 1823                | 0.05            | 267  |      | 1556                     | 100                            | 1556 | 100  |
| Jain                             | 1823                | 0.27            | 267  |      | 1556                     | 100                            | 1556 | 100  |
| Others                           | 1823                | 0.05            | 267  |      | 1556                     | 100                            | 1556 | 100  |
| **Standard of living**           | 1823                | 2.413           | 1.67 |      | 267                      | 2.03                           | 1556 | 2.48 |
| low                              | 1823                | 32.2            | 267  | 21.29 | 1556                     | 78.71                          | 1556 | 84.67 |
| medium                           | 1823                | 30.77           | 267  | 15.33 | 1556                     | 84.67                          | 1556 | 92.64 |
| good                             | 1823                | 28.3            | 267  | 7.364 | 1556                     | 92.64                          | 1556 | 89.66 |
| Very good                        | 1823                | 7.95            | 267  | 10.34 | 1556                     | 89.66                          | 1556 | 92.64 |
| **Source of drinking water**     | 1823                |                |      |    |                          |                                |      |    |
| Others, primarily open           | 1823                | 13.88           | 267  | 11.86 | 1556                     | 88.14                          | 1556 | 88.14 |
| Tube well                        | 1823                | 53.81           | 267  | 17.33 | 1556                     | 82.67                          | 1556 | 82.67 |
| Public tap                       | 1823                | 18.98           | 267  | 15.03 | 1556                     | 84.97                          | 1556 | 84.97 |
| Piped water                      | 1823                | 13.33           | 267  | 6.173 | 1556                     | 93.83                          | 1556 | 93.83 |
| **Toilet**                       | 1823                |                |      |    |                          |                                |      |    |
| Others including no facilities   | 1823                | 42.4            | 267  | 17.72 | 1556                     | 82.28                          | 1556 | 82.28 |
| Pit toilet/latrine               | 1823                | 8.23            | 267  | 19.33 | 1556                     | 80.67                          | 1556 | 80.67 |
| Flush toilet                     | 1823                | 49.37           | 267  | 11.22 | 1556                     | 88.78                          | 1556 | 88.78 |
| **Partner's education**          | 1823                | 1.319           | 1.01 |      | 267                      | 0.83                           | 1556 | 1.4 |
| No                               | 1823                | 28.69           | 267  | 24.28 | 1556                     | 25.78                          | 1556 | 25.78 |
| Primary                          | 1823                | 20.24           | 267  | 15.99 | 1556                     | 20.18                          | 1556 | 20.18 |
| Secondary                        | 1823                | 39.11           | 267  | 9.397 | 1556                     | 42.06                          | 1556 | 42.06 |
| Higher                           | 1823                | 10.53           | 267  | 4.167 | 1556                     | 11.98                          | 1556 | 11.98 |
| **Partner's occupation**         | 1823                |                |      |    |                          |                                |      |    |
| No work                          | 1823                | 0.93            | 267  | 17.65 | 1556                     | 82.35                          | 1556 | 82.35 |
| Others                           | 1823                | 0.05            | 267  |      | 1556                     | 100                            | 1556 | 100  |
| Manual                           | 1823                | 38.67           | 267  | 15.74 | 1556                     | 84.26                          | 1556 | 84.26 |
| Agriculture, hh & domestic       | 1823                | 27.21           | 267  | 17.94 | 1556                     | 82.06                          | 1556 | 82.06 |
| Professional, Clerical, service, sales | 1823        | 33.13           | 267  | 10.6  | 1556                     | 89.4                           | 1556 | 89.4 |
| **Mother's Characteristics**     | 1823                |                |      |    |                          |                                |      |    |
| Mother's age (in years)          | 1823                | 25.54           | 5.35 |      | 267                      | 28.1                           | 1556 | 25.1 |
| 15-30                            | 1823                | 83.6            | 267  | 11.75 | 1556                     | 88.25                          | 1556 | 88.25 |

(continued on next page)
Variable | ALL | DIED | NOT DIED |
|---------|-----|------|---------|
|         | Sample size (N) | Percentage (%) | Mean | SD | Sample size (N) | (%) | Mean | SD | Sample size (N) | (%) | 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 | 5.67 | 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 newspaper | 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 |

(continued on next page)
| Variable | Sample size (N) | Percentage (%) | Mean | SD | Sample size (N) | Percentage (%) | Mean | SD | Sample size (N) | Percentage (%) | Mean | SD |
|----------|----------------|----------------|------|----|----------------|----------------|------|----|----------------|----------------|------|----|
| Respondent's health care | 1823 | 4.39 | 1.39 | 1556 | 4.38 | 1.39 |
| Mobility | 1823 | 2.17 | 0.8 | 267 | 2.16 | 0.83 |
| Allowed to go to market | 1823 | 2.17 | 0.8 | 267 | 2.16 | 0.83 |
| Allowed to go to the health facility | 1823 | 2.45 | 0.57 | 267 | 2.45 | 0.59 |
| Allowed to go outside the village/community | 1823 | 2.25 | 0.64 | 267 | 2.27 | 0.65 |
| Money set aside for own use | 1823 | 1.38 | 0.49 | 267 | 1.29 | 0.45 |

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