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Identifying the effect of public health program on child immunisation in rural Bangladesh

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Abstract

Using unit-level data from Matlab villages in rural Bangladesh, this paper examines the impact of an exogenously assigned health care intervention– Maternal and Child Health (MCH) program– on children's immunisation status. In particular, we investigate how the program effect interacts with two key determinants of household immunisation choice, namely maternal education and risk perception of households. Results show that the MCH program has significantly enhanced immunisation status of children. In addition to directly improving immunisation demand, the MCH program also acts as a substitute for maternal education and compensates households for low access to public health information. Yet the MCH intervention does not have any influence on the household's risk awareness and perception towards child health. On the contrary, prenatal-care visits and tetanus toxoid immunisation by pregnant mothers, services which are provided by government health facilities, have independent effects on the household's demand for childhood immunisation. This suggests that the role of government health facilities cannot be ignored even in the presence of a very effective MCH program.

Introduction

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Public health programs have increasingly been linked to direct and indirect benefits to health and nutritional status of children in developing countries.[1] These programs have had a remarkable success in influencing immunisation coverage in developing countries not only by providing services, but also through improving knowledge and awareness of the concerned population to motivate them to vaccinate their children. Vaccine preventable diseases account for a considerable proportion of child deaths and morbidity in many developing countries. Understandably so, the expanded program of immunisation (EPI), one of the most cost effective health care interventions, features as a major corner stone of public health programs in most developing courtiers.[2] Despite these EPI initiatives, many developing countries are yet to achieve the target of Universal Childhood Immunisation of 80 percent, and in many situations immunisation uptake remains low.

A burgeoning literature looks at the different channels through which public policy can influence the household's immunisation choices. One strand of this literature documents the household factors that are important predictors of immunisation uptake, while the other focuses on the evaluation of government and community health care programs. Amongst the household level correlates, maternal education is observed as the single most powerful predictors of children's health status in developing countries (Bicego and Boerma, 1993; Caldwell, 1979, 1994; Gauri and Khaleghian, 2002; 2004; Munshi and Lee, 2000; Streatfield et al, 1990).

Public health programs strengthen the household's capacity to engage in efficient health care choices by removing material and informational constraints, and many studies have documented the impact of such programs on health, nutrition, education and intra-household allocation of resources (Chaudhuri, 2005; Muhury, 1995; Philips et al. 1987; Rosenzweig and Schultz, 1982). Education plays a key role in household's health care choice and it is evident that public health programs contribute to household's knowledge and skills as embodied in their education level. In addition to educating households, there are other potential pathways through which public health programs can contribute to household health care choices. Such channels of contribution if unaccounted may understate the true program effect.

In case of preventive health behaviour such as immunisation, perception of being at risk is an important determinant. It is expected that households who perceive the risk of infectious disease to be higher to more likely to vaccinate their child compared to households who perceive risk to be lower. In observational data, risk perception is not observed, but there are certain observed risk behaviours or risk attitudes, which represent risk perception of the household. It is plausible that parents' selection of earlier health care choices reflects their risk perception to child health, and we test the significance of this risk perception on child immunisation.

The objective of this paper is to evaluate the contribution of a public health program on the demand for childhood vaccination in Bangladesh. We study household demand for immunisation in a rural area of Bangladesh where a health care program known as Maternal and Child Health (MCH) Program in Matlab has been in operation since 1982. The MCH program was assigned exogenously to a set of villages in the Matlab area where households in the treatment villages received intensive health services over and above the services provided by government health facilities. Households in the control area are exposed to government health facilities/services only. Both treatment and control area have similar demographic characteristics and levels of impoverishment at the start of the MCH program. This provides a unique setting for identifying demand side determinants of immunisation choices along with the causal effect of the MCH program.[3] In addition to the direct impact of the MCH program, our analysis also accounts for other indirect channels through which a public health program can influence household demand for preventive health care.

The issue of demand for immunisation is of critical interest for Bangladesh for it is still to achieve the target of universal child immunisation of 80 percent. The coverage rate has stagnated at around 50 percent since 1990s, which makes it imperative to identify the demand side barriers to immunisation. This paper focuses on the immunisation behaviour especially on the continuity of immunisation as the drop-out of full vaccination coverage has emerged as one of the binding constraints for many developing countries to maximise their immunisation coverage. The problem appears to be more severe in rural areas of Bangladesh which host the majority of the Bangladeshi population. There are a number of studies that have analysed the immunisation behaviour in Matlab villages where the MCH program is placed (Ahmed et al., 2003; Bishai et al. 2002). Earlier studies in the context of Bangladesh (e.g. Bhuiyan et al, 1995; Jamil et al, 1999) have primarily focused on the socioeconomic factors in immunisation choice, namely parental education, household income, proximity to health facilities, frequency of visit of health worker, respondent's mobility, and gender of the child. This paper departs from the existing studies by examining the effect of the MCH program and its interaction with two household-specific factors -- maternal education and maternal risk behaviour – that are key to child immunisation against infectious disease.

The structure of the paper is as follows: section 2 provides a brief description of the MCH program in the study area; section 3 discusses the review of literature on demand for preventive health care. Section 4 will discuss the analytical framework and empirical specifications. Results will be discussed in section 5, and conclusion in section 6.

2. Description of Maternal and Child Health (MCH) Program in Matlab

The core element of Bangladesh's immunisation program is the Expanded Programme of Immunisation (EPI), which was launched in 1979, and further intensified in 1986. For maximum protection against six childhood killer diseases i.e. tuberculosis, pertussis (whooping cough), tetanus, polio, and measles, the EPI program follows the World Health Organisation (WHO) recommendations that each new born is to be vaccinated with one dose of Bacillus Calmette-Guérin (BCG), three doses of Diphtheria, Pertussis, and Tetanus (DPT) vaccine against diphtheria, pertussis and tetanus, three doses of Oral Polio Vaccine (OPV) against poliomyletis, and one dose of Measles vaccine against measles.

The EPI program in Bangladesh is implemented through various clinics and outreach services. Government sources are the principal provider of childhood vaccination services. Along with the government provided maternal and child health services there are some NGO and international donor supported health projects in Bangladesh. One internationally recognised project to reduce fertility and improve maternal and child health is the Matlab Maternal and Child Health/Family planning (MCH-FP) intervention. The project is located in a rural and impoverished area of Bangladesh i.e. Matlab thana. The program has its origin in Cholera Research Laboratory which was initially set up in 1963, and subsequently became known as the International Centre for Diarrhoeal Research (ICDDR,B). The MCH-FP program was initiated in 1977 in 70 out of the 149 villages in Matlab area. The program villages were chosen randomly at the time of the intervention. The treatment villages received specialised family planning services, while the control villages received only government family planning services. The family planning program was designed to test whether the provision of contraceptives at low cost could induce demographic change in the absence of economic development (Phillips et al, 1982). The family planning intervention is characterised by the outreach program consisting of home visits by trained female outreach workers. The intervention includes information, education, and motivational activities; and distribution of oral contraceptives, condoms, and foam tablets by health workers.

In 1982 Maternal and Child Health component was introduced in the intervention area. Households in the remaining villages (i.e. control or comparison area) continued to receive only the health services provided by the government programme. Households that have a woman of childbearing age and a child below the age of five are eligible to receive MCH services in treatment villages.

For administrative and research purposes, the intervention area was divided into four operational blocks, (A, B, C, D), each organised around a small Maternal and Child Health Family Planning Clinic, also known as subcenter. Subcenter located in each block provides various curative and preventive health services. There is one main center known as Matlab hospital treats complicated cases of diarrhoea, respiratory diseases, malnutrition, and maternity problems referred by the subcenter and also offers services, particularly to diarrhoeal patients from inside and outside the intervention area. Initially MCH program was introduced in block A and C, while in the other two blocks the program was introduced in 1986. The components of the intensive MCH programme were to treat common illness and family planning-related problems, dispense nutritional advice to pregnant and lactating women, administer tetanus toxoid shots to pregnant women, and distribute iron and folic acid tablets. The services were provided by community health workers of ICDDR, B through a door-to-door delivery method. The components in the intervention area have been phased in over time to include complete immunisation of six EPI diseases (in 1986), vitamin A supplementation (in 1986), nutritional rehabilitation (started in 1986), community based maternity care program involving midwives (in 1987), curative outreach services for acute respiratory infection and dysentery (started in 1989) (Fauveau, 1994). Intensive services included regular home visit by community health workers who were empowered to immunise children.

In the control area no such services have offered. Population in this area receives health and family planning services offered by the government program and has access to diarrhoeal treatment facilities of the Matlab hospital.

3. Demand for health care choice and program impact – literature review

Public health programs such as the MCH intervention in Matlab provide information, skills, resources, and technologies to households, the effect of which is ultimately manifested in better health and nutritional status (Hill and Mosley, 1989). A number of potential channels have been identified through which MCH intervention can affect child health – reducing cost of acquiring information related to health and health care[4], increasing greater awareness for health and health care, changing attitude and behaviour towards child health care.[5]

Muhuri (1995) provides a comprehensive analysis of the impact of maternal education, and the presence of MCH program in Matlab on child mortality. This study concludes that both maternal education and MCH program significantly contributed to the child survival in the study area. However, this analysis does not embark upon household's utilisation of health services which provides the underlying intervening mechanism through MCH program has affected child health and child mortality. Bishai et al (2002) have focused on use of health care services in Matlab area. They find that socioeconomic background of household are significantly associated with incomplete vaccination in the control area, and the presence of the MCH program greatly reduces, and in some cases eliminated, the prevailing gender and socioeconomic differentials in immunisation uptake. Chaudhuri (2005) also confirms the significant contribution of the MCH program in reducing socioeconomic barriers to immunisation. It is shown that maternal education is a significant determinant of child health and the MCH program acts as a substitute for formal education for uneducated mothers. Moreover, the MCH program is also found to have exerted significant spillover on the health of non-targeted members in the society (Chaudhuri, 2003). All these contribute to the fact that public health programs like the MCH program in Matlab have significant direct and indirect effects so that evaluation of their impact should account for all such effects.

The human capital framework suggests a number of reasons why health care choices (as an investment decisions) are influenced by education. A considerable body of evidence confirm the link between maternal education[6] and child health. Bicego and Boerma (1993) suggest three possible explanations. First, the link is merely a result of strong correlation between education and economic status. It is very likely that within a wealthier family, mothers are more educated, children receive greater quantities of food having greater nutritional value, and have better access to health services facilities. If wealth effect is predominant then inclusion of various indicators of wealth in statistical analysis will explain the relationship between maternal education and child health. A study by United Nations (1985) found that approximately half of the link between maternal education and child health can be explained by household income. Second, education produces behaviours that can affect the maternal education-child health link. Education generates behaviour to the extent that educated mothers have greater knowledge and awareness to seek out more health services than uneducated mothers.[7] Third, the link arises from greater access to health services where educated mothers take more advantage of these services. Orubuloye and Caldwell (1975) provide evidences in support of this view. Another argument suggests that greater access would make health care more visible and would encourage uneducated women to utilize health services. This suggests that difference in child health of educated and uneducated mothers would be small in areas where access to care is easy. Studies by Rosenzweig and Schultz (1982) and Bicego (1990) provide evidences in support of this view. Pebley et al (1996) in a study on Guetemala found that both father's and mother's education had a positive strong effect on immunisation status, but there are also some unobserved family and community heterogeneity in immunisation acceptance. Overall, no unique channel can be identified through which maternal education improves child health, particularly the likelihood immunisation status of children.

In case of any infectious disease, the perception of being at risk is one of the factors that influence parents' decision to vaccinate their child. The sensitivity to risk is guided by knowledge and awareness of an individual, namely the knowledge of infection mechanism, awareness of illness (its prevalence, severity of illness, and duration of illness), and the perception of general health status. There is a growing literature suggesting that parental use of health care services is related to their perceived risk of child mortality (Lee, 2005; Maitra and Pal, 2004; Rosenzweig and Schultz, 1991; Rosenzweig, 1986) and subsequent use of postnatal care (Munshi and Lee, 2000). In the production of child health, each care (prenatal care and postnatal care) has its own effect, but in the sequence of the dynamic decision process they are also related. In the long run, mothers' use of prenatal services reflects their risk attitude to child health, and the choice of postnatal care is dependent on the use of prenatal care. The argument is that expectant families observe signals on the likelihood of child mortality and therefore decides to take prenatal care.

4. Methodology and data

In this study, we aim to estimate the household's demand for postnatal care (i.e. childhood immunisation) by distinguishing between the direct effect MCH program and its interactions with other determinants of immunisation choice. Additionally we follow the recent literature and allow parents' decision to vaccinate their children to depend upon their earlier prenatal decision choice.[8] We primarily focus on the determinants of full immunisation choice[9] as for Bangladesh the drop out of immunisation is a major barrier to immunisation.[10]

We estimate an ordered probit regression model of the determinants of household immunisation choices Immunisation status of a child can be in three categories: no immunisation, partial immunisation, and full immunisation. Partial immunisation and full immunisation is defined as excluding BCG from the vaccine schedule as it leads to data problem.[11] This estimation technique is more appropriate since it accounts for the possibility that demand for various immunisation outcomes is jointly determined. 'No immunisation' status serves as the base category in ordered probit models.

The regression controls for household wealth (measured by landholding and value of total household assets), age, sex, religion, mother's education, mother's age, square of mother's age, household head's age and education, household head's employment, mother's market employment, access to radio and health advertisement, distance to health care facility, and index of village functionality. The regression also controls for the effect of prenatal risk attitude of mothers on consequent selection of postnatal health care choice. Risk perception is not observed, but health care choices of mothers during pregnancy can proxy their risk attitude and behaviour. We measure the level of mothers risk perception by their participation in antenatal care and tetanus immunisation during pregnancy. Mothers' usages of such care provide them with necessary information about their biological health condition and risk of child health, and the value of immunisation on child health. It is likely that mothers who participate in prenatal care may also engage in vaccinating their child, not only because of the role of prenatal care in disseminating information on postnatal care, but also because of mothers inherent risk perception. We have therefore controlled for risk perception in our estimation, where risk perception is measured by an index combining both antenatal care visit and tetanus immunisation. If a mother had chosen one of the prenatal services, she was given a score of ½. If both services were taken, a full score is awarded.

The key variable of interest in the regression analysis is a dummy indicating whether the household is located in the treatment area. As mentioned earlier, a MCH program providing health inputs and health information is in place in the study area where only a randomly selected group of villages has been exposed to the program. Given that there are well-defined control villages which have similar demographic characteristics and were equally impoverished at the start of the program, Matlab villages provide a unique experimental setting to identify the effect of a public program on immunisation choice. The MCH program is expected to have a positive effect on the immunisation probability of a child. However, from the policy point of view, it is important to understand the channels via which the program effect is mediated. The potential channels through which MCH program can affect health care choice are improved awareness and knowledge of the benefits from immunisation, and improved risk perception of parents with regard to health care need.

It is hypothesised that mothers with low schooling attainment have less adequate information about the severity of infectious diseases and therefore is less likely to vaccinate their child. Providing door-to-door services through family health care worker is an integral component of the MCH program, which plays an important role in improving mother’s knowledge and awareness regarding child health care. The program could interact with maternal education, a key determinant of child health status, in two ways. First, maternal education can have greater effect on child health in areas where intensive services are available (Orubuloye and Caldwell, 1975). This complementary effect is explained by the fact that educated mothers are better able to process new information that they receive via intensive health care services. On the other hand, maternal education could substitute for health care campaigns so that in areas with no intensive health care services, uneducated mothers are worse-off. This also means that less educated mothers gain most from the availability of health care services.

The second important channel via which the program effect is mediated is access to information. In the study area there are two sources of health-related information. First is the public media and the other is the health workers of the MCH program in the treatment area. The public media provides health information through countrywide radio transmission and the advertisement highlighting beneficial effects of child and maternal health care provided at the local level. The household's exposure to the public media is hypothesised to enhance demand for immunisation as households who are exposed to mass media are more likely to have the access to information on child immunisation and other determinants of child health. In the treatment area, MCH program workers provide households with additional health related information. Therefore, we are interested to examine the existence and magnitude of the informational effect of the MCH program.

Lastly, lack of maternal knowledge for prenatal and post-natal care (e.g., immunising child) has been widely reported as a major reason for child mortality and morbidity in Bangladesh (Hadi, 2001). Public health program addresses this issue by providing health advice and health care. Public health information leads to two sources of benefits: firstly it disseminates information for how to produce health inputs more efficiently and secondly, it reduces the cost of acquiring information to the production of health. The MCH intervention provides information to pregnant mothers along the time period during which they make prenatal care choice, which we have taken as a proxy of risk perception. Accordingly we expect that the intervention also influences risk perception of mothers.

In order to test the above hypotheses, we further extend our regression specification by additionally interacting the treatment dummy with maternal education, risk perception, access to public media, and income. The sign of the coefficient on the interaction term can inform about the ways the program benefits households' immunisation choices. For example, if the program is a complement to the mother's formal education, then we expect a positive coefficient on the interaction term with maternal education. This would suggest that in the program area, even the illiterate mothers would have higher propensity to immunise their children as opposed to those in the control area.

Data for this study comes from the Matlab Health and Socio-economic Survey (MHSS) 1996 dataset, which contains an in-depth section on immunisation and mortality outcomes of children along with a detailed module on household assets, family social networks and community health facilities. The MHSS surveyed 4346 households in 144 villages (Rahman et al, 2001). The MHSS data on immunisation is recorded only for the latest birth, which leaves us with only one child per household. We exclude children whose age is less than 1 year to conform to the ages at which children are eligible to complete all schedules of vaccinations.[12] This leads to a working sample of 1033 households that have full records on immunisation of their children born in the last five years. Among these children, 451 are from control area and the rest 582 are from the program area. Data on immunisation records have been matched with information on the household's socioeconomic conditions and village level facilities. The summary statistics and description of the key variables of interest are given in Table 1.

The data shows sufficient variation in variables (see Table 2): Equality of means test between control and program area does not show any significant difference regarding mother's age, mother's education, household's age, household head's education, land holding, household asset holding, and most importantly distance to health facilities. But differences are significant in the following characteristics: size of household, mother's market activities, exposure to media, and risk behaviour of household. The treatment area has lower family size, lower proportion of mothers involved in income earning activities, and on the other hand treatment area has higher exposure to media and better risk perception of parents. The treatment villages have better infrastructure than the control villages although at the start of the MCH program both area (control and treatment) shared similar socio-demographic background and similar level of economic conditions during. Some of the current differences may have arisen as an effect of the program operation.

In terms of immunisation outcomes, treatment area is ahead of the control area (Table 3). Full immunisation is significantly higher in treatment area (89.52%) as compared to 66.08% in the control area. Similar patterns emerge when we look at no immunisation, partial immunisation and drop out rates. Drop out as measured by DPT-No Measles represents the number of cases where children have failed to take measles vaccine conditioned on being immunised with DPT1 previously. The rate of no immunisation in the control area (9.76%) is five times as high as in the program area (1.03%), the corresponding figure for partial immunisation and drop out rate in the control area are 24.17 % and 16.19 % as opposed to 9.45 % and 5.63 % in the treatment area respectively. Having found significant differences in the health care choices, the following section aims to identify the possible explanations for such differences between the two areas.

5. Results

The descriptive statistics strongly suggest that treatment and control areas differ in terms of level of immunisation. We aim to find out how much of this differential performance can be attributed to the MCH intervention. The regression results are described in the following sub-sections (see Table 1 for estimates). We do not describe the effect of all regressors; instead the discussion is limited to the variables of primary interest, namely the program effect, mother's education, mother's risk perception, and exposure to media.

MCH program and other determinants of household immunisation choices

Program effect: Presence of the MCH program, as captured by the treatment dummy, shows a significant positive effect on the demand for full immunisation (see Table). The extent of this effect is as high as 21.19% in explaining full immunisation probability of a child, which indicates that even in the presence of government supported immunisation program, the MCH program has been very successful in improving immunisation seeking behaviour of households.[13]

Exogeneity of the program placement ensures that the treatment variable in the above estimation reflects an unbiased estimate of the contribution of the program on immunisation. But internal migration and diffusion of knowledge over the years in the study area may have affected the experimental setting, which might lead to biased estimate of the program effect. A number of matching estimation method addresses this bias by comparing similar households (on the basis of similar values of covariates) in both treated and untreated sample to find out efficient estimate of average treatment effect. In this regard we have used the radius matching method which computes average treatment effect by averaging the unit-level treatment effects of the treated where the control(s) matched to a treated observation is/are those observations in the control group that lie within a radius of 0.1 (Abadie et al., 2001). The resulting estimate of the program effect from this exercise is 19.1% (see Appendix Table 1), which is slightly lower than the ordered Probit estimate. This suggests that the program effect in the probit estimate is confounded by some other effects but the influences of such confounding factors are not large.

It is clear that the MCH intervention has significantly improved immunisation status in the study area. The MCH program (result in the first column of Table 4) alone improves full immunisation probability of a child by 24.04%. Contribution of this program declines when we add other covariates in our specification (column 2 of Table 4), as other covariates account for some of the expected treatment effect or some of the treatment effect is manifested in those variables.

Decomposition of the program effect

Information effect: As mentioned earlier, in the control area, the population is exposed to media campaign only, whereas in the treatment area, there exist both media campaign and the programmatic intervention which contains informational and awareness contents. In order to test for the information effect of the MCH program, we have run regression on treatment and control sub-samples separately (Appendix Table 2). Access to radio in the control villages encourages full vaccination (although only weakly significant, at 25% level). Public health advertisement through bill boards fails to account for any considerable impact. On the other hand, these media exposure variables have either no significant effect or have perverse effect on the full immunisation choice of household in the treatment area. The possible reason for this differential effect of media coverage on the choice of child health input is that the MCH program itself engages in the informational awareness campaign in the treatment area, so that the government health campaign via public media has no added effect. This can be taken as an evidence (albeit weak) in support of the hypothesis that the program effect works via improving household’s access to information in the treatment area.

Maternal Education: The results in Table 4 show that maternal education has a very negligible effect on childhood immunisation status. But this is not surprising as the effect of mother's education is usually very low when father's education is included in the specification. Low explanatory power of mother education may be linked to strong correlation between father's and mother's education (0.5033). When father's education is dropped, the effect of mother's education is strong and highly significant (the result is not reported here).

Absence of a direct impact of maternal education in pooled sample is not so puzzling if education affects immunisation demand only in the control area and has no effect in the treatment area. That is, instead of complementing mother's education, the program may simply serve as a substitute. This is not implausible given that the MCH program has informational and awareness components which can compensate for the low levels of maternal education in the treatment area. If so, mother's education will interact negatively in the treatment area and omission of this interaction term swamps the true effect of maternal education on immunisation outcomes.

In order to explore the differential impact of maternal education, we have run ordered probit on sub-samples of treatment and comparison area (see appendix table 2). It is found that maternal education in the control area leads to an early investment in child health by a small percentage - 1.74%, but the effect is significant (at 10%). In treatment area, the effect is again small and insignificant due to the reason that the effect of maternal education may have been picked by the presence of the MCH program itself.

Risk behaviour and risk perception: Mothers who participate in the prenatal care are expected to have better risk awareness regarding pregnancy related health conditions and their attendances to such care provide them with important health care input with regards to child health. It is expected that mother's prenatal visit will lead to higher probability of her child to be vaccinated. Our estimates across different specification strongly support the positive influence of risk perception (as reflected in their behaviour) on the choice of child vaccination. Parent risk perception on average accounts for 10% probability of a child being fully vaccinated. The magnitude of the effect is quite large, and emerged as better predictor of childhood immunisation than many socioeconomic variables.

Even though a positive association between risk perception (as measured from prenatal care of pregnant mothers) and postnatal child health care is argued, there can be non-linear relationship between the two. Beyond a certain average number of visits to health clinics, mother who have attended more clinic visits are more likely to drop out of vaccination. The intuition is that more than average number of visit to prenatal care does reflect the frail health condition of mothers and is a signal of low health stock and low life expectancy of mothers, all of which leads to lower awareness to child health care and child welfare. This line of thinking is based upon Rosenzweig and Schultz's (1991) finding that women with frail health are more likely to seek prenatal care than their counterpart whose health is robust. In order to test that possibility we replaced risk perception variable by three variables - the number of antenatal visit, its square, and mothers' tetanus immunisation. Our estimate (Appendix Table 3) shows that risk perception as proxied by number of prenatal visit is a strong predictor of demand for immunisation. Moreover, the effect of such antenatal visit is negative when prenatal visit is higher than certain optimum number.

This lead us to conclude that risk perception is important in the choice of health care for infectious disease. It can be questioned whether postnatal choice can be regressed on prenatal choice from the point of view that a mother who engages in prenatal care is also more likely to invest in child health care, as they are two inputs of child health at different points in time. We found that the correlation between the risk perception and immunisation choice variables is 0.23, which is not alarmingly high to underestimate our claim that the index of risk perception (as measured from prenatal visits) is a good proxy for households risk perception with regards to infectious disease, and therefore be regarded as an exogenous factor in the choice of immunisation.

Interaction of program and non-program effects: Average impact of the MCH program on immunisation choices is evident from the preceding discussion. However, estimates of mean impact may mask important variations in the program impact across different socio-economic groups. The program may interact with household-specific determinants of immunisation choices. A significant interaction effects arises if the program reinforces effect of a household-level correlate of immunisation demand or compensates for the lack of it. To test for such indirect channels via which the MCH program bolsters household demand for immunisation, we re-estimate the regression model by allowing interaction between the treatment dummy and a number of key household-specific factors – maternal education, household's access to radio, household's access to health advert, household assets and landholding. Results are reported in Table 5.

The coefficient on first interaction term (treatment dummy interacted with maternal education) is negative and significant (at 5%) implying that, in the demand for immunisation, the MCH program compensates for low mother education. To be precise, the effect of the MCH program is regressive in mothers' education.

It is already been found that the program has not worked by income supplementing activities. As an additional check to that finding, we have interacted household land holding with treatment variable. But without surprise this interaction variable failed to show any income effect of the MCH intervention.

The MCH program provides services to all households that have female members of childbearing age in addition to the government supported program. It is therefore likely to influence household decision to postnatal care by influencing their risk behaviour as evidenced in the prenatal care. To capture the effect we have interacted risk perception variable with the availability of MCH program. A negative coefficient would imply a complementary relationship between the MCH program and risk behaviour of households, and a positive coefficient indicates substitutability. The estimated coefficient of the above interaction terms is very small and insignificant, which imply that the MCH program has not been able to influence risk perception and risk attitude of households (Table 5). The risk perception itself has been strong predictor of immunisation demand, but the door-to-door provision of health information by MCH program is yet to influence risk behaviour of parents in favour of child health care and welfare.

It has been discussed that media exposures have important effect in the control area. In control area, the effect is very weak. But we expect that the MCH program compensated for the households who have insufficient media exposure, either because of mobility constraint or because of wealth constraint (to own a radio). An additional evidence for the contribution of MCH program can be found from the interaction effect, as the results show that (see Table 5) the MCH intervention compensates for the households access to radio (significant at 10%).

6. Conclusion

In this paper we have investigated household demand for childhood immunisation in Matlab sub-district of Bangladesh where an exogenously assign Maternal and Child Health program has been in operation since 1982. The exogeneity of treatment assignment has permitted us to explain the causal effect of the MCH program along with other important determinants of child health care investment, namely, maternal education and risk perception.

We find strong evidence that the MCH program enhances immunisation status of children. Most importantly, we find that the program effect varies by mother's educational endowment: the results suggest that the MCH program act as a substitute for maternal education as it is found to compensate low endowment of mothers' education. The other important pathway through which MCH program has enhanced immunisation demand is by providing information, knowledge and building health awareness. Prenatal care as an important source of information for child health input and household health production has found to significantly enhanced household's demand for childhood immunisation. This finding remains robust after controlling for household income, leading to the conclusion that the influence of risk perception is not proxying for an income effect. But the MCH program has failed to reinforce the household's risk perception towards child health choices. This suggests that the role of government health services should not neglected in influencing child immunisation demand even in the presence of very effective MCH program. Both MCH program and the government health program have their own beneficial effect, and in formulating an efficient policy to improve immunisation demand, both programs should learn from each other.

The finding that the public health program works via mitigating the maternal educational constraints and compensates for poor access to modern health care information in favour of child health by inducing households to fully immunise their child, has useful policy relevance for child health and welfare. Firstly, maternal education is important on its own right and it has been argued as the best health agenda for the third world. More educated mothers mean lower costs of public health programs in information, education and communication activities (Muhuri, 1995). Secondly, public health program creates greater awareness for childhood immunisation indirectly through antenatal services; mothers' visits to such care shape their risk perception for child health risks and benefits. Thirdly, given that child health is dependent on immunisation against killer infectious diseases, then future public interventions designed to improve immunisation uptake should focus on providing information to mothers in an effective way.

Notes

[1] See Chaudhuri (2005), Chen et al. (1983), Koeing and Strong (1993), Muhuri (1995), Phillips et al. (1987) for empirical evidence.
[2] An estimate shows that the EPI program saves more than 4 million children from premature death and 2.5 million from the agonizing life of polio victim.
[3] The MCH program has been identified by many previous researches for its promotion of better child health, nutrition and maternal health. See Behrman and Deolalikar (1988), Chaudhuri (2003, 2005), Koenig and Strong (1993), Phillips et al (1987), Rosenzweig and Schultz (1982). Unlike many of the above research we are interested to look into household demand for immunisation, and relate that to program effect.
[4] Empirical evidence in support of this channel can be found from a study in Columbia by Rosenzweig and Schultz (1982).
[5] Use of one MCH service is expected to change behaviour and attitude in favour of other health care services. According to behavioural models, consolidation of one behaviour such as family planning services may facilitate the more rapid adoption of a similar behaviour as information and knowledge acquired through one service-use extends the required awareness for other health care needs. Evidences in support of this view can be found in Ahmed and Mosley (2002).
[6] In the demand for childhood immunisation parents act as an agent for the child in question, therefore information, knowledge and awareness of parents influences the decision to immunisation.
[7] This claim coincides with Caldwell's (1979) hypothesis that education generates behaviour in mothers by increasing their knowledge, thus prompting them to take care of their children's health at a higher level and to a greater extent. Education also enhances mothers' capability to manipulate modern world, including interactions with medical personnel, and a shift in familial power structures, permitting the educated women to exert control over health care choices for their children.
[8] Parents' prenatal health care choices are assumed to reflect their risk attitude towards child health. And the use of those services increases parents' awareness for postnatal care as these services have information awareness component for future health care inputs for the expecting child.
[9] A child 12-23 months old is considered as fully immunised if she/he had received all of the vaccinations in the EPI vaccination schedule and is considered as partially immunised if all schedules are not completed during the scheduled time period.

[10] In 2002 the national dropout rates for DPT1-DPT3 was 10.5 percent and for DPT1-Measles was 18.5 percent. These rates are substantially higher in rural areas compared to urban areas. The most common reason cited for not continuing vaccinations is the lack of knowledge of mothers about the number of times to be vaccinated for vaccines which have multiple shots (like DPT and Polio each of which requires three shots).

[11] The BCG is usually given at birth and most of the time it is given by the birth attendant. Memory bias with BCG response is likely to be large. After BCG, DPT1 is the next one to go and usually there is high turn out for

DPT1. The highest risk vaccination discontinuity arises out of DPT1 to measles vaccination since there is longest interval between the two schedules making it for difficult for parents to forget about it. So in order to examine full immunisation choice, we will consider vaccination from DPT1 measles vaccination.

[12] A child is defined as fully immunised if she accepts all vaccines during the age of 12-23 months. So our restriction of minimum age of 1 year clearly makes them eligible for analysing if they are fully immunised or not.

[13] We have also examined the effect of the extent of 'exposure to MCH program' on immunisation probability. But controlling for treatment status, the length of program exposure has no additional effect

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Table 1: Variable description

Variable	*Definition*	*Obs*	*Mean*	*sd*
No immunisation	1 if no immunisation	1033	0.048	0.215
Partial immunisation	2 If partially immunised	1033	0.318	0.731
Full immunisation	3 if fully immunised	1033	2.379	1.216
Vaccination drop-out	1 if taken DPT but failed to take measles	1033	0.103	0.304
Treatment	1 if treatment area	1033	0.563	0.496
Household size	Family size	1033	5.800	1.759
Age	Age of child in years	1033	2.461	1.222
Sex	1 if female	1033	0.539	0.499
Religion	1 if Hindu	1033	0.891	0.312
House head age	Age of household head	1033	41.583	11.689
House head education	Years of household head's education	1033	3.077	3.744
Maternal age	Maternal age	1033	31.182	6.209
Square of Maternal age	Square of maternal age	1033	1010.844	418.530
Maternal education	Years of mother's education	1033	2.470	3.026
Log house expenditure	Log of total household expenditure	1033	10.773	0.627
Log House asset	Log of total household asset	1033	10.338	1.382
Land	Land in acre	1033	1.014	4.786
Mother market activity	1 if females in household has rearing activities	1033	0.397	0.489
House head unemployed	1 if household doesn't work	1033	0.032	0.176
Cows	Number of cows owned by household	1033	0.729	1.261
Rooms	Number of rooms in the house	1033	2.788	1.223
Access to radio	1 if household member listen to radio	1033	0.664	0.473
Access to health adverts	1 if household members has seen health advert	1033	0.144	0.352
ANC	1 if mother has made antenatal care visit	1033	0.727	0.446
Number of ANC visits	Number of prenatal care visit by pregnant mothers	1033	1.757	1.543
Square of ANC visits	Square of ANC care	1033	5.467	11.463
Mother's Tetanus	1 if mother was injected with tetanus toxoid shot	1033	0.668	0.471
Risk perception[4]	Index of household risk attitude to health care	1033	0.697	0.437
Distance to health facility	Distance to nearest health facility	1033	8.156	7.963
Village index*	Composite index of village infrastructure	1033	1.327	0.723

* Village index includes availability of three facilities – local market, post office, and irrigation facility in the village. The index is calculated in a 0-3 scale where presence of all three amenities produces a score of 3, and absence of all gives a score of 0.

[4] Index of perceived risk of household is measured in a 0-1 scale where the index is calculated as an average value of mothers' participation in antenatal care and TT immunisation. We haven't included place of delivery in the index due to the fact that traditionally in many parts of Bangladesh births are organised at household irrespective of household's risk perception to child health.

Table 2: Baseline characteristics

Variable	*Control mean (sd)*	*Program mean (sd)*	*H_0: mean(C)-Mean(P) = 0*
Household size	6.130 (1.821)	5.542 (1.664)	**t = 5.400 (P> ItI = 0.000)**
House head age	42.478 (11.919)	40.889 (11.469)	**t= 2.171 (P> ItI = 0.030)**
Maternal age	31.493 (6.509)	30.941 (5.959)	t = 1.418 (P> ItI = 0.156)
Maternal education	2.458 (2.958)	2.479 (3.079)	t =-0.107 (P> ItI = 0.914)
House head education	2.973 (3.656)	3.158 (3.811)	t = -0.786 (P> ItI = 0.432)
Land	1.148 (5.934)	0.909 (3.660)	t = 0.794 (P> ItI = 0.427)
Log House asset	10.308 (1.371)	10.360 (1.391)	t = -0.608 (P> ItI = 0.543)
Mother market activity	0.470 (0.499)	0.340 (0.4741)	**t =4.264 (P> ItI = 0.000)**
Risk perception	0.550 (0.023)	0.811 (0.014)	**t = -9.917 (P> ItI = 0.000)**
Access to radio	0.625 (0.484)	0.694 (0.461)	**t = -2.328 (P> ItI = 0.010)**
Access to health adverts	0.093 (0.290)	0.183 (0.387)	**t = -4.146 (P> ItI = 0.000)**
Distance to health facility	8.139 (0.373)	8.168 (0.332)	t = -0.057 (P> ItI = 0.522)
Village index	1.224 (0.028)	1.407 (0.033)	**t = -4.071 (P> ItI = 0.000)**

Table 3: Immunisation rate in program area and comparison area

Characteristics	**Comparison area**		**Program area**		**Differences in means**
	n	%	n	%	**H_0: mean(C)-Mean(P) = 0**
No immunisation	44	9.76	6	1.03	**t = 6.610 (P> ItI = 0.0000)**
Partial immunisation	109	24.17	55	9.45	**t = 6.545 (P> ItI = 0.0000)**
Full immunisation	298	66.08	521	89.52	**t = -9.616 (P> ItI = 0.0000)**
Vaccination drop-out	73	16.19	33	5.67	**t = 5.602 (P> ItI = 0.0002)**

Table 4: Full sample – baseline model

Variable	Treatment only		Baseline model	
	Marginal Effect	z	Marginal Effect	z
Treatment	0.240***	9.66	0.212***	7.99
Household size			-0.010	-1.24
Age			0.014	1.32
Sex			-0.012	-0.51
Religion			0.005	0.12
House head education			0.006	1.51
Maternal education			0.006	1.03
House head age			0.002	1.60
Maternal age			0.001	0.10
Square of maternal age ($\times 10^{-2}$)			0.140	-0.79
Access to radio			0.012	0.49
Access to health adverts			0.030	0.84
Log of house asset			-0.005	-0.51
landholding			0.012	1.31
Household head unemployed			-0.114	-1.14
Mother's market activity			0.068***	2.97
Risk perception			0.100***	3.81
Distance to health facility			-0.004**	-2.18
Village index			-0.005	-0.36
Observation	1033		1033	
Adj-R^2/Psuedo R^2	0.073		0.123	
Log pseudo-likelihood	-596.190		-564.365	

Note: * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Full sample – interaction model

Variable	Marginal Effect	z
Treatment[Ψ]	0.097	0.46
Household size	-0.010	-1.34
Age	0.013	1.21
Sex	-0.012	-0.53
Religion	0.009	0.21
House head education	0.006	1.49
Maternal education	0.013**	2.00
Maternal education*Treatment	-0.018**	-1.98
House head age	0.002*	1.65
Maternal age	0.004	0.33
Square of maternal age ($\times 10^{-2}$)	0.150	-0.96
Access to radio	0.046	1.34
Access to radio*Treatment	-0.101*	-1.84
Access to health adverts	0.060	1.10
Access to health adverts*Treatment	-0.057	-0.61
Log house asset	-0.016	-1.10
Log house asset*Treatment	0.026	1.32
Land	0.016	1.26
Land*Treatment	-0.007	-0.39
House head unemployed	-0.096	-1.01
Mother market activity	0.070***	3.02
Risk perception	0.114***	3.44
Risk perception*Treatment	-0.055	-0.93
Distance to health facility	-0.004**	-2.21
Village index	-0.007	-0.55
Observation	1033	
Adj-R^2/Psuedo R^2	0.132	
Log pseudo-likelihood	-558.550	

Note: * significant at 10%; ** significant at 5%; *** significant at 1%

[Ψ] In the interaction specification treatment dummy becomes insignificant when both household asset and land holding are interacted with the treatment dummy. When one of the income variables is treated as non-interacting variable, then as usual in other specifications, treatment is highly significant.

Appendix table 1: Average Treatment effect

n Treatment	n Control	ATT	se	t
370	287	0.191	0.035	5.487

Appendix table 2: baseline model – treatment sample and control sample

	Treatment sample		Control sample	
	Marginal Effect	z	Marginal Effect	z
Household size	-0.009	-1.17	-0.013	-0.97
Age	0.004	0.43	0.028	1.36
Sex	-0.039*	-1.72	0.033	0.75
Religion	-0.010	-0.30	0.086	0.98
House head education	0.002	0.36	0.012*	1.67
Maternal education	-0.002	-0.32	0.017*	1.87
House head age	0.003**	2.33	0.002	0.77
Maternal age	0.012	1.32	-0.004	-0.25
Square of maternal age ($\times 10^{-2}$)	0.120**	-2.13	0.050	-0.25
Access to radio	-0.032	-1.38	0.056	1.21
Access to health adverts	0.010	0.33	0.076	0.95
Log of house asset	0.008	0.87	-0.024	-1.17
landholding	0.006	0.62	0.026	1.53
Household head unemployed	-0.074	-0.71	-0.156	-0.91
Mother's market activity	0.074*	3.45	0.070	1.60
Risk perception	0.037	1.19	0.159**	3.42
Distance to health facility	-0.004***	-2.97	-0.002	-0.73
Village index	0.012	1.25	-0.080**	-2.46
Observation	582		451	
Adj-R^2/Psuedo R^2	0.0819		0.0790	
Log pseudo-likelihood	-197.29488		-350.5985	

Note: * significant at 10%; ** significant at 5%; *** significant at 1%

Appendix table 3: risk perception non-linear

Variable	Marginal Effect	z
Treatment	0.217***	8.00
Household size	-0.010	-1.28
Age	0.014	1.34
Sex	-0.013	-0.55
Religion	0.006	0.16
House head education	0.006	1.51
Maternal education	0.005	1.02
House head age	0.002	1.60
Maternal age	0.000	0.03
Square of maternal age ($\times10^{-2}$)	-0.102	-0.75
Access to radio	0.009	0.38
Access to health adverts	0.032	0.88
Log of house asset	-0.005	-0.48
landholding	0.012	1.31
Household head unemployed	-0.113	-1.14
Mother's market activity	0.069***	2.99
Number of ANC visits	0.017	1.06
Square of ANC visits	-0.002*	-1.85
Mother's tetanus	0.070**	1.99
Distance to health facility	-0.004**	-2.18
Village index	-0.005	-0.38
Observation	1033	
Adj-R^2/Psuedo R^2	0.1228	
Log pseudo-likelihood	-564.35096	

Note: * significant at 10%; ** significant at 5%; *** significant at 1%