THE IMPACT OF WOMEN'S EDUCATION ON UNDER-5 MORTALITY, LOW BIRTH WEIGHT, AND PREVALENCE AND SEVERITY OF CHILD ANEMIA: EVIDENCE FROM GUATEMALA AND BOLIVIA

ABSTRACT
Educational attainment of women in Latin America has substantially improved in the past decades. In addition, child health has improved sharply. While an extensive literature has focused on examining this positive relationship, few studies have assessed heterogeneity at the individual, regional, and country level, especially in Latin America. In this chapter, I use Demographic and Health Survey (DHS) data from Guatemala and Bolivia between 1986 and 2015. I explore the relationship between mother's education and child health outcomes, specifically, under-5 mortality, low birth weight, and prevalence and severity of child anemia. Preliminary results suggest that mother's education has a strong negative relationship with under-5 mortality, low birth weight, and prevalence and severity of anemia among children in Guatemala and Bolivia. In addition, these preliminary results also provide evidence for substantial heterogeneity at the regional and country level. Finally, I will further explore this relationship by investigating the utilization of prenatal-, natal-, and postnatal-care services, ethnolinguistic majority-minority heterogeneity, and child healthcare through a composite index.

INTRODUCTION
The sociology of health literature has explored the significant role of educational attainment on health outcomes throughout the lifetime (Adler and Newman 2002; Adler and Rehkopf 2008; Ahmed et al. 2010). Research has suggested that maternal education is the single most important factor in explaining differentials in health outcomes for women themselves, and their children (Caldwell 1979; Martin et al. 1983; Raghupathy 1996; Young, Edmonston, and Andes 1983). While educational attainment of women in Guatemala and Bolivia has substantially improved in the past decades (Castro Martin and Juarez 1995), these two countries have the highest rates of infant and child mortality, morbidity, and malnourishment in Latin America (Boerma, Sommerfelt, and Rutstein 1991; García Pimental and Montaño García 1995; Sommerfelt and Stewart 1994; Sullivan, Rutstein, and Bicego 1994).

For example, the 2017 infant mortality rate in Guatemala of 25 per 1,000 live births is higher than the average for the Central American region of 19 per 1,000 live births (Population Reference Bureau 2017). Similarly, the 2017 infant mortality rate in Bolivia of 39 per 1000 live births is higher, and more than double, than the average for the South American region of 15 per 1000 live births (Population Reference Bureau 2017). Similar statistics have been documented for infant and child morbidity and malnourishment. Another reason for looking at the case of Guatemala and Bolivia is to assess the variation in health outcomes and health inequalities among majority-minority groups. In both countries, most of the total population is indigenous, representing 66% and 71% respectively (Montenegro and Stephens 2006). Research has demonstrated that in most Latin American countries, indigenous people have higher rates of mortality and morbidity indicators than their non-indigenous counterparts (Casas, Dachs, and Bambas 2001; Plant 1998). However, few studies have systematically addressed and compared variation in health outcomes and health inequalities for ethnolinguistic minorities.

While researchers have also reported substantial between-country variability in the magnitude of the relationship between low socioeconomic status (SES) and high morbidity and mortality in Latin America, less is known about cross-country and cross-regional variation in health outcomes and health inequalities linked to ethnic minorities in this region (Carvajal and Burgess 1978; Elo 2009; Hatt and Waters 2006; Rivera et al. 2004). Extensive research has shown that marginalized and minority groups worldwide often experience earlier mortality, higher morbidity, and worse overall health, but less is known about this variability across groups and contexts (Anderson 1995; Balarajan 1995; Marmot et al. 1997; Vega and Rumbaut 1991; Williams et al. 1997; Williams and Sternthal 2010). Despite vast demographic literature, to my knowledge, few, if any studies have provided a thorough assessment of heterogeneity of this relationship affecting different subnational groups. Failing to look at the heterogeneity in these historical relationships, across and within countries, masks the inequalities that exist, and which have led to the emergence, persistence, and coexistence of different fertility regimes across and within the Latin American context.

Building on this research gap, I use cross-sectional Demographic and Health Survey (DHS) data for Guatemala and Bolivia between 1986 and 2015, this chapter explores the association between mother's education and under-5 mortality, low birth weight, and prevalence and severity of child anemia. First, I explore the relationship between mother's education and child health outcomes. Second, I study the changes in this relationship with utilization of prenatal-, natal', and postnatal-care services, as well as, child healthcare through composite indexes. Third, I discuss differences between majority-minority groups based on ethnolinguistic identity. Results from this research add to the literature that describes differential child health outcomes based on parent's socioeconomic and demographic characteristics in the developing world (Bicego and Boerma 1993; Boyle et al. 2006; Desai and Alva 1998; Frost, Forste, and Haas 2005; Glewwe 1999; Hobcraft 1993; Thomas, Strauss, and Henriques 1991). I extend the work of previous scholars, by examining not only this association, but also the regional and country level variation of this relationship in countries with high ethnolinguistic populations.

BACKGROUND

Research has suggested that educational attainment plays a significant role on health outcomes throughout the lifetime (Adler and Newman 2002; Adler and Rehkopf 2008; Ahmed et al. 2010). Cutler and Lleras-Muney (2012) explain this relationship through three pathways. First, poor health early in life may lead to less educational attainment. Second, lower educational attainment may adversely affect subsequent health. And third, differences in social discount rates may affect education and health-seeking behavior. In this chapter, I will focus on the second pathway, to understand the role of maternal educational attainment on child health outcomes.

Maternal education has been suggested to be the single most important factor in explaining differentials in health outcomes for women themselves, and their children (Caldwell 1979; Martin et al. 1983; Raghupathy 1996; Young et al. 1983). Empirical studies have shown that women's education is associated with longer life expectancy, lower death rates, and improved child health and nutrition (Barrera 1990; Hadden and London 1996; Schultz 2002). In addition, educated women seem somewhat more successful at reducing the prevalence of diarrheal diseases, initiating immunization and ensuring that their children are fully vaccinated, and entering motherhood later and/or having fewer children (Hobcraft 1993). Due to their greater likelihood of using health services, avoiding high-risk pregnancies, and experiencing fewer pregnancies, educated mothers are less likely to die in childbirth (Elo 1992; Hobcraft 1993; Raghupathy 1996).

Frost, Forste, and Haas (2005) discussed and tested five potential pathways linking maternal education and child health: (1) improved socioeconomic status (Desai and Alva 1998; LeVine et al. 1994; Mason 1984); (2) health knowledge (Castro Martin and Juarez 1995; Glewwe 1999; LeVine et al. 1994); (3) modern attitudes towards health care (Castro Martin and Juarez 1995; Glewwe 1999); (4) female autonomy (Castro Martin and Juarez 1995; Mason 1984); and (5) reproductive behaviors (Castro Martin and Juarez 1995; LeVine et al. 1994). Other scholars have distinguished between micro-level and macro-level mechanisms, as well as interactions between maternal education and child health. Caldwell (1994) argued that maternal education has the power to improve child health through higher use of treatment and prevention services from the local health system. In addition, Mason (1984) hypothesized various pathways linking female education and infant and child mortality, such as contraceptive use, female autonomy, and family socioeconomic status.

Other scholars have tested the association between female education on fertility and child survival through intervening mechanisms, such as the acquisition of skills related to health, socioeconomic aspirations, and interactive interpersonal behaviors (Glewwe 1999; LeVine et al. 1994), as well as attitudes forged through educational attainment (Castro Martin and Juarez 1995). Glewwe (1999) argues that mother's education is linked to child health through three possible mechanisms: (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 (Frost et al. 2005).

Education and Under-5 Mortality

Empirical studies have confirmed that higher education is associated with lower mortality. Kitagawa and Hauser (1973) documented that mortality in the United States fell with education. Since then, empirical studies have confirmed this relationship, and have shown that there is a growing gap between the more and less educated as it pertains to under-5 mortality (Meara, Richards, and Cutler 2008). Researchers have also provided evidence that this relationship is observed in most countries, regardless of their level of development (Strauss and Thomas 1995). In fact, other studies have found a linear relationship between parent's education and childhood mortality in both developed and developing countries (Bicego and Ahmad 1996; Cleland and van Ginneken 1988; Cochrane, O'Hara, and Leslie 1980; Schultz 2007; Strauss and Thomas 1995; United Nations 1985; Ware 1984). Caldwell (1979) argued that mother's education played an important role in determining child survival even after controlling for several other factors, including socioeconomic characteristics of the husband. He suggested different pathways through which mother's education might enhance child survival: "a shift from 'fatalistic' acceptance of health outcomes towards implementation simple health knowledge; an increased capability to manipulate the modern world, including interaction with medical personnel; and a shift in the familial power structures, permitting the educated woman to exert greater control over health choices for her children" (Caldwell 1979; Hobcraft 1993:159; Raghupathy 1996).

Education and Low Birth Weight

In addition, research has also reported consistency between mother's education and fetal health, particularly, birth weight (Chevalier and O'Sullivan 2007; Kramer 1987; Parker, Schoendorf, and Kiely 1994; Starfield et al. 1991). Some studies also find that results vary between majority-minority groups, as well as, between very educated and less educated women (Kleinman and Madans 1985; Shmuelib and Cullen 1999). Other researchers have also studied the effects of low birth weight on subsequent growth faltering during childhood. In their study of maternal education and growth faltering for children aged 3-23 months at the time of the surveys, Bicego and Boerma (1993) find that low height for age ('stunting') in early life is strongly related to maternal education. They find that even after controlling for economic status, children of women with no education are at least twice as likely to be stunted as children of secondary-educated women (Bicego and Boerma 1993). This association is significant since studies have argued that low weight and height for age are closely associated with future mortality (Chen, Chowdhury, and Huffman 1980; Hobcraft 1993).

Education and Anemia Prevalence and Severity among Children

The relationship between mother's education and child morbidity, specifically, the prevalence and severity of anemia has also been documented in the literature. Hatt and Waters (2006) test whether education and socioeconomic status interact, or act independently, to influence children's risk of illness and death. They find that, after controlling for environmental exposures and biological susceptibility factors, mother's education and socioeconomic status interact in DHS data. Research on the prevalence and severity of child anemia has concluded that children with more educated mothers are less likely to develop anemia and iron deficiency than those with less educated mothers (Choi et al. 2011; Goswmai and Das 2015; Xin et al. 2017). The same relationship was found when decomposing anemic children based on anemic severity; children with more educated parents suffer from less moderate and severe anemia compared to their peers with less educated parents (Assefa, Mossie, and Hamza 2014; Ncogo et al. 2017).

Cross-National Minority Health Inequalities

Finally, a large body of literature, particularly in the United States, has documented persistent and pronounced health disparities between majority and minority ethnic- and racial groups, as well as between-group variation in the relationship between maternal education and child health (Williams and Sternthal 2010). However, less is known about variations across and within countries outside of the United States. According to Bakhtiari, Olafsdottir, and Beckfield (2018), large-scale comparisons of health inequalities associated with minority status have proven difficult due to the challenge of disentangling the similarities and differences in social determinants between groups and across context. I attempt to address this gap and overcome these methodological and conceptual issues by considering the context of indigenous minorities in Guatemala and Bolivia. Since the historical configurations of boundaries of identity, as well as the institutionalization of inequality through phenotypical markers of color-, culture-, and linguistics-coded ethnicity, are quite similar in both contexts, I will be able to compare health inequalities among and between ethnolinguistic minority groups (Foner 2015).

Drawing on previous research, I hypothesize that mother's education has a negative relationship with under-5 mortality, low birth weight, and prevalence and severity of anemia in children in Guatemala and Bolivia. Second, I hypothesize that mothers use of prenatal-, natal-, and postnatal-care, and general positive child healthcare, will mediate the relationship between mother's education and child health. Given previous work on the inequalities of access and utilization of maternal health-care services (Ahmed et al. 2010; Elo 1992; Raghupathy 1996; Thomas et al. 1991), research has shown that the relationship between mother's education and children's health outcomes will differ based on prenatal-, natal-, and post-natal care. As might be expected, it will also differ based on general child healthcare. Third, I hypothesize that the relationship between mother's education and children's health will differ based on household's ethnolinguistic identity in Guatemala and Bolivia. Children of households that identify as ethnically and linguistically "indigenous" will fare worse than children of households that identify as ethnically and linguistically "ladino." Indigenous people have higher rates of mortality and morbidity indicators than their non-indigenous counterparts, as well as, less access and utilization to prenatal-, natal-, and postnatal-care (Casas et al. 2001; Plant 1998).

METHODS

Data

This analysis uses pooled cross-sectional DHS data from two Latin American countries: Guatemala and Bolivia. The DHS is a publicly available nationally representative survey of women ages 15-49 collected by ICF International in collaboration with host country governments (ICF International 2012). The standardized questionnaires across countries allow for easy cross-country comparisons for a wide range of socioeconomic and demographic indicators in the areas of population, health, and nutrition. Data for this analysis came from all available survey waves for Guatemala and Bolivia, with the first rounds collected in the mid- to late-1980s and the last round collected in 2014-2015. The DHS waves included were the following: Guatemala 1987, 1995, 1998-1999, and 2014-2015; and, Bolivia 1989, 1994, 1998, and 2003, and 2008.

Measurement

Outcome Variables: Under-5 Mortality, Low Birth Weight, and Prevalence and Severity of Anemia

The outcomes of interest in this study are under-5 mortality, low birth weight, prevalence and severity of anemia, and child stunting among children in Guatemala and Bolivia. The first outcome, under-5 mortality, measures whether a woman's child died before the age of five, which corresponds to 60 months. The second outcome, low birth weight, measures whether a woman gave birth to a child weighing less than 5.467464 pounds.[1] In line with previous research and theory, I dichotomized under-5 mortality and low birth weight because dichotomization has been identified as an optimal specification that will produce the variables' strongest effects (Koenig et al. 1990; Palloni et al. 2009).

In addition, I measured child nutritional status as both prevalence and severity of anemia, as well as stunting. The third outcome, prevalence and severity of anemia measures whether a child has anemia, and whether it is mild, moderate, or severe. Thus, this outcome is measured as an ordinal scale measuring whether the child is or is not anemic, and if they are anemic, whether they are mildly, moderately, or severely anemic. However, I dichotomize this variable to test for Hypothesis 4 for ease in analyzing the multilevel results. Finally, the last outcome, stunting, measures whether a child's height-for-age Z-scores (HAZ) fall within –2 standard deviations below the median height for age curve.[2] Stunting is an anthropometric index of height-for-age that reflects pre- and post-natal growth, and deficits in height-for-age measure long-term and cumulative effects of nutritional and/or health inadequacies (Haddad and Gillespie 2001). Stunting was measured as a dichotomous variable indicating whether or not the child is too short for his/her age.

Although other measures of nutritional status exist, such as wasting, which measures low weight-for-height (de Onis et al. 2006), stunting was preferred for this analysis because wasting is very low throughout the region (Ruel and Menon 2002) and is not influenced as much by maternal characteristics as is stunting (Frost et al. 2005). I propose to test alternative specifications for these variables, as continuous and as a set of indicators characterizing possible combinations of thresholds, such as mortality under one, one to two, three to four, and four to five years, and very low, low, and normal birth weight.

Explanatory Variables: Maternal Education, Age, Household Type, and Region

I controlled for several other factors that potentially confound the relationship between my independent and dependent variables of interest. The main independent variable of concern is maternal education in single years, recoded into educational categories: 0 years, 1-3 years, 4-6 years, 7-

[1] I use the definition of Low Birth Weight (LBW) established by the World Health Organization (WHO) as weight at birth less than 2500 g (5.5 lb.) (World Health Organization 2014)

[2] I use the definition of stunting established by the World Health Organization (WHO), the National Center for Health Statistics (NCHS), and the Center for Disease Control (CDC), which defines HAZ less as less than –2 SD from the mean (de Onis et al. 2006).

9 years, and ≥10 years. In addition, I control for other measures at the individual and community-level, such as mother's educational attainment, literacy, age, health insurance, region, and ethnicity.

Other Explanatory Variables: Socioeconomic Status, Health Care Utilization, and Child Feeding Indices

To control for multiple determinants of child health outcomes, I create additive indices to operationalize the effects of household's socioeconomic status, prenatal, natal, and postnatal health care utilization, and a child feeding index. To construct these indices, I first selected variables that seem to measure the underlying construct of each variable, focusing on key dimensions of these indices, namely type, quality, and frequency into a composite index. The characteristics will be constructed separately for each country and for urban and rural areas in each country because the characteristics that define child healthcare are expected to differ from one country to the other, and between urban and rural areas within countries. Then, I performed a factor analysis to determine how well each set of variables factored together, omitting obvious outliers. All variables used will be categorical and ranked by ascending order. **Table 1** shows factor loadings, Cronbach's alpha, and sample proportions for variables included in each index.

Drawing on previous research, socioeconomic status is operationalized through one main index, measuring household wealth and environment, ranging from 0 to 8 (Frost et al. 2005). This variable measures the presence of consumer durables in a household, including radio, television, refrigerator, and telephone, as well as, overall living conditions, such as the presence of piped drinking water, a flush toilet facility, electricity, and a non-dirt floor(Ruel and Menon 2002). Building on the Integrated Management of Childhood Illness (IMCI) strategy, prenatal, natal, and postnatal health care utilization will be operationalized into two categories. [3] First, prenatal and natal health care was measured using information on whether mother's received prenatal care from doctor or nurse, whether a doctor or nurse attended the birth, whether a woman delivered their baby at home, whether they received tetanus injection before birth, and whether she has used modern method of contraception. Second, postnatal health care utilization was measured using information on whether children received follow-up medical visits. The selection criteria for the inclusion of individual variables into the final factor will be that the loadings have a value greater or equal to 0.50. The main purpose of creating the index for each country and region will be to categorize households into healthcare terciles (poor, average, and excellent), and to control for child healthcare in the regression analyses.

Finally, drawing on previous research, child's nutritional status is operationalized through one main index, based on current feeding recommendations for children 0-60 months (Brown, Dewey, and Allen 1998; Ruel and Menon 2002; The Linkages Project 1999). Optimal feeding practices were defined for 5 different age groups: 0–6 months, 6–9 months (breast-feeding plus gradual introduction of complementary foods); 9–12 months (same as 6–9 but increasing the amount and frequency of complementary feeding); 12–36 months (continued breast-feeding for as long as possible, gradual transition to the family diet and focus on dietary quality), and 36–60 months. The use of baby bottles was considered an inappropriate practice at all ages. The following variables were used in the index creation: breastfeeding (whether the mother is currently breastfeeding the child or not); use of baby bottles in the previous 24 hours (yes/no); dietary diversity (whether or not the child received selected food groups in the previous 24 hours); food frequency (how many days the child received selected

[3] IMCI is an integrated approach developed by the WHO, UNICEF, and other stakeholders, to address child health that focuses on the well-being of the whole child. IMCI aims to reduce death, illness and disability, and to promote improved growth and development among children under five years of age. IMCI includes both preventive and curative elements that are implemented by families and communities as well as by health facilities (Tulloch 1999).

food groups in the past 7 days); and feeding frequency (how many times the child was offered solid or semisolid foods in the previous 24 hours (including meals and snacks).

The list of variables and the scoring system used to create the child feeding index for the different age groups are presented in **Table 2**. The general scoring system was to assign a score of "0" for a potentially harmful practice and a positive score of "1" for a positive practice. Practices considered particularly important at a given age, such as breast-feeding between 6 and 12 months of age or feeding the child animal products regularly between 12 and 36 months of age received a score of "2". As indicated above, practices were considered positive or negative on the basis of current child feeding recommendations and available scientific evidence about their benefits or risks (Brown et al. 1998; The Linkages Project 1999).

ANALYSIS

First, to test Hypothesis 1, which explores the relationship between mother's education and under-5 mortality, low birth weight, and prevalence and severity of anemia among children, I will conduct logistic regression analyses for Guatemala and Bolivia. In the first model, I control for mother's years of education and educational attainment, literacy, age, household type, household wealth, health insurance, region, and ethnicity. I use a mixture of logistic and ordered logistic regression models. I propose to use logistic regression models for under-5 mortality and low birth weight, given their dichotomized nature. I then use an ordered logistic regression model for prevalence and severity of anemia among children because my outcome of interest is an ordinal realization of an underlying continuous variable (Winship and Mare 1984). The largest limitation of this methodological strategy is that I can capture associations only and not the causal effect of mother's educational attainment child health outcomes.

Second, I will test for Hypothesis 3, which explores differences by household's ethnolinguistic identity. I will control for ethnolinguistic identity by respondent's reported language spoken at home and ethnic self-identification. In this next part of the analysis, I will include interactions by ethnolinguistic identity and mother's education to assess whether the effect of mother's education on children's health differ by ethnolinguistic identity. Finally, I include three-way interactions with mother's education, healthcare utilization, and ethnolinguistic identity to determine whether child health outcomes differ by these constraints. Again, while I only include Guatemala and Bolivia in the proposal stage, I plan to include four other Latin American countries with large indigenous populations to ensure a large enough sample to test for ethnolinguistic heterogeneity. For the dissertation phase, I propose to include Peru (47% indigenous; *n*= 558,676), Ecuador (42.99% indigenous; *n*=11,835), Honduras (14.99% indigenous; *n*= 99,356), and Mexico (13.99% indigenous; *n*=22,676) (Montenegro and Stephens 2006)

Then, I test for Hypothesis 4, by exploring cross-regional and cross-country variation of the relationship between female education and under-5 mortality, low birth weight, and prevalence of anemia among children in Guatemala and Bolivia. I ran preliminary multilevel logistic regression models using the full sample (*n*=95,713), to estimate the relationship between female education and under-5 mortality, low birth weight, and prevalence of anemia in children at the individual, regional, and country level. I am proposing to use multilevel models to test Hypothesis 4 because this methodology provides conceptual and methodological advantages that both traditional linear and nonlinear models cannot address. For instance, multilevel models provide a way to study multilevel data, particularly, how the macro-context affects the impact of a covariate at the micro-level (Guo and Zhao 2000). More technically, methodologists have also addressed the advantages of multilevel models in correcting for biases in parameter estimates resulting from clustering, correcting for standard errors and corresponding confidence intervals and significance tests, and estimating variance and covariance of random effects at various levels (Guo and Zhao 2000; Pebley, Goldman, and Rodriguez 1996).

To test for Hypothesis 4, I propose to link the micro and macro levels of analysis through two-level multilevel approach to study child health outcomes, where individual women units (level 1) are nested within regional units (level 2). In the first level, individual characteristics have effects on variations in women's education on child health outcomes. At the second level, regional characteristics are predicted to have independent effects as well as to moderate the effects of women's education on child health outcomes. In addition, to test for cross-country differences, I include a cross-level interaction between country indicators and mother's education. The sample for the first level includes 95,713 observations and the sample for the second level includes 17 observations.

Although I only include Guatemala and Bolivia in the proposal stage, I will add another four Latin American countries with large indigenous populations. This larger sample will allow me to test for Hypothesis 3, which assesses ethnolinguistic majority-minority heterogeneity in the relationship between maternal education and child health. I propose to include Peru (47% indigenous; *n*= 558,676), Ecuador (42.99% indigenous; *n*=11,835), Honduras (14.99% indigenous; *n*= 99,356), and Mexico (13.99% indigenous; *n*=22,676) (Montenegro and Stephens 2006). The final version of the dissertation will include approximately 788,256 individuals from 75 regions and from the 6 countries. Expanding the data to include the full sample will increase the sample size, particularly at the regional level, to yield unbiased estimates of the second-level standard errors (Maas and Hox 2005).

The dependent variables of the multi-level regression model are under-5 mortality, low birth weight, and prevalence of anemia in Bolivia and Guatemala between 1985 and 2015. I control for mother's and family's socioeconomic and demographic characteristics. Specifically, the multilevel models provide estimates of the variance in the outcome variables that is due to unobserved regional factors, generally known as the random effect (Bingenheimer and Raudenbush 2004). Accordingly, all models include a random intercept at the regional level and a random coefficient for mother's education to capture heterogeneity among clusters. Equation 1 presents the two-level combined model to be used.

$$\log\left[p_{ij}/\left(1-p_{ij}\right)\right] = \beta_0 + \beta_1 x_{ij} \cdots \beta_k X_k + u_j \qquad \text{Eq. (1)}$$

Where y_{ij} is a binary (1) under-5 mortality, (2) low birth weight, (3) prevalence of anemia response for women i in region j. I define the probability of the response equal to one as $p_{ij} = \Pr(y_{ij} = 1)$ and let p_{ij} be modeled using a logit link function. In addition, x_{ij} is an explanatory variable at the individual woman level and u_j is the random effect at level two. Table 3 reports the multilevel results for the three outcomes.

RESULTS

Sample Characteristics

Table 1 provides descriptive statistics of the variables included for Guatemala (1987, 1995, 1998-1999, and 2014-2015) and Bolivia (1989, 1994, 1998, and 2003, and 2008).

[Table 1 Here]

Table 2 contains the results of logistic and ordered logistic regressions predicting under-5 mortality, low birth weight, and prevalence and severity of anemia among children in Guatemala and Bolivia. In line with Hypothesis 1, preliminary findings suggest a negative relationship between mother's education and under-5 mortality, low birth weight, and severity and prevalence of child anemia. However, the results also suggest heterogeneous trends for women in rich and poor regions and between the two countries.

[Table 2 Here]

Individual and Household-Level Models

Under-5 Mortality

Table 2 suggests that there is some partial support for Hypothesis 1, which predicts that mother's education has a negative relationship with under-5 mortality, low birth weight, and prevalence and severity of anemia in children in Guatemala and Bolivia. Women in Guatemala with 4-6 years of education have 46.21% predicted odds of having a child die before the age of 5, compared with women in Guatemala with zero years of education and controlling for the other variables in the model (odds ratio 0.859; p-value<0.000). The effect of higher maternal education on early childhood survival increases for more educated women. For instance, women in Guatemala with 10+ years of education only have 37.07% predicted odds of having a child die before the age of 5, compared with women in Guatemala with zero years of education and controlling for the other variables in the model (odds ratio 0.589; p-value<0.000). The difference in the predicted odds of having a child die before the age of 5, between more educated and less educated women, and compared to women with zero years of education, is 9.14%.

Preliminary findings suggest a similar story in Bolivia, where higher maternal education translates into child survival advantages. For example, women in Bolivia with 1-3 years of education have 62.04% predicted odds of having a child die before the age of 5, compared with women in Bolivia with zero years of education (odds ratio 1.635; p-value<0.000). The predicted odds of early childhood death decrease with higher maternal education. For example, women in Bolivia with 4-6 years of education have 59.36% predicted odds of having a child die before the age of 5, compared with women in Bolivia with zero years of education (odds ratio 1.461; p-value<0.000). The difference in the predicted odds of having a child die before the age of 5, between more educated and less educated women, and compared to women with zero years of education, is 2.68%. Thereafter, the relationship loses statistical significance among more educated women, which I interpret as the result of the diminishing returns to child health premiums as women gain more education.

Low Birth Weight

As it pertains to low birth weight, preliminary results indicate that the odds of having a child born underweight is higher for less educated women than for their more educated counterparts. For example, women in Guatemala with 4-6 years of education have 41.76% predicted odds of having a child born underweight, compared with women in Guatemala with zero years of education and controlling for the other variables in the model (odds ratio 0.717; p-value<0.000). The predicted odds of having a child born underweight decreases with maternal education. For example, women in Guatemala with 7-9 years of education only have 37.23% predicted odds of having a child born underweight, compared with women in Guatemala with zero years of education and controlling for the other variables in the model (odds ratio 0.593; p-value<0.000). The difference in the predicted odds of having a child born underweight, between these two groups of women, compared to women with zero years of education, is 4.53%.

I find a similar pattern for Bolivia, where higher maternal education is associated with lower predicted odds of having a child born underweight. For example, women in Bolivia with 1-3 years of education have 21.51% predicted odds of having a child born underweight, compared with women in Bolivia with zero years of education (odds ratio 0.274; p-value<0.000). While the odds increase slightly to 24.30% for women in Bolivia with 4-6 years of education (odds ratio 0.321; p-value<0.000), it goes down among more highly educated women. For instance, women in Bolivia with 7-9 years of education only have 19.87% predicted odds of having a child born underweight, compared with women in Bolivia with zero years of education (odds ratio 0.248; p-value<0.000).

Prevalence and Severity of Anemia

Unexpectedly, preliminary results suggest that the odds of having a child with more severe anemia are higher for women with more education in Guatemala. For example, women in Guatemala with 1-3 years of education have 56.02% predicted odds of having a child with more severe anemia, compared with women in Guatemala with zero years of education and controlling for the other variables in the model (odds ratio 1.274; p-value<0.000). This unexpected, yet statistically significant, trend increases with maternal education. For example, women in Guatemala with 10+ years of education have 64.63% predicted odds of having a child with more severe anemia, compared with women in Guatemala with zero years of education and controlling for the other variables in the model (odds ratio 1.827; p-value<0.000). The relationship between maternal education and child anemia is not significant in Bolivia.

Table 3 contains the results of the multilevel logistic regression models predicting under-5 mortality, low birth weight, and prevalence of anemia among children in Guatemala and Bolivia. In line with Hypothesis 4, preliminary findings suggest variation in the relationship between educational attainment and child health outcomes across countries and regions. Countries and regions that are more developed and rich experience lower under-5 mortality, low birth weight, and prevalence of child anemia compared to poorer and rural regions.

[Table 3 Here]

Regional and Country Variations

Preliminary findings presented in Table 3 suggest that there is some partial support for Hypothesis 4, which predicts variation in the relationship between educational attainment and child health outcomes across countries and regions. Similarly, to the results presented in Table 2, women in Bolivia have 71.29% predicted odds of having a child die before the age of 5 compared to women in Guatemala (odds ratio 2.483; p-value<0.000) and 82.72% predicted odds of having a child suffering from anemia compared to women in Guatemala (odds ratio 4.787; p-value<0.000). However, they only have 22.12% predicted odds of having a low birth weight compared to women in Guatemala (odds ratio 0.284; p-value<0.000). Relative to the interaction between country and women's education, women in Bolivia with 1-3 years of education and 4-6 years of education have a respective 53.13% and 55.84% predicted odds of having a child die before the age of 5 compared to women in Guatemala with zero years of education (odds ratio 1.134 and 1.265; p-value<0.000). The opposite is true concerning child anemia given that more educated women in Bolivia do have an advantage over uneducated women in Guatemala.

Results from the two-level logistic regression model confirm that there is statistically significant variance in region level fertility. The estimated variance of the region level intercepts for Model 1 is 0.226 and is statistically significant (p-value<0.000), for Model 2 is 0.149 and is statistically significant (p-value<0.000), and for Model 3 is 0.297 and is statistically significant (p-value<0.000). The same is true for the estimated variance of the slope of women's education across regions, although it is not significant for low birth weights. However, this variance is small and to an extent not meaningful, which suggests that the relationship between female education and fertility in these two Latin American countries is very similar. Table 3 reports the multilevel Poisson regression results of the three nested models.

DISCUSSION

This preliminary analysis provides an important step in unpacking the relationship between mother's educational attainment and child health outcomes in Latin America. I plan to extend this work in the future in several ways. First, I will test for Hypothesis 2, which explores the mediating effect of prenatal-, natal-, and postnatal-care utilization on the relationship between mother's education and child health. I will conduct nested logistic regression analyses to see the effect of the introduction of these variables on the models used to test Hypothesis 1. I will control for the same variables listed earlier and operationalize prenatal-care use by controlling for the effects of reported prenatal-care utilization. In addition, I operationalize natal-care use by controlling for the effects of reported assistance during birth. Finally, I operationalize postnatal-care use by controlling for postnatal reported utilization.

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APPENDIX

Table 1: Descriptive Statistics of the Dependent and Indepent Variables, by country, 1986-2015

Measure	**Bolivia**		**Guatemala**	
	Mean	**S.D.**	**Mean**	**S.D.**
Under-5 Mortality	0.430	0.495	0.332	0.471
Low Birth Weight	0.007	0.086	0.020	0.138
Anemia	1.827	1.592	1.252	0.548
Women's Education				
1-3 years	0.266	0.442	0.264	0.441
4-6 years	0.244	0.429	0.171	0.376
7-9 years	0.118	0.322	0.046	0.208
≥10 years	0.196	0.397	0.072	0.258
Highest Educational Attainment	1.167	0.787	0.722	0.711
Literacy	2.397	0.835	1.937	0.903
Age	36.320	7.875	35.588	8.068
Type of residence (ref. rural)	0.534	0.499	0.303	0.459
Wealth	2.720	1.368	2.764	1.370
Health Insurance (ref. no)	0.227	0.419	0.099	0.299
Region	0.187	0.390	0.238	0.426
Ethnicity	0.713	5.028	0.557	0.497

Table 2: Logit coefficients for the effect of women's education on under-5 mortality, low birth weight, and anemia, by variable and by country, 1986-2015

	Bolivia												**Guatemala**											
Measure	**Under-5 Mortality**				**Low Birth Weight**				**Anemia**				**Under-5 Mortality**				**Low Birth Weight**				**Anemia**			
	Odds Ratio		95% C.I. Low	95% C.I. High	Odds Ratio		95% C.I. Low	95% C.I. High	Odds Ratio		95% C.I. Low	95% C.I. High	Odds Ratio		95% C.I. Low	95% C.I. High	Odds Ratio		95% C.I. Low	95% C.I. High	Odds Ratio		95% C.I. Low	95% C.I. High
Women's Education																								
1-3 years	**1.635**	***	1.440	1.856	**0.274**	**	0.121	0.621	1.061		0.889	1.265	1.101		0.977	1.241	**0.705**	***	0.529	0.941	**1.274**	***	1.130	1.437
	(0.106)				(0.114)				(0.095)				(0.067)				(0.104)				(0.078)			
4-6 years	**1.461**	***	1.268	1.682	**0.321**	**	0.131	0.785	0.887		0.725	1.086	**0.859**	**	0.753	0.981	**0.717**	*	0.523	0.983	**1.411**	***	1.236	1.610
	(0.105)				(0.146)				(0.092)				(0.058)				(0.116)				(0.095)			
7-9 years	1.160		0.986	1.366	**0.248**	**	0.095	0.645	1.108		0.881	1.394	**0.721**	***	0.562	0.924	**0.593**	*	0.352	1.000	**1.852**	***	1.473	2.327
	(0.096)				(0.121)				(0.130)				(0.091)				(0.158)				(0.216)			
≥10 years	1.037		0.821	1.310	**0.211**	**	0.074	0.608	1.170		0.863	1.586	**0.589**	***	0.451	0.769	0.955		0.549	1.662	**1.827**	***	1.429	2.337
	(0.124)				(0.114)				(0.181)				(0.080)				(0.227)				(0.229)			
Highest Educational Attainment	**0.637**	***	0.580	0.698	**1.575**	**	1.185	2.094	0.978		0.876	1.091	**0.762**	***	0.684	0.848	1.226		0.969	1.550	**0.826**	***	0.745	0.917
	(0.030)				(0.229)				(0.054)				(0.042)				(0.147)				(0.044)			
Literacy	**0.838**	***	0.800	0.877	1.384		0.931	2.058	0.930		0.868	0.997	**0.932**	***	0.894	0.971	1.022		0.910	1.148	**0.907**	***	0.868	0.948
	(0.020)				(0.280)				(0.033)				(0.020)				(0.060)				(0.020)			
Age	**1.086**	***	1.082	1.089	**0.879**	***	0.866	0.892	**0.968**	***	0.964	0.972	**1.087**	***	1.083	1.090	**0.879**	***	0.872	0.886	**0.967**	**	0.964	0.970
	(0.002)				(0.007)				(0.002)				(0.002)				(0.003)				(0.001)			
Type of residence (ref. rural)	1.044		0.976	1.116	**1.555**	**	1.119	2.161	0.976		0.886	1.074	1.041		0.987	1.097	1.126		0.987	1.286	**0.937**	***	0.890	0.988
	(0.036)				(0.261)				(0.048)				(0.028)				(0.076)				(0.025)			
Wealth	**0.791**	***	0.770	0.813	1.075		0.946	1.222	**0.861**	***	0.827	0.895	**0.813**	***	0.795	0.831	**0.890**	***	0.840	0.942	**0.894**	***	0.874	0.914
	(0.011)				(0.070)				(0.017)				(0.009)				(0.026)				(0.010)			
Health Insurance (ref. no)	0.963		0.909	1.021	1.199		0.935	1.538	0.964		0.890	1.045	**1.171**	***	1.065	1.287	0.879		0.717	1.077	0.984		0.907	1.068
	(0.029)				(0.152)				(0.040)				(0.057)				(0.091)				(0.041)			
Region	**1.205**	***	1.126	1.289	0.931		0.670	1.294	**0.710**	***	0.643	0.784	1.046		0.990	1.106	1.060		0.927	1.213	**1.083**	**	1.028	1.142
	(0.042)				(0.156)				(0.036)				(0.030)				(0.073)				(0.029)			
Ethnicity	0.942		0.830	1.069	1.223		0.708	2.114	0.991		0.841	1.167	0.973		0.927	1.021	**0.816**	***	0.723	0.919	1.040		0.991	1.091
	(0.061)				(0.341)				(0.083)				(0.024)				(0.050)				(0.026)			
N	**40024**				**40024**				**14269**				**55247**				**54985**				**54483**			

Notes: * p<0.05, ** p<0.01, *** p<0.001

Table 3: Multilevel logit coefficients for the effect of women's education on under-5 mortality, low birth weight, and anemia, by variable for Guatemala and Bolivia, 1986-2015

Measure	Under-5 Mortality				Low Birth Weight				Anemia			
	Odds Ratio		95% C.I. Low	95% C.I. High	Odds Ratio		95% C.I. Low	95% C.I. High	Odds Ratio		95% C.I. Low	95% C.I. High
Women's Education												
1-3 years	**1.127**	*	1.024	1.240	**0.625**	***	0.503	0.778	1.062		0.962	1.173
	(0.049)				(0.112)				(0.051)			
4-6 years	**0.84**	**	0.736	0.958	**0.625**	***	0.501	0.779	1.124		0.992	1.273
	(0.067)				(0.112)				(0.064)			
7-9 years	**0.788**	*	0.624	0.994	**0.422**	***	0.285	0.624	**1.423**	**	1.150	1.759
	(0.119)				(0.200)				(0.108)			
≥10 years	**0.668**	***	0.511	0.874	**0.612**	*	0.404	0.928	**1.380**	*	1.077	1.767
	(0.137)				(0.212)				(0.126)			
Bolivia (ref. Guatemala)	**2.483**	***	1.974	3.124	**0.284**	***	0.172	0.470	**4.787**	***	3.512	6.526
	(0.117)				(0.257)				(0.158)			
Bolivia x 1-3 years (ref. Guatemala x 0 years)	**1.134**	*	1.012	1.271	0.797		0.444	1.428	0.922		0.792	1.073
	(0.058)				(0.298)				(0.077)			
Bolivia x 4-6 years (ref. Guatemala x 0 years)	**1.265**	**	1.073	1.492	1.128		0.658	1.932	**0.702**	***	0.585	0.842
	(0.084)				(0.275)				(0.093)			
Bolivia x 7-9 years (ref. Guatemala x 0 years)	1.058		0.818	1.367	1.516		0.843	2.726	**0.736**	*	0.574	0.945
	(0.131)				(0.300)				(0.127)			
Bolivia x 10+ years (ref. Guatemala x 0 years)	1.008		0.748	1.357	1.260		0.745	2.132	0.801		0.609	1.054
	(0.152)				(0.268)				(0.140)			
Highest Educational Attainment	**0.671**	***	0.625	0.720	**1.403**	***	1.175	1.675	**0.869**	***	0.804	0.939
	(0.036)				(0.090)				(0.040)			
Respondent Age	**1.087**	***	1.084	1.089	**0.879**	***	0.873	0.885	**0.970**	***	0.967	0.972
	(0.001)				(0.004)				(0.001)			
Type of residence (ref. rural)	1.026		0.984	1.069	1.216	**	1.076	1.374	0.980		0.935	1.027
	(0.021)				(0.062)				(0.024)			
Wealth	**0.796**	***	0.782	0.809	**0.917**	***	0.871	0.965	0.878	***	0.861	0.895
	(0.009)				(0.026)				(0.010)			
Health Insurance (ref. no)	**1.054**	*	1.000	1.110	0.947		0.811	1.106	**1.071**	*	1.007	1.139
	(0.027)				(0.079)				(0.031)			
Constant	**0.029**	***	0.025	0.035	**2.081**	***	1.592	2.721	1.033		0.822	1.299
	(0.094)				(0.137)				(0.117)			
Random-effects Parameters												
region												
sd(women's education in single years)	**0.067**	***	0.044	0.104	0.000		0.000	.	**0.058**	***	0.037	0.092
	(0.220)				(1.67e+05)				(0.233)			
sd(constant)	**0.226**	***	0.158	0.324	**0.149**	***	0.079	0.279	**0.297**	***	0.2	0.442
	(0.183)				(0.321)				(0.202)			
N	**95713**				**95273**				**68904**			
chi2	6666.672				1715.683				1235.121			

Notes: * p<0.05, ** p<0.01, *** p<0.001

ANNEX 2: DESCRIPTION OF VARIABLES USED IN THE ANALYSIS

Variable	**Description**
Dependent Variables	
Under-5 Mortality	Coded as: (1="yes; died before the age of 5"; 0="no; did not die before the age of 5")
Low birth weight	Coded as: (1="yes; born weighing<=5.467464"; 0="no; born weighing>=5.511557")
Prevalence and Severity of Anemia	Coded as: (1="not anemic"; 2="mild"; 3="moderate"; 4="severe"); Coded as (1="anemic"; 0="not anemic") for Hypothesis 4 only
Independent Variables: Education	
Years of Schooling	Coded as: (0="0"; 1="1-3"; 2="4-6"; 3=">10")
Highest educational level	Coded as: (0="no education"; 1="primary"; 2="secondary"; 3="higher")
Literacy	Coded as: (1="cannot read"; 2="reads with difficulty"; 3="reads easily")
Independent Variables: Household and Respondent Characteristics	
Woman's Current Age	Coded as continuous (15-49="15"-"49")
Type of Place of Residence	Coded as: (0="rural"; 1="urban")
Wealth Index	Coded as: (0="poorest"; 2="poorer"; 3="middle"; 4="richer"; 5="richest")
Covered by Health Insurance	Coded as: (1="yes"; 0="no")
Region of Residence	For Guatemala coded as: (1="guatemala & sud-occidental"; 0="central, noroccidental, and other"); for Bolivia coded as: (1="valle"; 0="altiplano, llano, and other")
Ethnolinguistic Identity	Coded as: (1="espanol/ladino"; 0="ethnic & other")
Multilevel Variables: Contextual	
Region	Coded as continuous: (Bolivia 1-9; Guatemala 10-17)
Country	Coded as continuous: (0="Guatemala"; 1=" Bolivia")

ANNEX 2: CHILD HEALTHCARE VARIABLES FOR PCA ANALYSIS

Promotion of Growth, Prevention of Disease	Variables	Response to Sickness	Variables
Breastfeeding/ Early Nutrition	Fed food in bottle with nipple	**Early Care Management**	Baby postnatal check within 2 months
	Breastfed child in first days		
	Number of times breastfed during the day and night		Assistance with newborn
	Age when started to give other liquids or foods besides breast milk		Took children to get vaccinations
Developmental Nutrition	Gave child any dark green leafy vegetables		
	Gave child any other fruits		When child had a cough, taken to seek help (health clinic, pharmacy, private hospital, public hospital, private practice doctor, traditional medicine, somewhere else) Used national and/or state programs for mothers and children
	Gave child baby cereal		
	Gave child baby formula		
	Gave child cheese yogurt other milk products		
	Gave child chocolates, sweets, candies, pastries, etc.	**Appropriate Care Seeking Behavior**	When child is seriously ill, can decide whether they should seek medicine
	Gave child cows or goats milk		
	Gave child eggs, fish, poultry		
	Gave child fish or shellfish		
	Gave child food made from beans, peas, lentils, nuts		
	Gave child fresh milk		
	Gave child herbal tea		
	Gave child liver, heart, other organs		
	Gave child mangoes, papayas, other vitamin A fruits		
	Gave child meat		
	Gave child oil, fats, butter, products made of them		
	Gave child other liquid		
	Gave child other porridge/gruel		
	Gave child plain water		
	Gave child powder/tinned milk		
	Gave child powdered milk		
	Gave child pumpkin, carrots, squash (yellow or orange inside)		
	Gave child solid or mushy food		
	Gave child sugar water		
	Number of times given the above food and when did they start eating it		
Micronutrient Supplementation	Frequency using "nutribebé" complementary feeding		

	Frequency using micronutrient sprinkles		
Prevention of Disease	Where was the baby checked for the first time		
	Disposal of youngest child's stools when not using toilet		
	Precautions when preparing food: wash hands		Followed treatment prescribed
	Precautions when preparing food: wash utensils		
	Precautions when preparing food: boil, wash utensils		
	Precautions when preparing food: other		
	Food leftovers are stored in a controlled environment		
	Bottle food stored in a controlled environment		
	Drinking water is boiled/filtered		
	Wash hands with water and soap		
	Wash hands before preparing last meal, after cleaning baby, before eating, after using toilet		
	Wash fruits and vegetables		
	Use soap or detergent to bathe children and self		
	Disposes garbage		
	Household has a bednet		