



## Linkages between maternal education and childhood immunization in India

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### ABSTRACT

While correlations between maternal education and child health have been observed in diverse parts of the world, the causal pathways explaining how maternal education improves child health remain far from clear. Using data from the nationally representative India Human Development Survey of 2004–5, this analysis examines four possible pathways that may mediate the influence of maternal education on childhood immunization: greater human, social, and cultural capitals and more autonomy within the household. Data from 5287 households in India show the familiar positive relationship between maternal education and childhood immunization even after extensive controls for socio-demographic characteristics and village- and neighborhood-fixed effects. Two pathways are important: human capital (health knowledge) is an especially important advantage for mothers with primary education, and cultural capital (communication skills) is important for mothers with some secondary education and beyond.

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### Introduction

Maternal education has often been suggested to be the single most important factor explaining differentials in child health outcomes. At least since the 1988 overview by Cleland and van Ginneken, much effort has focused on identifying the linkages that explain why maternal education has such a strong impact. This paper contributes to that literature by investigating the possible social and cognitive pathways that mediate the relationship between maternal education and childhood immunization. It uses an especially rich data source with measures of many of the advantages that accrue to educated mothers. While causally distinct variables like socioeconomic status and area of residence explain some of the association of maternal education with child health outcomes, maternal education continues to have a strong and positive relationship with child health after extensive controls. We explore hypotheses that mothers' education leads to better human, social, and cultural capitals which then help increase immunization rates for their children. Additionally, we test whether more educated mothers' greater mobility and decision-making autonomy may enable them to achieve better health outcomes for their children.

### Pathways

If access to medical care is a primary pathway explaining why maternal education leads to better child health, the pathways through which education engenders an advantage to mothers' use of medical care remain unclear (Hobcraft, 1993). What is it about education that enables mothers to better utilize existing medical care? Or, conversely, in what ways are uneducated mothers inhibited from using medical care?

There are many benefits of education that may explain the advantages of educated mothers in obtaining medical care for their children. We explore four in this paper. First, educated mothers may have better knowledge of good medical practices and thus be more aware of the benefits of medical care; we summarize this as the human capital advantage of maternal education. Second, education may provide women with a wider range of contacts who are aware of the benefits of medical care and who can ease access to medical services; we label this the social capital route to better medical care. Third, education confers general skills that are socially valued and give educated women a higher status; this higher status raises self-confidence and eases social interaction with other high status actors such as medical providers; we identify this as the cultural capital route to medical care. Finally, more education may enable women to play a more active, assertive role in their households and in public that enables them to insist on better medical care for their children; this is the empowerment

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route to medical care. We review the evidence for each of these pathways below.

#### *Human capital*

Education leads to more accurate knowledge about health and greater receptivity to health messages (Glewwe, 1999; LeVine, 1987; Streatfield, Singarimbun, & Diamond, 1990). Greater health knowledge is not necessarily a consequence of the curriculum covered in schools, but academic skills, especially literacy, may help women to become more receptive to health information through other sources such as the mass media (LeVine, LeVine, & Schnell, 2001). Schooling also imbues individuals with a greater problem-solving capability and helps them understand novel messages (LeVine, 1987). A mother with only incomplete knowledge about immunization doses and timing may be less likely to fully complete her child's immunization (Jamil, Bhuiya, Streatfield, & Chakrabarty, 1999).

Streatfield et al. (1990) found in two Indonesian villages that knowledge of immunization although prevalent, benefitted only slightly from more education. Strong correlations between knowledge of immunization (such as knowing which diseases vaccines prevent, vaccine dosage and schedule) and immunization levels existed even for illiterate mothers. Multivariate analysis demonstrated that the effect of formal education disappeared when mothers had correct knowledge about vaccine functions.

Basu and Stephenson (2005) found particularly strong evidence for the protective role of maternal education for many mortality and mortality-determinant outcomes (Mosley & Chen, 1984) in India even after controlling for demographic and socioeconomic background and health behaviors. They suggest that even a "little learning" in primary schools was beneficial because girls learn to accord teachers with great authority and then, as mothers, bestow similar authority on health practitioners in following prescribed treatments.

Too often, education research in developing countries has studied only literacy or years of schooling. In societies where school quality varies widely across regions and types of schools, as in India (PROBE Team, 1999; World Bank, 1997), years of schooling does not provide adequate measures of education (Fuller & Heyneman, 1989). The addition of direct human capital measures is a substantial improvement over simple educational levels such as grade completion.

Independent measures of health knowledge are particularly important because health knowledge may also be gained informally. The inclusion of health knowledge in a model with formal education will help explain the contribution of education to increased health knowledge as well as the independent effect of knowledge on medical care. We hypothesize that the higher their education, the greater is the acquisition of human capital among mothers, and that more health knowledge is associated with better medical care independently of levels of education (H1).

#### *Social capital*

The benefits of education are not merely cognitive. Schools teach social skills in addition to facts and mental skills. Educated parents have broader social networks that provide knowledge of good health behaviors and where to find good medical care. They also participate more often in local organizations that broaden their social contacts, which make medical services more accessible. We hypothesize that social capital of better educated mothers is associated with greater immunization (H2).

Cassell, Leach, Fairhead, Small, and Mercer (2006) found that mothers in rural Gambia were influenced by their peer networks and organizations like village music groups to attend clinic days as

a group. In urban settings where this support was lacking, fewer mothers attended the clinic alone. Integration into these social networks encouraged women to go to health facilities and seek immunization. Prior social connection with the clinic staff also led to privileged treatment. Babalola (2009) also found a positive association between perceived social approval of childhood immunization in the community and the uptake of DPT3.

However, the kind of social capital may also define how networks affect access to medical care. An association with religious or caste organizations may reinforce traditional attitudes such as the use of indigenous medicine or encourage orthodox norms discouraging mothers from venturing out to seek immunization for their children. In contrast, association with development organizations may encourage more modern modes of thought and may increase information about the benefits of immunization and the presence of local immunization campaigns. Mothers' participation in women's saving groups in Bangladesh (e.g. the Grameen Bank), or even residing in NGO program areas, increases their children's probability of being fully immunized (Amin & Li, 1997; Steele, Diamond, & Amin, 1996).

#### *Cultural capital*

Higher educated mothers are more likely to carry a position of privilege that commands respect from health care providers and enables families to better utilize the medical system (Gittelsohn et al., 1994). Command over English, for example, identifies individuals as belonging to upper social strata and elicits respectful communication from service providers. Education raises a mother's social status and enables a more self-confident interpersonal style that smoothes interactions with the medical care system. Bourdieu (1977) famously introduced these skills into social science research as cultural capital – the institutionalized, widely shared, high status cultural signals (attitudes, formal knowledge, behaviors, goods and credentials) used for social exclusion (Lamont & Lareau, 1988).

Cultural capital has become common in education research (DiMaggio, 1982; Farkas, Grobe, Sheehan, & Yuan, 1990). It is only a small extension to presume that cultural capital also facilitates interaction with medical institutions. Schools socialize students into the dominant culture by giving them "more social confidence at handling officials and perhaps an enhanced ability and willingness to travel outside the home community in search of services" (Cleland & van Ginneken, 1988: 1363). The less educated are less familiar with the dominant culture and may be treated more condescendingly by sophisticated medical personnel. Their treatment may reinforce the low confidence the less educated bring to the institutional interaction in the first place. The result is a greater reluctance to use medical care and less satisfactory outcomes even when those inhibitions are overcome.

Joshi (1994) has shown that educated mothers have greater language skills to draw upon in their interactions with modern health settings. LeVine et al. (2001) suggest that children undergo *communicative socialization* in school as they learn new forms of discourse. Children are socialized in schools to deal with bureaucratic organizations through their interactions with teachers, administrative personnel and other staff members. This knowledge is carried into transactions with other bureaucracies such as health centers.

We hypothesize that a mother's communication ability reflects higher levels of education (LeVine, 1987) and increases her ability to navigate the bureaucratic health system to gain immunization for her children (H3). English fluency also serves as a sorting mechanism that distinguishes upper classes from the general public and provides parents with confidence in dealing with

educated medical personnel. We include a measure of her fluency in the English language as a component of her cultural capital.

### Empowerment

Household decisions in many societies, particularly in South Asia, are dominated by hierarchies based on gender and generation. Constraints on women's physical mobility outside the home further restrict their ability to make and act on independent decisions about medical care (Jeffrey, Jeffrey, & Lyon, 1989; Mandelbaum, 1986). These restrictions may require veiling the head and face. In such places, women face limits on direct contact with unrelated males and on going to places such as a pharmacy (Desai, 1994). Even where women can make decisions regarding health care, they may need help from other family members to actually conduct these transactions. However, these gendered restrictions may be relaxed with greater exposure to modern institutions such as schools (Jejeebhoy, 1995).

Studies in India have long emphasized the relationship between maternal education, decision-making autonomy, and greater utilization of health services (e.g. Basu, 1992; Das Gupta, 1990). Surveys have shown that educated women have higher autonomy regarding decision-making and mobility, which facilitate their use of antenatal care (Bloom, Wypij, & Das Gupta, 2001; Jejeebhoy & Sathar, 2001). Maternal autonomy may enable mothers to achieve better health outcomes for their children (Shroff et al., 2011). We hypothesize that more education will lead to mothers' greater decision-making, more mobility autonomy, and less extensive veiling (*pardah* or *pallu*); these, in turn, will be associated with greater immunization for the child (H4).

These capitals are measured in a manner that best fit our data, but our measures are necessarily imperfect and do not exhaust the possible ways to operationalize these capitals. Our tests are therefore conservative in that other measures might demonstrate significant pathways when our tests show little relationship. It is also difficult to draw sharp distinctions between the pathways included here so there is bound to be some overlap. For instance, English fluency can be seen as the accumulation of human capital as well as cultural capital.

### The causality debate

The association between maternal education and child mortality is usually understood as causal (Bicego & Boerma, 1993; Caldwell, 1979; Cleland & van Ginneken, 1988). Initial studies found a strong relationship although they often used weaker background controls because the early World Fertility Surveys had limited information about the socioeconomic status of the mother's family. Recent studies have shown that the strength of the maternal education relationship declines significantly with more extensive socioeconomic controls, suggesting that mother's education may in part be a proxy for these other factors. Using Demographic and Health Survey data from 22 countries, Desai and Alva (1998) showed that the effects of maternal education on child health outcomes reduce significantly in many countries after detailed controls for the socioeconomic status of the family and the local geographic area of residence.

Controls for contextual factors often associated with maternal education may be especially important. Well-educated mothers tend to live in villages with other well-educated mothers, better access to medical care, and better water and sanitation services. Steele et al. (1996), for instance, found that the effect of mother's education on immunization in Bangladesh is not statistically significant if village-level variables are held constant. Kravdal (2004) documented the positive externalities produced by other

local women's education on childhood immunization and other child health outcomes. Similarly, Parashar (2005) documented the importance of the district average female literacy for childhood immunizations in rural India. Streatfield et al. (1990) have suggested that social compliance with the practices of more educated neighbors may be a strong factor for improved uptake of immunization among illiterate women in Indonesia.

Causally prior factors such as socioeconomic status and geographic location that help determine maternal education need to be controlled to estimate education's causal impact on immunization. While causally prior variables explain much of the association of maternal education with child health outcomes, they rarely explain all of the education advantage (Govindasamy & Ramesh, 1997). Desai and Alva (1998) show that a strong link remains after controls especially for childhood immunization, more than for infant mortality or children's height-for-age. They conclude that more education does translate into health seeking behavior, but its impact on health outcomes remains weaker due to the importance of community level factors such as water supply and health services for actual outcomes. This is consistent with the accepted wisdom that the beneficial effect of maternal education on child health is mediated largely by better health care utilization (Cleland, 2010).

### Data and methods

The India Human Development Survey (IHDS) is a nationally representative face-to-face survey of 41,554 households across all Indian states and union territories (with the minor exceptions of the Andaman and Nicobar Islands and Lakshadweep), 384 districts, 1503 villages and 971 urban blocks (Desai et al., 2008). The survey was translated into 13 Indian languages and administered by pairs of local interviewers; women respondents were interviewed by women interviewers whenever possible. The fieldwork was carried out from September 2004 to August 2005 under the supervision of the National Council of Applied Economic Research, New Delhi. See Desai et al. (2010, pp. 214–216) for detailed information on sampling. This study uses only secondary analysis of publicly available data. The data do not contain any information, which can identify the individuals. The original survey received IRB approval in the United States and in India.

The IHDS survey asked a knowledgeable informant, typically the male head of the household, about the socioeconomic condition of the household, its level of social capital as measured by social networks and association memberships, and the employment and education of all household members. An interview with an ever-married woman, 15–49, asked about health, medical care utilization, her knowledge of health issues, gender relations in the household, and the interviewer's assessment of her communication abilities and interaction style. These measures permitted us to test the intervening linkages hypothesized above.

The survey collected immunization histories for the last-born children of these women. Complete immunization data were available for 8794 children who were 12 months to 5 years of age. For the sampling cluster fixed effects analyses reported here, 3507 cases in 1218 clusters were dropped because of lack of variance in the dependent variable; parallel analyses on all 8794 children showed substantively similar results (available from the website, Internet Table 3).

### Immunization

The dichotomous dependent variable indicates whether the child has received all five recommended immunizations by twelve months of age: three doses of DPT vaccine

(diphtheria–pertussis–tetanus), one dose of BCG (*Bacillus Calmette-Guerin*) against tuberculosis, and one dose of measles vaccine. Immunization histories were recorded from the government issued vaccination card if available, or from the mother's recall if the card was missing. We included a measure indicating whether the data were obtained from the card or through recall.

We have omitted polio vaccinations from our measure because an extensive national campaign has raised polio immunizations above other vaccinations. Our sample shows 73% of children have received all three polio vaccinations but only 57% received three DPT dosages and only 50% received all five recommended immunizations (details available on website, internet Table 1). Full polio vaccination did not have a statistically significant association with maternal education once village or neighborhood and other household factors were controlled (analysis not shown). The success of the polio campaign reminds us of the possibilities that aggressive service delivery can achieve independently of the usual social processes of inclusion and exclusion.

#### *Independent variables*

##### *Education*

Maternal education was measured as the highest number of years of education completed as reported by *the woman herself*. For missing cases ( $n = 78$ ), the information provided by the household head for the woman was used. Education levels were coded into six categories: illiterate (no schooling), some primary education from the grades one to five, some upper primary education (grades six to eight), some secondary education (grades nine and ten), some senior secondary education (grades eleven and twelve), and some college education (thirteen or more years of schooling). These separate dummy variables enabled us to detect ceiling effects that have been reported in the literature (Basu & Stephenson, 2005; Caldwell & McDonald, 1982; LeVine, 1987).

##### *Human capital*

The mothers were asked three questions about child health and pregnancy: (1) if it is harmful to drink one or two glasses of milk every day during pregnancy, (2) if colostrum is beneficial for the child, and (3) if a child needs to be given more than usual water to drink during diarrhea. The responses were coded as dichotomous to indicate correct answers versus incorrect answers or unknown. Correct responses to these questions can be indicative of general health knowledge although not specific to immunization. Correlations among the three items were rather low (ranging from 0.08 to 0.12) so no scale was created. The low correlations suggest that a unidimensional construct of human capital for health knowledge may be misleading.

##### *Social capital*

One household respondent (usually the head of the household) was asked whether their family participated in nine social organizations. Two measures of associational membership were created: membership in any religious, caste, or festival organization; and membership in any other, mostly development, associations (women's groups; youth clubs, sports groups, reading rooms; trade unions, business or professional groups; self help group; credit or savings groups; development NGOs, or agricultural co-operatives). We separated religious and caste organizations from development organizations as their impact may be quite different. Participation in caste and religious groups may reinforce traditional norms while participation in development organizations may suggest a shift in values toward more modern modes of thought. Both indices have moderate Cronbach's alpha estimates of reliability: 0.59 for religious and caste groups and 0.56 for development organizations.

Another measure of social networks is developed by counting whether the household has acquaintances or relatives who work in schools, health services, or the government. Network ties from the three domains scale well (Cronbach's alpha = 0.72).

##### *Cultural capital*

The third pathway, cultural capital, included two variables. The first measured the communication ability of the woman as rated by the interviewer. The scale had five items: whether she understood the purpose of the interview; whether she had any difficulty understanding the questions; whether she looked directly at the interviewer; whether she was knowledgeable about health and education expenditure; and whether she appeared confident (Cronbach's alpha = 0.74). The second was a dichotomous variable indicating whether she was fluent in the English language.

##### *Empowerment*

Women's empowerment was measured with three dichotomous variables: if the respondent is the main decision maker when the child is ill, if she can go to the local health center without seeking permission, and if she does not practise veiling.

##### *Control variables*

##### *Regional factors*

Educated women tend to live in educated communities with better access to resources such as health services. Following Desai and Alva (1998), we used fixed effects to control for village and urban neighborhood characteristics. They have demonstrated that controlling for community characteristics using cluster-level fixed effects reduces the impact of maternal education on child health outcomes. The villages and urban blocks that formed the primary sampling units (PSUs) were used as the clusters in the analysis. The clustering reduced the sample of 8794 children to 5287 and the 2279 original PSUs to 1061 clusters because there was no variance on immunization within some PSUs for our sample. Our approach is equivalent to adding 1061 cluster dummies to the equation; with cluster fixed effects, we are testing whether more educated mothers are more likely to have fully immunized children than less educated mothers within the same PSU. Fixed effects models have the advantage of controlling both for measureable and unmeasured local characteristics.

##### *Household characteristics*

While we are primarily interested in the effects of maternal education, father's education may be important also (Caldwell & McDonald, 1982; Pebley, Goldman, & Rodríguez, 1996). We controlled for the highest male educational attainment in the family as the benefits of education of any member in the household may accrue to all (Basu, Narayan, & Ravallion, 1999). Standard of living reflects the long-term economic status of the household as measured by possession of 30 housing amenities and household goods (Filmer & Pritchett, 2001). We also included an ordinal measure of women's television viewing with three levels: never, sometimes, and regularly (Jensen & Oster, 2009). Caste was controlled in five broad categories: Brahmins, other forward castes, other backward classes, scheduled castes and scheduled tribes. Religion was divided into three categories: Hindus, Muslims and other religions. Lastly, we controlled for family structure with a dummy variable for a joint versus a nuclear family.

##### *Child characteristics*

In India, girls suffer from neglect and discrimination, reflected in higher mortality and skewed sex ratios at birth (Das Gupta, 1987; Das Gupta & Bhat, 1997; Kishor, 1993). We expected this gender



discrimination to be reflected in immunization rates as well. Immunization also increases with age; we included linear and quadratic terms to test for a curvilinear relationship with immunization. Lastly, mother's parity was also included as a control.

#### Mother's characteristics

Mother's employment is generally found to increase child mortality (Guillot & Allendorf, 2010; Hobcraft, McDonald, & Rutstein, 1984; Kishor, 1993) so it is plausibly related to incomplete immunization. We included variables indicating whether the mother was employed full time (at least 2000 hours and 250 days during the year), part-time, or not at all during the last twelve months. Mother's age was recorded in three categories: under 25, 25 to 35, and above 35 years.

#### Statistical models

We computed stepwise logistic regressions adding each type of hypothesized pathway to a base model that regressed complete immunization on maternal education and controls. We started with an analysis of the simple association between maternal education and child immunization controlling for the child's age and whether the immunization data came from a government card or the mother's report. The next model added all available background controls about the mother and her household and includes sampling cluster fixed effects to hold constant any unobserved community level factors. We call this the control model. The analysis then added each of the four mediating pathways separately to the control model. The focus of the analysis was the change in the education coefficients with the introduction of each hypothesized pathway. The final model included all hypothesized pathways together.

## Results

#### Bivariate relationships with maternal education

Table 1 reports the bivariate relationships of maternal education with immunization and each of the hypothesized pathways. Immunization rates rose sharply with mother's education through upper primary education. After the upper primary level, the returns from additional years in secondary school or university were positive but diminished considerably.

Similarly, health knowledge about the beneficial effects of colostrum and the importance of liquids for treating diarrhea

increased with maternal education until early secondary school, after which the returns from education were weaker ( $\gamma = 0.35$  and  $0.24$  respectively). The education relationship with the third item was quite low as even illiterate mothers knew that milk consumption is beneficial during pregnancy ( $\gamma = 0.06$ ).

Social capital was even more strongly related to maternal education than was human capital. Family networks with modern institutions or memberships in development organizations were twice as common for mothers with senior secondary education as for mothers with no schooling (Networks:  $\gamma = 0.40$ ; Development social capital:  $\gamma = 0.32$ ). Even family memberships in religious and caste organizations were more common for mothers with secondary education.

Cultural capital also had strong relationships with maternal education. Not surprisingly, mothers without secondary education – over three fourths of the sample – rarely had much English ability but fluency rose steeply with secondary and especially university education ( $\gamma = 0.90$ ). Self-confidence in an interview situation rose more steadily throughout primary and secondary education ( $\gamma = 0.33$ ).

Educated women gained autonomy for all three empowerment measures, but the relationship was modest for decision-making and mobility. Only in a fourth of the households was the mother the primary decision maker about child health and although more educated mothers exercised more autonomy, the gains with education were not large ( $\gamma = 0.12$ ). Even fewer mothers could visit a health center without first seeking someone's permission, and while the rates increased with education, significant gains were only seen at the senior secondary and college levels ( $\gamma = 0.15$ ). As expected, practising *pardah* had a negative relationship with education; 60% of the college-educated women did not practise *pardah* as compared to only 27% of women with no education ( $\gamma = 0.30$ ).

#### Maternal education and child immunization: controlling for confounds

The basic association between maternal education and child-hood immunization confirmed that with each higher level of mother's education, children were more likely to be completely immunized (Model 1 of Table 2). The coefficients were larger for secondary and tertiary education, but the largest relative increases were seen for mothers with any primary or upper primary education.

**Table 1**

Bivariate relationships of maternal education with immunization and pathways.

	None	Primary	Upper primary	Secondary	Senior secondary	College	Total	Gamma	Tau-b
<b>Percent fully immunized</b>	38	52	62	65	68	67	50	0.32	0.20
Human capital	Percent having accurate health knowledge in each education category.								
Colostrum good for children	67	75	80	84	91	90	75	0.35	0.18
Water intake during diarrhea	52	55	65	72	68	72	58	0.24	0.14
Daily milk during pregnancy	75	70	75	75	80	73	74	0.06	0.03
<b>Social capital</b>	Percent having one or more memberships/networks.								
One or more network contacts	41	45	57	69	84	78	51	0.40	0.25
Development organization	14	21	21	29	35	27	19	0.32	0.16
Religious or caste organization	17	21	21	26	24	20	20	0.19	0.09
<b>Cultural capital</b>	Mean of communication abilities and percent fluent in English.								
Communication ability (mean)	1.56	1.63	1.68	1.77	1.81	1.79	1.63	0.33 <sup>a</sup>	0.21 <sup>a</sup>
English fluency	0	2	7	22	55	79	10	0.90	0.47
<b>Empowerment</b>	Percent of women empowered with respect to decision-making regarding child health, mobility autonomy and veiling.								
Decision when the child is ill	23	26	23	31	32	36	25	0.12	0.05
Visit health center	16	15	19	20	25	33	18	0.15	0.07
Practices veiling	73	66	65	58	51	40	67	0.30	0.18
% of sample (weighted)	49	26	13	13	5	4	100		

<sup>a</sup> Association between maternal education and a dichotomous variable indicating a median split of the communication ability scale. Source: India Human Development Survey.  $N = 5287$ .

**Table 2**  
Stepwise logistic regressions of full immunization on mother's characteristics.

Full immunization	Only method controls	Control model	Human capital	Social capital	Cultural capital	Empowerment	Full model
Mother's education (Reference: none)							
Primary	0.334*** (0.099)	0.168 (0.104)	0.148 (0.104)	0.167 (0.104)	0.138 (0.104)	0.170 (0.104)	0.120 (0.105)
Upper primary	0.758*** (0.108)	0.477*** (0.116)	0.421*** (0.117)	0.473*** (0.116)	0.431*** (0.117)	0.475*** (0.116)	0.371** (0.118)
Secondary education	1.076*** (0.114)	0.617*** (0.130)	0.566*** (0.131)	0.612*** (0.130)	0.519*** (0.136)	0.620*** (0.131)	0.467*** (0.137)
Senior secondary	1.199*** (0.163)	0.639*** (0.181)	0.562** (0.182)	0.622*** (0.181)	0.480* (0.196)	0.632*** (0.182)	0.382 (0.199)
Any college	1.417*** (0.181)	0.685*** (0.206)	0.627** (0.207)	0.689*** (0.206)	0.492* (0.233)	0.675** (0.207)	0.424 (0.235)
Human capital							
Milk while pregnant			0.228* (0.095)				0.212* (0.095)
Colostrum feed			0.286** (0.089)				0.288** (0.090)
Fluids if diarrhea			0.266** (0.081)				0.250** (0.082)
Social capital							
Social networks				0.118 (0.082)			0.112 (0.083)
Religious or caste				0.003 (0.115)			-0.010 (0.116)
Development				0.220* (0.098)			0.209* (0.099)
Cultural capital							
Communication skills					0.378** (0.117)		0.365** (0.118)
Some English					0.163 (0.144)		0.179 (0.145)
Empowerment							
No veiling						0.034 (0.102)	0.028 (0.103)
Visit health center						0.239* (0.103)	0.222* (0.103)
Decision-making						-0.185* (0.089)	-0.192* (0.090)
Household controls	No	Yes	Yes	Yes	Yes	Yes	Yes
Cluster-level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Figures are beta coefficients. Robust standard errors in parenthesis. \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ .

For complete results see Internet Table 4. Source: India Human Development Survey,  $N = 5287$ , Sample cluster fixed effects, clusters = 1061.

Model 2 adds background controls and sample cluster-level fixed effects. Children of the more educated mothers within these localities were more likely to be immunized, but their advantages were substantially attenuated. The strong effect of household economic standing on immunizations was especially important here: a main reason why children of educated mothers are better immunized is that they live in wealthier households. The impact was particularly strong for higher levels of education where the coefficients were reduced by more than half. Consequently, education beyond the secondary level does not offer advantages for childhood immunizations beyond the correlated effects of the higher socioeconomic status of the mother's household.

The education coefficients of model 2 can be interpreted as the best estimates of the direct causal impacts of a mother's education on her child's immunization. All the coefficients except for early primary education were significantly associated with immunization. The coefficients for secondary education and beyond are quite similar in magnitude. Most of the benefits of maternal education were concentrated at the middle years of schooling between the end of primary school at grade 5 and finishing lower secondary school at grade 10. Even at these levels, the estimates of the causal effects in model 2 were much reduced from the total associations reported in model 1. These results highlight that much of the maternal education and childhood immunization association is indeed not causal.

#### Mediating pathways

##### Human capital

Each of the three health knowledge questions had a strong positive association with immunization. The more a mother understood about health, the more likely it was that her children would be immunized. Because health knowledge is more common among educated mothers, the magnitudes of the education coefficients declined modestly when human capital controls were

added to the model. The human capital measures explained roughly a tenth of the education effects.

##### Social capital

In contrast, social capital controls did not change the education coefficients very much. Only a household's membership in development organizations had a positive impact on a child being fully immunized. But social capital was only weakly related to maternal education after household and local fixed effects controls so it was not a main pathway through which the mother's education translated into higher children's immunization.

##### Cultural capital

A mother's communication ability had a strong association with her children's full immunization. Mothers who impressed interviewers with their ability to respond confidently to survey questions were the ones who were most likely to have their children immunized. Moreover, the addition of cultural capital variables to the model reduced the education coefficients substantially, especially at senior secondary and college levels. These results suggest that within a village or neighborhood cluster, greater communication abilities are a pathway through which education, especially higher education, leads to complete immunization. Fluency in English, however, was not a significant correlate of immunization.

##### Empowerment

Two empowerment variables were significantly related to immunization but in opposite directions. As hypothesized, a mother's freedom to visit a health center without seeking permission was positively associated with her child's immunization. However, a mother's having the most say in decisions related to childhood sickness was negatively associated with full immunization. This might indicate the absence of others in the household who are involved with children's health. In any case, because of these offsetting effects, adding gender empowerment variables to

the control model had a minimal impact on the maternal education coefficients.

Finally, when all the pathways were included in one equation (model 7), the coefficients for each of the intervening pathways remained statistically significant as in the previous models. As compared to the control model 2, education coefficients in the final model were reduced at all levels especially at the senior secondary and college levels where in fact, the estimates remained only marginally significant ( $p < 0.10$ ). The original difference between college graduates and women who had finished upper primary school ( $\beta = 0.685 - 0.477 = 0.208$ ) was reduced by 75% in the final model ( $\beta = 0.053$ ); almost all of this change was due to the controls for cultural capital. In contrast, the larger increase in immunization between mothers who had finished upper primary school versus the illiterate ( $\beta = 0.477$ ) was reduced by only 22% ( $\beta = 0.371$ ) due almost equally to the human capital and cultural capital controls.

## Discussion

Our results show that the background variables such as local residence and socioeconomic status of the household explain much of the initial association between maternal education and children's immunization. Children of well-educated mothers are more fully immunized in part because they live in areas where other children are fully immunized and because they live in more affluent households. Similar results have been found by other studies of children's health. For instance, Frost, Froste, and Haas (2005) find that half of the maternal education effect on child nutritional status is explained by socioeconomic status and geographic residence.

Although the association is weakened with the addition of household and locality controls, maternal education continues to have a substantial estimated impact on children's immunization. This analysis has tested four specific pathways that might explain such a causal effect. Of these, human and cultural capitals receive the strongest support as intervening links between maternal education and children's immunization.

Increased health knowledge may be a route through which modest education, even at the primary level, influences child health. Human capital controls have a uniform impact on lowering all of the education coefficients but slightly more at lower and upper primary levels. Mothers with primary education may follow immunization guidelines better not just because of their doctor's advice but also because they understand the importance of those messages. Frost et al. (2005) have found similar results in their analysis of child nutritional status in Bolivia where the knowledge pathway led to a 15% reduction in the education effect.

Although the results suggest the importance of human capital as a pathway through which maternal education leads to increased immunization, our measure of human capital is quite restricted. We use just three questions about health knowledge, none specifically a direct measure for knowledge about immunization. Nevertheless, all three variables assessing health knowledge are positively associated with immunization resulting in a modest decrease in the education coefficients. It seems likely that a more extensive battery of questions on health knowledge, especially regarding immunization itself, would lead to an even greater human capital explanation of the maternal education effect.

Social capital is not a significant pathway through which education translates into better immunization outcomes for the child. Connections to development institutions do have a beneficial impact on immunization uptake. These connections may increase familiarity with progressive ideas and modern medicine and therefore increase the acceptability of vaccines. Secondly, they may directly inform the family about vaccination drives and access to immunization. Lastly, these development organizations could also

create community social pressure for families to have their children fully immunized.

This study shows the heterogeneity of social capital and its differential impact by type. A single overall measure for household memberships in all organizations is not significantly related to children's immunizations (results not shown). However, decomposing memberships into modern associations versus traditional memberships revealed a significant relationship for development social capital.

Despite the beneficial impact of membership in development organizations on children's immunizations, this relationship explains little of the maternal education effect since this kind of social capital is more a consequence of the household's general socioeconomic standing than of the mother's educational attainment. All our measures of social capital, however, represent relationships with institutional structures and measures of more informal networks might better explain health outcomes (Cassell et al., 2006).

In contrast, cultural capital emerges as an important pathway for the effect of maternal education on children's immunizations. The addition of the communication ability scale led to a significant reduction in the magnitude of education coefficients, especially at higher levels. In India, the medical system is a high status, largely Western institution that may deter easy access because of the social and cultural gap between the general population and medical personnel. Being confident and skilled in social interaction helps educated women achieve greater access to health services and helps them navigate patriarchal households for greater control over their children (Cleland & van Ginneken, 1988, Gittelsohn et al., 1994).

Cleland and van Ginneken (2008) have suggested that even primary schooling enables girls to develop the skills needed to interact successfully with modern institutions. They conclude that these abilities are an important pathway through which maternal education translates into increased service utilization. Our results show that in India secondary and tertiary levels of education are especially important for these kinds of social skills.

Lastly, empowerment appears to be the weakest pathway as there was minimal change in the education coefficients with the introduction of empowerment controls. As expected, a mother who does not need permission to visit the health center is more likely to have her child immunized, but this impact is offset by the negative association of greater maternal decision-making.

The use of separate maternal education categories has added depth to this analysis by showing how different levels of education affect pathways differently. At higher levels of maternal education, it is mainly the greater ease of mothers' social interactions that explains their children's greater immunization; health knowledge has a modest impact. But the greater knowledge of the primary school educated mother does give her children an immunization advantage over those of the totally illiterate. Moreover, it is the advantages of higher levels of education that are best explained by our analyses; in the final model there is little difference in immunization rates between children of college graduate mothers and of mothers with only ten years of schooling.

Nevertheless, maternal education advantages are not fully explained by the pathways included in our analyses. Middle levels of education continue to be significantly related to childhood immunizations after controls for all pathways. Other pathways not included in this analysis could be responsible for the remaining relationship. For example, Basu and Stephenson (2005) argue that even a "little learning" teaches women respect for authority and, thus, compliance to suggested medical treatments like immunization. Alternatively, Ewbank (1994) suggests that what may matter is not how educated women differ from uneducated women but how

society has different expectations for the educated and uneducated. Educated mothers are expected to always use the available medical care for their children in ways that the illiterate may not be. Cultures communicate these expectations to mothers in many ways. An educated mother who does not immunize her child may be explicitly chastised while poor care from an illiterate mother might be dismissed as just typical of her ignorance. The differential treatment of educated mothers from medical providers also conveys the sense of what is expected of them – expectations that mothers fulfill even if subconsciously. This greater social pressure for educated mothers to live up to higher expectations becomes internalized so that they see immunizing their children as part of their definition of being a good mother – what separates them from lower status, illiterate mothers.

Finally, educated women are granted higher status in most social interactions. In particular, medical providers treat them more respectfully. The importance of communication ability in our results suggests that the interaction between the medical system and the mother is at least as important as the individual characteristics of the mother herself. Surveys may be good at measuring these individual characteristics, but they are not as effective in measuring how social interactions proceed between mothers and society. Multilevel studies incorporating measures of medical institutions might help our analyses move beyond the individual limitations of most survey research. Complementary qualitative studies could help to explore the interactional processes that show how unmeasured status variables influence access to health care. If interactions consistently differ because of the higher status of educated mothers, we should not expect our survey analyses to explain all the benefits of maternal education.

Survey analyses such as ours contribute by quantitatively adjudicating amongst the various plausible pathways that have been suggested to explain the maternal education effect. With the measures available in our data, we have found good support for the human and cultural capital pathways but less evidence for social capital and empowerment.

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## Appendix A. Supplementary material

Supplementary material associated with this article can be found, in the online version at doi:10.1016/j.socscimed.2012.02.043.

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