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Maternal education and child nutritional status in Bolivia: finding the links

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Abstract

This study models various pathways linking maternal education and child nutritional status in Bolivia, using a national sample of children. Pathways examined include socioeconomic status, health knowledge, modern attitudes towards health care, female autonomy, and reproductive behavior. The data come from the 1998 Bolivia Demographic and Health Survey. Logistic regression results suggest that socioeconomic factors are the most important pathways linking maternal education and child nutritional status, and that modern attitudes about health care also explain the impact of education. Health care knowledge accounts for less of the effect of maternal education on child nutritional status, with autonomy being the weakest pathway. Other pathways, such as reproductive behaviors, appear to influence nutritional status independent of maternal education. Overall, the pathways examined accounted for 60 percent of the effect of maternal education on child nutritional status.
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Introduction

Child health and survival in Bolivia continue to be issues of national and international concern. Bolivia has some of the highest rates of infant and child mortality, morbidity, and malnourishment in the region (Boerma, Sommerfelt & Rutstein, 1991; Pimental & García, 1995; Sommerfelt & Stewart, 1994; Sullivan, Rutstein, & Bicego, 1994). For example, the 2003 Bolivian infant mortality rate of 61 per 1000 live births contrasts sharply with Bolivia's geographical neighbors, ranging from 10 deaths per 1000 live births in Chile to 33 deaths per 1000 births in Peru (Population Reference Bureau, 2003). In 1998, approximately 29 percent of Bolivian children younger than 5 years of age were malnourished; this is a larger proportion than any other country in South America (Demographic and Health Surveys, 2002). These rates escalate among high-risk Bolivian populations, such as indigenous populations in the Altiplano region (República de Bolivia, 1994; Pimental et al., 1995).

Beginning with the work of Caldwell (1979), a considerable body of research suggests that maternal education is the single most important factor in explaining differentials in child health outcomes, more important than paternal education, health service availability, and socioeconomic status (Martin, Trussell, Salvail, & Shah, 1983; Young, Edmonston, & Andes, 1983). Comparative studies in all major regions of the developing world have shown a linear relationship between education and childhood mortality (Bicego & Ahmad, 1996; Cleland & Van Ginneken, 1988; Ware, 1984; Cochrane, 1980; United Nations, 1985).

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However, more recent research calls into question the causal association between maternal education and child health outcomes (Desai & Alva, 1998; Basu, 1994; Hobcraft, 1993). In particular, Desai and Alva (1998) concluded that maternal education is mostly a proxy for socioeconomic status and geographic area of residence: thus, the effect of maternal education disappeared or was greatly reduced once controlling for these factors. Thus, there is continued debate regarding the influence of maternal education on child health outcomes; additional research is needed to further understanding of how maternal education impacts child health (Barrett & Brown, 1996; Bicego & Boerma, 1993; Desai & Alva, 1998). It is this gap in the literature that we attempt to address.

Specifically, we use data from the 1998 Bolivia Demographic and Health Survey in this study to explore several specific pathways through which maternal education likely influences child nutritional status, and we analyze the relative contribution of each pathway. These pathways include socioeconomic status, knowledge, modern attitudes about health care, autonomy, and reproductive behavior. Bolivia is one of the poorest nations in Latin America, with a gross national income of $2240 in 2001 US dollars (Population Reference Bureau, 2003), and it provides a useful context for studying the linkages between education and child nutritional status in a disadvantaged setting. In order for policy makers to better promote change and improve child well-being in impoverished regions, it is necessary to more completely identify the mechanisms through which maternal education is associated with child health outcomes.

Background

Conceptual model

Various studies have attempted to model the effects of female education on child survival and health outcomes. Mason (1984) hypothesized various pathways linking female education and infant and child mortality. Her model included contraceptive use, female autonomy, and family socioeconomic status as potential pathways. LeVine, Le Vine, Richman, Tapia Uribe and Sunderland Correa (1994) linked female schooling to fertility and child survival through intervening mechanisms including the acquisition of skills related to health, socioeconomic aspirations, and interactive interpersonal behaviors. Based on both qualitative and quantitative research in Mexico, they found some empirical support for these pathways (LeVine et al., 1994).

Other models have examined the pathways between women's education and fertility in Latin America specifically. Castro Martín and Juárez (1995), drawing upon sociology of education literature, modeled the mediating influences of knowledge, socioeconomic status, and attitudes on the number of children ever born. They hypothesized that education operates as a source of knowledge by providing literacy skills, information, and cognitive changes. In addition, education is a vehicle for socioeconomic improvement, opening economic opportunities and encouraging social mobility. Lastly, education is a transformer of attitudes by encouraging the acceptance of modern ideas over traditional beliefs and authority structures. Using Demographic and Health Survey data from nine Latin American countries, Castro Martín and Juárez (1995) found that a substantial portion of the effect of maternal education on fertility was mediated through indicators of knowledge, socioeconomic status, and attitudes.

More recently, Glewwe (1999) connected parental schooling to child health through parental values, parental cognitive skills (literacy and numeracy), parental health knowledge, and household income. He argued that possible mechanisms linking mother's education and child health include (1) health knowledge—formal education directly teaches health-related information; (2) literacy and numeracy skills—formal education helps mothers diagnose and treat child health problems; and (3) exposure to modern society—formal schooling makes women more receptive to modern medicine. Based on data from Morocco, Glewwe (1999) concluded that health knowledge directly improves child health outcomes, but that little health knowledge is taught in Moroccan schools. Instead, literacy and numeracy skills taught in schools foster the acquisition of health knowledge learned outside the classroom.

In addition to the individual influence of maternal education on child health, studies have also indicated that aggregated levels of maternal education at the community level can influence child nutrition (Alderman, Hentschel, & Sabates, 2003). Thus, maternal education appears to influence child health outcomes both at the community level and at the individual level. Communities with higher proportions of more educated women are likely to provide better sanitation and medical services and shared health knowledge within the community (Alderman et al., 2003; Desai & Alva, 1998).

At the individual level where we focus attention, there are at least five potential pathways linking maternal education and child health based on the models previously discussed: (1) improved socioeconomic status (Desai & Alva, 1998; LeVine et al., 1994; Mason, 1984); (2) health knowledge (Glewwe, 1999; Castro Martín & Juárez, 1995; LeVine et al., 1994); (3) modern attitudes towards health care (Glewwe, 1999; Castro Martín & Juárez, 1995); (4) female autonomy (Mason, 1984; Castro Martín & Juárez, 1995); and (5) reproductive behaviors (Le Vine et al., 1994; Castro Martín & Juárez,

1995). There is very little empirical research examining the relative contribution of these pathways, particularly in one study. Using individual level data, we test these various pathways and their relative importance in mediating the effect of maternal education and child nutritional status. In addition, we include controls for geographic residence. Prior to presenting our model specifications, we examine in more detail the literature underlying these five hypothesized pathways.

The pathways

Socioeconomic status

One of the most commonly researched links between maternal education and children's health is socioeconomic status. Its association with child mortality and health has largely been explained by the link between educational attainment and an increased ability to buy goods and services linked with health outcomes (Cleland & Van Ginneken, 1988; Defo, 1997; Victora, Smith, & Vaughan, 1986). Education has a clear connection to income. Women with more education are more likely to find a superior, steadier job that pays in cash rather than in kind so they can more consistently supplement the family income (Barrett & Browne, 1996). Furthermore, educated women are more likely to marry husbands with greater educational attainment and higher paying jobs (Barrett & Browne, 1996; Cleland & Van Ginneken, 1988).

The influence of socioeconomic status on health behavior is also fairly evident. Higher levels of income are correlated with better housing conditions; thus, households with latrine facilities, piped water, and electricity generally have lower contaminant levels than households without such amenities (Barrett & Browne, 1996; Defo, 1997; Martin et al., 1983). Additionally, more money can be spent on nutritional food, warm clothing, medicine, and health care services that can directly impact children's health (Barrett & Browne, 1996; Martin et al., 1983).

The empirical evidence, thus, demonstrates that socioeconomic status has a strong influence on children's health outcomes (Bhuiya, Wojtyniak, & Karim, 1989; Bicego & Ahmad, 1996; Sommerfelt & Stewart, 1994; Victora, Smith, & Vaughan, 1986). Comparative studies have found that paternal occupation is strongly correlated with neonatal, infant, and child mortality, with agricultural and blue collar workers having the highest childhood mortality levels and professional/white collar workers the lowest (Bicego & Ahmad, 1996; United Nations, 1985). Declining levels of child mortality have also been associated with piped water, flush toilets, non-dirt floors, and radio ownership (Bicego & Ahmad, 1996; Sullivan et al., 1994; United Nations, 1985; Victora et al., 1986). In summary, socioeconomic factors have consistently explained half or more of the effect of maternal education on child health outcomes in prior research (Cleland & Van Ginneken, 1988; Desai & Alva, 1998). We therefore expect socio-economic status to be the most important pathway linking maternal education and child nutritional status.

Knowledge

An explicit goal of formal education is knowledge transmission. Education facilitates mothers' learning about the causation, prevention, recognition, and cure of disease, as well as nutritional requirements that can subsequently affect their health behavior (Caldwell, 1979; Cleland & Van Ginneken, 1988; Defo, 1997; Frenzen & Hogan, 1982). Furthermore, education can lead women to greater exposure and better understanding of health messages and recommendations through mass media or other sources (Cleland, 1990; Streatfield, Singarimbun, & Diamond, 1990). The link between knowledge and children's health implies that mental understanding of the health process directly impacts behaviors focused on improved health. If this is true, acquired knowledge "should lead to greater protection against infection through improved hygiene, reduced susceptibility to infection through nutrition, and enhanced recovery from infection through more effective domestic and external health care" (Defo, 1997, pp. 1029).

Studies linking formal education, health knowledge and child health outcomes are limited and the empirical relationship between knowledge and health behavior is inconclusive. Some research has shown that higher levels of education are associated with specific types of health knowledge, including awareness of the dangers of not boiling water, the importance of hand washing after latrine use, the proper use of oral rehydration therapy to treat diarrhea, and an understanding of contagions as a cause of disease (Bhuiya, Streatfield, & Meyer, 1990; Boerma et al., 1991). However, in past research knowledge of these factors was not always been predictive of health outcomes. Some studies have found health knowledge to be a mediating factor between maternal education and child health (Glewwe, 1999); whereas others have found little or no association between education and health knowledge (Cleland & Van Ginneken, 1988; Cleland, 1990).

Attitudes

In addition to basic health knowledge, education can also influence attitudes about health behavior by producing a shift away from traditional beliefs and practices, leading to a greater receptivity to novel ideas and practices, and a more frequent acceptance of rational explanations of disease and modern medicine (Barrett & Browne, 1996; Caldwell & Caldwell, 1993; Cleland & Van Ginneken, 1988; Defo, 1997). Thus, if this accurately describes the connection between

education and health attitudes, mothers with higher levels of education are more accepting of modern medicine, more likely to use preventive health services, more willing to take their children to a medical center, and less likely to attribute the future health of their child to fate (Bicego & Boerma, 1993).

Research findings in nutrition support attitudes as a link between education and child health outcomes, including nutritional status (Zeitlin, Ghassemi, & Mansour, 1990). One study found that optimistic and enterprising mothers were successful in maintaining good nutritional status of their children in spite of impoverished surroundings. In contrast, children whose mothers have fatalistic outlooks were more likely to suffer from malnutrition (Zeitlin et al., 1990). Zeitlin et al. (1990) conclude that formal education and modernization are key factors producing the attitudinal shift from fatalism to a sense of control. Past findings, therefore, suggest that a change in attitudes is another pathway through which maternal education influences child health. As an indicator of this attitude shift, previous research has found that educated women are more likely to seek modern health care (Addai, 2000; Barrett & Brown, 1996; Desai & Alva, 1998). Because our data do not include direct attitudinal measures, we use measures of the utilization of modern health care services as a proxy for attitudes towards health care.

In addition, ethnicity is also examined as an indicator of attitudes towards health care. Studies in Guatemala demonstrated that indigenous populations were less likely to believe in modern medical practices, instead believing that illnesses were caused by hot–cold imbalances or evil spirits (Burleigh, Dandano, & Cruz, 1990). Similar beliefs have also been found among indigenous populations in Bolivia (Bastien, 1992). Pebley, Goldman and Rodriguez (1996), in a Guatemalan study of prenatal care and childhood immunizations, concluded that modern health care utilization differs greatly by ethnicity and Spanish language ability, as well as by socio-economic status and accessibility. We therefore include ethnicity as an indirect indicator of attitudes towards health care.

Autonomy

Female education can also influence child health by increasing the decision-making power of women within the family. Women generally are the primary care givers in their home, devoting more time to the protection and care of their children than men (Caldwell & Caldwell, 1993; Caldwell, 1993). Mothers, therefore, are usually the first to recognize a child is sick. However, in many traditional cultures uneducated women often do not act until other traditional authority figures notice the child's illness (Caldwell et al., 1990). Increased maternal education changes the traditional balance of power in familial relationships, granting educated women more authority. Educated mothers feel personally responsible for their children and are more likely to draw attention to the illness, demand that action be taken, and take a sick child to the health clinic, rather than deferring decisions to traditional authority structures (Caldwell, 1979, 1993; Caldwell et al., 1990).

The empirical evidence supporting autonomy as a mechanism linking maternal education to child health is limited by the few studies investigating the topic. One study concluded that an increase in mother's control over family income is associated with improved nutritional status for female infants (Saraswathi, 1992). Another study demonstrated that the survival of a mother's children is positively associated with her autonomy level (Kishor, 1995). Jejeebhoy (1995) linked education with maternal decision-making autonomy and increased child survival. The more education a woman receives, the more likely she is to be the primary decision-maker with regards to her children's health. Thus, past findings suggest that female autonomy is another pathway through which maternal education influences child health (Jejeebhoy, 1995; Mason, 1984).

Reproductive variables

Reproductive factors provide another pathway between education and child health and previous studies have attempted to link maternal education and reproductive behaviors to child survival (Mason, 1984; Le Vine et al., 1994). With higher levels of education, women are more likely to view reproduction as being within their direct control. Moreover, decisions regarding the timing of births are conscious, and reproductive behavior is monitored to prevent undesired pregnancies. Previous research has found an association between higher education and lower fertility, reproduction at low-risk ages, and longer birth intervals (Cleland & Van Ginneken, 1988). These reproductive factors are all associated with increased child survival.

Higher levels of infant mortality are associated with both child bearing among adolescents and women over the age of 35 (Gubhaju, 1986; Martin et al., 1983; Tagoe-Darko, 1995). Few studies have examined the effect of maternal age on child nutritional status. A comparative study using DHS data did not find a consistent pattern between stunting and maternal age (Sommerfelt & Stewart, 1994); however, a recent study using a Bolivian population found that the likelihood of stunting decreases with maternal age (Forste, 1998).

Birth intervals of less than 2 years are associated with increased childhood mortality rates (Sullivan et al., 1994; Tagoe-Darko, 1995; Curtis & Steele, 1996; Gubhaju, 1986). Children spaced two or more years apart have a greater chance of being well cared for, of being breast-fed longer, and of being taller and heavier (Bastien, 1992; Gubhaju, 1986). Additionally, stunting is more common among children with a prior birth

interval of less than 24 months than among children following longer birth intervals (Sommerfelt & Stewart, 1994; Boerma et al., 1991; Forste, 1998).

Regarding parity, first-order and high parity births are at greater risk of mortality than lower parity births (Sullivan et al., 1994); Tagoe-Darko, 1995; Gubhaju, 1986; Pebley & Stupp, 1987). Furthermore, past research findings show that stunting increases as birth order increases (Sommerfelt & Stewart, 1994; Forste, 1998). The overall support for reproductive factors as a pathway linking maternal education and child health is mixed. Cleland and Van Ginneken (1988) argued that the effect of maternal education on childhood mortality has little to do with shifting reproductive behavior, whereas others have argued for reproductive linkages between maternal education and child survival (Mason, 1984).

Based primarily on the models proposed by Mason (1984), LeVine et al., 1994), and Glewwe (1999), we hypothesize and test various pathways linking maternal education and child health outcomes. Specifically, we model the effects of socioeconomic status, knowledge, modern attitudes about health care, autonomy, and reproductive behavior as pathways linking maternal education to child nutritional status. We examine these linkages using national data from Bolivia in order to examine these relationships within a context of poverty. In addition, we include measures of geographic residence and region to control for health service availability.

Data and methods

Data

We model pathways of influence between maternal education and child nutritional status in Bolivia using the 1998 Demographic and Health Survey (DHS). The DHS interviewed 11,187 women between the ages of 15 and 49. A stratified cluster-sampling design was used to randomly select women aged 15–49 within each cluster. Sample cases are adjusted for over-sampling of particular areas and to compensate for differences in response rates. The survey was executed in four steps: (1) the sample was selected to represent the nine major geographic regions of the country, the questionnaire was designed, and the survey instruments were translated into local languages, pre-tested, and finalized; (2) field staff were trained and eligible households and individual respondents were identified and interviewed; (3) the data were entered, edited, and coded and checked for consistency; and (4) the data were made public for analysis. The Demographic and Health Surveys are collected by MACRO International, an opinion research corporation.

Survey data in the DHS include fertility, family planning, and work histories, as well as information on maternal and child health care utilization. In addition, the DHS collected anthropometric measures and health and vaccination histories for all children aged 0–60 months whose mothers were surveyed. In order to estimate the effects of maternal education on child nutritional status, our sample from the DHS is limited to children between the ages of 0–60 months for whom height data are available. Additionally, to facilitate investigation of the autonomy link, we focus on the division of decision-making power within a household between parents, and thus limit the sample to children whose mothers are married or in a consensual union. Our total study sample includes 5562 children.

Measurement

The focus of this analysis is on the pathways linking maternal education and child nutritional status. Based on height and age data, the dependent variable is a dichotomous variable indicating whether or not the child is too short for his/her age. The anthropometric index of height-for-age reflects pre- and post-natal growth, and deficits in height-for-age show the "long-term, cumulative effects of inadequacies of nutrition and/or health" (Gillespie & Haddad, 2001). According to the National Center for Health Statistics/World Health Organization International Growth Reference, children two standard deviations below the median height for age curve are classified as stunted (Dibley, Goldsby, Strehling, & Trowbridge, 1987). Wasting is another measure of nutritional status defined as low weight-for-height, and is often associated with starvation and/or severe disease (Gillespie & Haddad, 2001). Because very few children in Bolivia, less than 2 percent, exhibit wasting and because stunting measures chronic malnutrition that is influenced more by maternal characteristics than is wasting, we focus our analysis on stunting.

Maternal education is measured by an interval scale based on four categories: (0) no schooling, (1) basic (1–5 years), (2) intermediate (6–8 years), and (3) secondary or more (9+ years). Initial analyses (available from the authors) indicate that an interval measure of education fits the model as well as does either including education as a categorical variable or measuring education with a continuous variable in terms of total years attained. For ease of interpreting the influence of each mechanism, the interval scale from 0 to 3 is used to estimate the change in the maternal education effect. We expect to see a strong negative relationship between maternal education and child stunting.

Using various measures, we create additive indices to operationalize the effects of socioeconomic status, knowledge, modern attitudes about healthcare, and

autonomy on child health. To construct indices, we first selected variables that seem to measure the underlying construct of each mechanism. Then, we performed a factor analysis to determine how well each set of variables factored together, omitting obvious outliers. Table 1 shows factor loadings, Cronbach's alpha, and sample proportions for variables included in each mechanism. With the set of variables established, we then create the indices in simple additive form. A correlation matrix (available from the authors) shows only moderate correlations between the indices, suggesting that in general they each measure separate constructs.

Socioeconomic status is quantified by two additive indices measuring household environment and household wealth, each ranging from 0 to 4. Our household environment variable measures the presence of piped drinking water, a flush toilet facility, electricity, and a non-dirt floor, and gives a sense of overall living conditions. Household wealth measures the presence of consumer durables in a household, including radio, television, refrigerator, and telephone. We also include paternal education and occupation as measures of household socioeconomic status. Preliminary analyses showed that maternal employment status did not mediate the maternal education effect and was not a significant predictor of stunting, so this variable was excluded from further analysis. We anticipate that socioeconomic status will explain the largest portion of the maternal education effect on child nutritional status.

Measures of mothers' knowledge concerning disease treatment and prevention, and nutritional requirements, are limited in the DHS and several indirect measures are used to create an index of general health knowledge. We include maternal knowledge of the correct use of oral rehydration therapy, a remedy for diarrhea, as a direct measure of an appropriate treatment for a common childhood ailment. Four indirect measures of general health knowledge are used, including maternal knowledge of any type of modern contraception, knowledge of AIDS, knowledge of the ovulatory cycle, and knowledge of a national health program guaranteeing free services

Table 1
Description of variables included in indices

Description of variable	Sample proportion	Factor loading	α
Household wealth			
Own a television	0.522	0.6074	
Own a radio	0.808	0.3453	
Own a fridge	0.221	0.6391	
Own a phone	0.110	0.5878	
			0.6396
Household environment			
Electricity	0.585	0.7668	
Piped water	0.639	0.6713	
Flush toilet	0.174	0.4658	
Nondirt floor	0.551	0.7217	
			0.7734
Knowledge			
Has heard of oral rehydration therapy	0.859	0.4578	
Has heard of modern method of contraception	0.820	0.6306	
Has heard of AIDS	0.656	0.7081	
Has heard of Seguridad de Maternidad y Niñez	0.600	0.5788	
Knows when in ovulatory cycle can get pregnant	0.401	0.4865	
			0.7217
Health care utilization			
Received prenatal care from doctor or nurse	0.653	0.6274	
Doctor or nurse attended birth	0.542	0.9252	
Delivered baby at home	0.509	0.9206	
Received tetanus injection before birth	0.496	0.4165	
Has used modern method of contraception	0.335	0.4150	
			0.7743
Autonomy			
Both husband and wife approve of family planning	0.659	0.6115	
Discussed number of children with husband	0.767	0.6170	
Discussed family planning with husband	0.749	0.6964	
			0.7205

for women and children called Seguridad de Maternidad y Niñez. The knowledge index for the DHS sample ranges from zero to five.

Another way that education can influence health is by challenging traditional beliefs and attitudes, leading to a greater willingness to accept and utilize modern health-care. To measure attitudes, we assume that mothers using preventative health services are more open to accessing the modern health sector compared to mothers using only emergency and curative services. Thus, our attitudes indicator is mostly based on measures of preventative health service use. The health care utilization index combines measures of medical prenatal care, receipt of a tetanus injection during pregnancy, birth in a medical facility, medical birth attendants, and use of any form of modern contraception. Separately, we include a measure of ethnicity as another indicator of attitudes towards health care. Thus, following other research, we use membership in an indigenous group with limited Spanish proficiency as an indicator of more fatalistic and traditional beliefs towards health care.

The DHS lacks any direct measures of autonomy. Thus, we combine several proxies to measure a woman's status in relation to her spouse regarding family planning and child bearing. We include whether the couple discussed family planning use and the number of children they want to have, where discussion of either topic suggests greater relative status for the mother. Additionally, we incorporate into the index whether both the husband and wife approve of family planning. Table 1 shows that these three variables factor together.

Reproductive variables include maternal age at birth, parity, and birth interval. Maternal age at birth is measured in three categories: 15–19, 20–34, and 35+. We include dummy measures of first birth, second or third birth, and fourth and higher order births as measures of parity. Finally, preceding birth interval is coded into dummy variables indicating 2 or less years, between 25 and 47 months and 48+ months. Given past research, we expect that although reproductive variables affect children's nutrition, they will not provide a strong pathway linking maternal education and child nutritional status.

In addition, to control for community factors and access to health care, controls for geographic region of residence (Altiplano, Valle, or Llanos regions) are included. The DHS also provides an indicator of residence size measured in dummy variables for capital or large city, small city, town, and countryside. These measures provide a rough control for the availability and accessibility of health facilities. In addition, 32 percent of the children in the sample have at lease one sibling in the sample. Thus, we also adjust for any clustering that occurs at the mother level in all of our models to correct the standard errors.

Because the dependent variable is a dichotomous measure, models are estimated using logistic regression. The logit equation is as follows: $\log [P/1 - P] = a + bX$, where $P/(1 - P)$ is the odds of the outcome given the independent measure X, and where a and b represent coefficients to be estimated. Thus, this equation expresses the log of the odds of a child being stunted versus not as a linear function of the set of explanatory variables previously mentioned.

In order to determine the pathways of influence that maternal education exerts on child stunting, a baseline model estimating the bivariate relationship between maternal education and child nutritional status is first considered. We then introduce geographic controls. The education coefficient after controlling for residential and geographic variables serves as the basis of comparison to measure how the pathways mediate the education effect. Here, we consider two interrelated factors: first, how the magnitude of the education coefficient changes with the introduction of each pathway, and second, the statistical significance of the education coefficient. Subsequent models add mechanisms separately to see how the effects of education are mediated, until a full model is assessed with all mechanisms and controls included.

Results

Descriptive statistics are presented first in Table 2. Approximately 30 percent of children aged 0–60 months are stunted in Bolivia, a relatively high proportion for Latin America. Overall, maternal education levels are low, with almost 60 percent of the children's mothers reporting 5 years of schooling or less, indicating that many women never progress past the basic education level.

Socioeconomic levels as measured by the wealth and environment indicators reflect high levels of poverty in Bolivia. The measures constituting the indices, shown in Table 1, are the most basic household possessions and conditions. Yet, the average for each index is less than two, out of a possible four items. Paternal education is also low, with fathers obtaining less than 7 years of formal education. Furthermore, the majority of fathers are employed in either blue collar or agricultural work.

The knowledge index indicates moderate levels of health knowledge on average with children's mothers scoring 3.3 out of a possible 5 items. Health care utilization is lower, with mothers only obtaining slightly more than 2 of 5 modern health services on average. About half of the children's mothers had prenatal or delivery care, suggesting that many women have sporadic and/or infrequent contact with medical professionals. Additionally, 15 percent of the mothers are indigenous with limited Spanish-speaking ability. Our autonomy index shows moderate levels of maternal

Table 2
Stunting, maternal education, and intervening mechanisms: proportions, means, and standard deviations

Characteristics	Demographic and health survey
Total sample (unweighted) (*N*)	(5562)
Dependent Variable	
Stunted	0.300
Primary independent variable	
Mother's education	
None	0.138
Basic (1–5)	0.437
Intermediate (6–8)	0.170
Secondary or more (9+)	0.256
Mechanisms	
Socioeconomic status	
Household wealth index	
Range	0–4
Mean	1.66
(SD)	(1.14)
Household environment index	
Range	0–4
Mean	1.95
(SD)	(1.44)
Paternal education	
Mean	6.70 years
(SD)	(4.02)
Paternal occupation	
Agriculture	0.421
White collar	0.179
Blue collar	0.355
Service	0.102
Knowledge index	
Range	0–5
Mean	3.34
(SD)	(1.52)
Health care utilization index	
Range	0–5
Mean	2.16
(SD)	(1.07)
Member of indigenous group, limited Spanish capability	0.146
Autonomy Index	
Range	0–3
Mean	2.16
(SD)	(1.07)
Reproductive variables	
Birth interval	
First birth	0.185
0–23 months	0.261
24–47 months	0.371
48+ months	9.184
Maternal age at time of birth	
15–19	0.043
20–34	0.726
35+	0.231
Parity	
First birth	0.185
2–3 birth	0.352
4+ birth	0.464

Table 2 (*continued*)

Characteristics	Demographic and health survey
Geographic controls	
Area of residence	
Capital or other large city	0.301
Small city	0.135
Town	0.073
Countryside	0.491
Region	
Llano	0.268
Valle	0.335
Altiplano	0.397

Source: 1998. Demographic and Health Survey, Bolivia.

status on average across this range of child-bearing and family-planning items.

Reproductive measures indicate that a small proportion of children, around 5 percent, were born to adolescent mothers and a larger proportion, almost 25 percent, were born to at risk older mothers. Almost half of the births are four or higher parity births and a quarter of births had a preceding birth interval of less than 2 years, placing them at higher risk for stunting.

Residence measures indicate that about 30 percent of the children live in the capital city or another large city, while 20 percent live either in a small city or town. Almost half live in the countryside. Geographic region shows that 40 percent of the children live in the Altiplano, the impoverished highland region of Bolivia, with the remainder distributed between the Valle and Llanos regions.

Turning to multivariate, logistic regression models, log odds or logits are presented in Table 3. The first column, model 1, gives the effect of maternal education on the likelihood of the child being stunted without controlling for any other factors. Model 2 presents the maternal education effect after including geographic controls. Each intervening mechanism is then added separately in models 3–7, along with the geographic controls. The last column presents the full model.

The bivariate effect of maternal education on child nutritional status is shown in model 1, Table 3. Each level of education decreases the likelihood of stunting by approximately 44 percent (1—exponent of the log odds). The top row in Table 3 shows the changing education effect as mechanisms are introduced into each analysis. The maternal education coefficient ranges from a decreased likelihood of stunting by 38 percent for each level of additional education attained when controlling for geographic variables in model 2, to 18 percent in the full model when all pathways are included. Table 4 shows the proportion of the education effect on child stunting explained by each mechanism.

Table 3
Effects of Maternal Education and Intervening Mechanisms on Likelihood of Stunting (standard errors)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Full Model
Maternal education	−0.578***	−0.480***	−0.290***	−0.409***	−0.373***	−0.464***	−0.427***	−0.197***
	(0.034)	(0.038)	(0.047)	(0.041)	(0.042)	(0.039)	(0.040)	(0.050)
Socioeconomic factors								
Household environment			−0.161***					−0.132**
			(0.042)					(0.043)
Household wealth			−0.203***					−0.170***
			(0.050)					(0.052)
Husband education			−0.022					−0.014
			(0.012)					(0.013)
Husband occupation								
White collar								
Service			0.235					0.241
			(0.170)					(0.173)
Agriculture			0.221					0.155
			(0.165)					(0.166)
Blue collar			0.234					0.223
			(0.145)					(0.146)
Knowledge				−0.100***				−0.033
				(0.025)				(0.030)
Attitudes								
Health care utilization					−0.115***			−0.051*
					(0.024)			(0.026)
Ethnicity					0.392***			0.392***
					(0.094)			(0.100)
Autonomy						−0.045		0.026
						(0.031)		(0.036)
Reproductive behaviors								
Maternal age at birth								
15–19							0.092	0.012
							(0.177)	(0.179)
20–34								
35+							−0.038	−0.010
							(0.085)	(0.090)
Parity								
First							−0.748***	−0.741***
							(0.114)	(0.117)
Second or third							−0.203**	−0.183*
							(0.079)	(0.082)
Fourth or higher								
Birth interval								
Less than 2 years								
2–4 years							−0.210**	−0.223**
							(0.076)	(0.078)
4+ years							−0.657***	−0.602***
							(0.102)	(0.107)
Geographic controls								
Area of residence								
Capital								
Small city		−0.085	−0.239*	−0.091	−0.130	−0.085	−0.093	−0.253*
		(0.118)	(0.120)	(0.118)	(0.119)	(0.117)	(0.118)	(0.122)

Table 3 (*continued*)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Full Model
Town		0.039	−0.180	0.022	−0.033	0.043	−0.008	−0.216
		(0.144)	(0.149)	(0.144)	(0.144)	(0.143)	(0.146)	(0.151)
Countryside		0.424***	−0.176	0.351***	0.185*	0.414***	0.340***	−0.269*
		(0.085)	(0.126)	(0.088)	(0.094)	(0.085)	(0.085)	(0.129)
Region								
Altiplano								
Valle		−0.455***	−0.459****	−0.436***	−0.398***	−0.448***	−0.466***	−0.430***
		(0.074)	(0.078)	(0.074)	(0.077)	(0.074)	(0.074)	(0.082)
Llano		−0.633***	−0.741***	−0.563***	−0.480***	−0.627***	−0.699***	−0.640***
		(0.087)	(0.091)	(0.089)	(0.091)	(0.087)	(0.088)	(0.099)
−2LL	3217.38	3160.1	3023.04	3134.32	3112.7	3518.93	3122.78	2946.74
N	5562	5562	5366	5535	5528	5562	5562	5309

Source: Demographic and Health Survey, Bolivia 1998.
$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$.

Table 4
Proportion of education effect[a] on child stunting explained by mechanism, demographic and health survey

	Education coefficient	Proportion of effect explained by mechanism
Bivariate model	−0.578	
Geographic controls	−0.480	0.170
Socioeconomic model	−0.290	0.396
Knowledge model	−0.409	0.148
Attitudes model	−0.373	0.223
Autonomy model	−0.464	0.033
Reproductive model	−0.427	0.110
Full model	−0.197	0.590

Source:1998. Bolivia DHS.
[a] Compared to education coefficient in model with geographic controls.

Controlling for urban/rural residence and geographic region of the country in model 2, the education coefficient is reduced by almost 20 percent (see Table 4). This suggests a selection of residence based on education level. When comparing this model to the subsequent model controlling for socioeconomic status, rural residence becomes statistically insignificant, implying that the impact of living outside urban areas on children's nutritional status is due more to its association with socioeconomic factors than residence per se. However, with controls for socioeconomic status, residence in a small city is associated with a lower likelihood of stunting. The combination of health conditions and health care in smaller cities may be better than in large urban cities. Additionally, the variables representing the region of residence in Bolivia retain their strong significance throughout all the models.

Results from model 3 suggest that the impact of education on stunting is reduced in large part by socioeconomic factors and residence controls. The education coefficient drops from −0.578 to −0.290, an almost 50 percent reduction, with both sets of factors, giving credence to Desai and Alva's (1998) argument. However, education retains its strong statistical significance after controlling for socioeconomic status and geographic residence, suggesting that other factors explain portions of the maternal education effect as well.

Results from Table 4 suggest that once controlling for geographic variables, socioeconomic and attitude factors have the largest mediating influence between maternal education and stunting. Socioeconomic variables explain 40 percent of the education effect and attitude factors, measuring the propensity to use modern health care, explain 22 percent. When general health knowledge factors are included in the model, the education coefficient decreases by 15 percent. Reproductive variables and autonomy explain smaller proportions of the maternal education impact on child stunting, 11 percent and 3 percent, respectively. When all factors are included together in the full model, the education effect decreases by 59 percent.

The final column of Table 3 shows the results from the full model. Taken together with Table 4, a more complete picture of the pathways between maternal education and child stunting becomes clearer. Among the mechanisms, the socioeconomic and health care utilization indices, as well as the variables measuring ethnicity, birth interval, and parity, remain significant in the full model. Although the reproductive variables are related to children's nutritional status directly, Table 4 suggests that they explain only a small percent of the

maternal education effect. Thus, the results show that among the mechanisms considered, socioeconomic status and utilization of modern health facilities are the most important pathways of influence between maternal education and child nutritional status. However, the education coefficient in the full model retains its statistical significance. Thus, the mechanisms as they are currently measured do not account for all of the maternal education effect on child nutritional status.

Discussion

In contrast to the findings of Caldwell (1979) and Martin et al. (1983), we find that part of the effect of maternal education on child health outcomes is explained by socioeconomic status. This finding is supported by Desai and Alva (1998). However, in contrast to their work, we find that only about half of the maternal education effect is explained by socioeconomic status and geographic residence. In addition, we account for about 65 percent of the maternal education effect on child nutritional status via geographic residence, socioeconomic status, modern attitudes towards health care, health knowledge, and reproductive behaviors. Socioeconomic status remains the primary pathway linking maternal education and child nutritional status, but modern health care utilization and health knowledge also account for portions of the maternal education effect. Reproductive behaviors explain some of the maternal education effect, but parity and birth spacing also exhibit a strong independent influence on child nutritional status.

More specifically, Desai and Alva (1998) argue that individual-level and community-level factors greatly attenuate the influence of maternal education on stunting and infant mortality, but that maternal education remains strongly associated with child immunizations. They conclude that maternal education may influence health-seeking behaviors such as immunizations, whereas environmental conditions are more likely to influence nutritional status and child survival outcomes than are parenting behaviors and characteristics. Our findings are similar, except that we find modern health care utilization accounts for some of the maternal education effect on stunting. In our model, maternal education influences health-seeking behaviors, which in turn influences stunting. Thus, in our Bolivian sample, environmental conditions are important in determining child nutritional status, but so too are health-seeking behaviors such as modern health care utilization and reproductive behaviors, as well as maternal education.

In concurrence with the model estimated by Castro Martín and Juárez (1995) examining pathways linking maternal education and fertility in Latin America, we find similar links between maternal education and child nutritional status. We also conclude that maternal education is a vehicle for socioeconomic improvement, and a transformer of attitudes from traditional, fatalistic views of health care to acceptance and utilization of modern health care. In addition, we find some evidence of maternal education as a source of knowledge related to health.

Still, even in our final model, maternal education continues to have a significant, independent influence on child nutritional status. There may yet be other pathways through which maternal education operates to influence child nutritional status. Past studies have also suggested parental values and cognitive skills such as literacy and numeracy, as well as parental interpersonal behaviors as potential mechanisms (LeVine et al., 1994; Glewwe, 1999). In addition, studies suggest that educated mothers are better able to comply with doctors' treatment and care regimens for their children (Ware, 1984), and that they can better understand, question, and communicate with health care professionals (Joshi, 1994). Maternal education may also operate through community level variables in addition to individual level factors (Alderman et al., 2003). Our data do not allow us to consider these pathways. Future research is needed to broaden and test additional pathways linking maternal education and child health outcomes.

Our inability to explain all of the maternal education effect may also be the result of measurement error. In particular, we found female autonomy to be a very weak pathway linking maternal education and child nutritional status. Because we do not have direct measures of autonomy, our results may be due to poor measurement. Perhaps, with better measures, autonomy would be a more important pathway or autonomy may operate independent of maternal education. Das Gupta (1990) argues that the basic abilities and personality characteristics of the mother influence child health outcomes independent of education or economic wealth. She concludes that women with greater decision-making power in the household have children with better health outcomes. Additionally, Simon, Adams and Madhavan (2002) find that mothers indicating they feel power to influence outcomes are better able to mobilize resources to meet the nutritional needs of their children. Thus, with more direct indicators of autonomy, the conclusions found in our data regarding autonomy might be quite different.

Our findings overall suggest that, given an environment with sufficient resources, maternal education can influence child nutritional status by promoting the utilization of modern health care, as well as improving health care knowledge and reproductive behaviors. Our findings, however, are limited to one context—Bolivia. Improved measures in different contexts are needed in

order to clarify further the mechanisms through which maternal education influences child health outcomes.

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