Child Health in Peru: Importance of Regional Variation and Community Effects on Children's Height and Weight

Heeju Shin

Department of Sociology

University of Texas at Austin

March 1, 2005

1. Introduction

Child health has been important issue in most countries for policy makers because of its short-term and long-term effect not only on individual but also on society. As one of the vital indicators of nutritional condition, children health is the sign of the development level of the society especially in developing countries. For human being, intelligence, personality, and social behavior develop most rapidly during their earliest years. It is believed that half of all intellectual development potential is established by age four. For example, many studies conducted in the U.S. during 1960-1970s confirmed that intervention and good quality of care in the early child's life has lasting positive effects (Smith & Haddad, L. 2000). From the human capital perspective, health status in childhood is believed to determine health of next generation as well as socioeconomic status in adulthood through its human capital formation (Case, Lubotsky, and Paxson, 2002).

Among various factors which have an influence on child health, maternal education has been regarded as the most important and strongest one. Since Caldwell's study of Nigeria (1979), many researchers have studied the relationship of maternal education to child health in various contexts. Relying on the demographic studies, public policy discourse has assumed that investments in women's education are important for improving child health (World Bank, 1993).

In this paper, however, I argue that regional differences have stronger explanatory power for child health than any other factors by comparing regression models. Hence, I suppose that significant part of observed correlation between maternal education and various markers of child health might have been mediated by regional differences. Also, using fixed effect model, I will show the extent to which unobserved community specific characteristics reduces the effect of maternal education on health outcome. Consequently, my object of this study is to show that public policies emphasizing investment in women's education as an important method of improving child health in developing countries might be not efficient as much as it has been stressed, although such investments may have other social benefits.

Using Peruvian Demographic and Health Surveys, I will demonstrate the relationship of height-for-age and weight-for-age of children to maternal education, regional difference, and health care behavior in Peru.

2. Maternal Education and Child Health

Prevailing studies of relationship between maternal education and child health focus on changes in mother's health care behavior through formal education (Caldwell, 1979; Mosley and Cowley, 1991; World Bank 1993). In his study of Nigeria, Caldwell argues that maternal education is the single most significant determinant of child mortality, and cannot be employed as a proxy for general social and economic change but must be examined as an important force in its own right (Caldwell, 1979; Caldwell 1993). Especially for the countries in transition from traditional into modern society, women play a key role in improving family health in various ways as they become get involved in decision making process in family. First, educated mothers are more likely to break with tradition or become less fatalistic about illness, and adopt many of the alternatives in child care that become available in the rapidly changing society. Second, educated mothers are more capable of manipulating the modern world and knowledgeable about good diets and hygiene. Also, they can communicate with modern medical service provider better than not educated ones. Third, as a child care provider in the family, educated mother greatly changes the traditional balance of familial relationships, and may have enough status and power to take appropriate action when her child needs health care (Caldwell, 1979; Mosley and Cowley, 1991).

Many researches, however, has also approved that maternal education has an effect on child health through various socioeconomic mediators in which education serves as human capital rather than been focusing on direct role of educated mother in family (Desai and Alva,1998; Schultz, 1984; Ware 1984). For example, maternal schooling reflects a higher standard of living and access to financial or other resources because better educated women are more likely to marry wealthier men who can mobilize the health care resources easily or through their own increased earnings (Schultz, 1984, Ware 1984). Behrman and Wolfe regard social background as social capital antecedent to education, and maternal education as proxy of mother's background for explaining child health. From their study of Nicaragua (1987a, 1987b), they suggest that, without controls for the woman's childhood environment, education may serve as a proxy for human capital which includes health-related skills and habits acquired during childhood.

Furthermore, these studies suggest that maternal education works differently in various contexts, putting some doubts on the commonly believed relationship between maternal education and child health (Begrman and Wolfe, 1987b; Muhuri, 1995; Narayan, 1997; Rosenzweig and Schultz, 1982; Shobana, 1996). Especially, the interaction of maternal education with regional or community factors is regarded as affecting health outcome differently. These findings have important meaning especially in the context of developing countries in which regional variation in the living conditions and distribution of health care services is huge. Thus, there is common agreement that differences in health status are not the outcome of one single determinant but of interaction of education with various socioeconomic components[1].

Nevertheless, the regional and community factors themselves have got relatively little attention when explaining the differences in health outcome. As shown in preceding researches, regional differentials may determine the degree of influence of maternal education and importance of education may decrease according to community endowments. However, regional and communal characteristics imply more than mediating of education and health.

For huge regional variation of social and economic development is common attribute of many developing countries such as Peru, public health system of these country cause enormous difference in health outcome. The regional differentials in child mortality may be explained by differences in the provision of social services and basic amenities, the physical and epidemiological environment (Sastry, 1997). Also, living condition or accessibility to public health services of one community may be the explanatory factor for child health which is independent of maternal education. In other words, in areas where such services are readily accessible, they will be used by both educated and uneducated women, and thus the advantage bestowed by schooling on health outcome is narrowed. In this context, my hypotheses are; 1) the effect of regional and communal differences dominates the effect of maternal education, and 2) unobserved community-

[1] On this relationship, some researches argues that health outcome is not so much related to maternal education as it has been believed in that education is not necessarily led to improvement of child health; that decline in mortality occurs in all education groups controlling maternal education; that improvement in mortality seem to occur independent of improvement in female education; mortality can decline without concurrent improvement in education. (Desai and Alva, 1998)

specific characteristics reduce the effect of maternal education on health outcomes. That is, in Peru, contextual inequalities dominate the effect of maternal education.

3. The regional differences in child health in Peru

Peru has one of the highest infant-mortality rates in the Latin American countries. In 2002, infant mortality of Peru was 38.2 per 1,000, which is much higher than contiguous countries such as Chile (9.12), Argentina (16.7), Ecuador (33), and Colombia (23.2) as well as 6.9 per 1,000 in North America. Although infant mortality rate of Peru has sharply decreased from 57.8 per 1,000 on average in 1990[2], it still remains high. Furthermore, sharp regional and residential differentials continue to characterize patterns of infant and child mortality within the country. In 2000, the average infant mortality in rural area in Peru was 53 per 1,000 infants while it was 27 in urban, thus rural has double rate of infant mortality of urban.

Urban-rural and regional differentials in infant and child mortality reflect variations in living conditions, patterns of economic development and the distribution of health-care services within the country(Elo, 1992). Peru can be divided into three distinctive geographic and ecological regions. The coastal area has been historically the most urbanized and industrialized. Relative to coastal areas, the Sierra is agricultural, rural and poor. The rural areas of the Sierra are home to Peru's poorest households while relatively well-off families are concentrated on the coast, particularly in the Lima metropolitan area. Selva, which is the jungle and forested eastern slopes of the Andes and the Amazon River

[2] Infant mortalities presented here are from U.S census bureau. They are slightly different from the estimations of USAID or INEI (Instituto Nacional de Estadística y Informática). I used infant mortality estimations of U.S Census bureau for comparative reason. Other information is from INEI.

basin, has remained the least developed and populated region in Peru, because of its geography and climate.

The differentials of malnutrition of children under 5 years old among these areas are huge. In 2000, 36 percent of children had been suffering from chronic malnutrition in rural area whereas 12 percent in urban. The proportion of chronic malnutrition in urban area has decreased almost 50% since 1986, however, there was only 28 % of decrease in rural area during same time period.

Despite governmental efforts to redistribute health-care facilities and to improve availability of preventive health-care services, access to modern medicine varies widely among the three regions and urban and rural areas. Moreover, the privatization strategy of public health service since early 1990s has also been widening the gap in access and quality of health care service between poor rural and wealthy urban area in Peru.[3]

4. Data

Source of data

The data used for this study are from the Peruvian Demographic and Health Survey (below, DHS) of reproductive-aged women carried out in 2000 with the standard DHS questionnaire[4]. DHS is USAID funded project which collects and provides data and analysis on the population, health, and nutrition of women and children in developing countries. Peruvian DHS survey has been conducted by Instituto Nacional de Estadistica e Informática since 1986, and carried out every 4 years after 1992. This data includes the

[3] For the privatization of public sectors including health and education in Peru, refer to Kim (2000).
[4] The standardized questionnaire includes two sets. One is for the countries with high contraceptive prevalence (type A), and the other is for those with low contraceptive use (Type B). For Peru, as other Latin American countries with low contraceptive use, Type B questionnaire was employed.

information about reproductive behaviors and intentions, contraception, antenatal/ delivery/postpartum care, breastfeeding and nutrition, children's health, status of women, and AIDS or other sexually transmitted diseases as well as the women's and their husbands' background, education, and work experience. In total, 27,843 women, 28,900 households, 1414 communities, and 24 regions were surveyed with the standard DHS questionnaire in 2000 for this data.

My sample is based on the children who were born during last five years (from 0 to 59 months old) prior to the interview date and the information of their mothers. Combining the information of each child under 59 months old with data of their mothers and households, I obtained 13,697 children from 10,499 mothers. Among those cases, only the last child that mothers gave birth during recent 5 years was included.[5] The distribution of the number of children a woman has had is shown in Table 1.

<Table 1 about here>

For facilitating the comparison of a model to the others, I dropped the observations coded as missing for the categories of mother's education, place of residence, health care accessibility, and other independent variables as well as child height and weight. Thus, data for 8127 children and mothers, and 1369 communities were used in this study.

Measurement of child height-for-age and weight for age

The most commonly used measures for assessing child health and risks to survival are anthropometric measurements; height for age and weight for age (Martorell and Ho

[5] DHS data has twin code indicating that the child is single, twin, triple, and so on. In case of twin or more children, I chose only one child from a mother of which order was reported as the first.

1984; V.M.R. Marins and R.M.V.Almeida, 2002). Especially, the growth of children during the first years of life is the measurement defining their health and nutritional condition (Jordan 1984; WHO 1986; INEI, 2000; Mosley and Chen, 1984).

Height for age is the indicator of the longer-term health outcome of children in adulthood. This is not a key indicator of being risk of death or bad health outcome in urgent (Hobcraft, 1993). However, low height for age is widely regarded as indicative of adaptation to routine and chronic malnutrition. On the other hand, weight of age is more closely associated with future mortality, reflecting short term nutritional crisis to a greater extent than height (Martorell and Ho 1984).

To indicate long-term and short-term health outcome of the children, I employed height and weight for age percent of reference median. In DHS data, NCHS/WHO standard is used for reference population.[6] Because my sample includes all the children under 5 years old and their growth rate is different by age, health outcome would be biased if it is represented by height and weight in the unit of centimeter and kilogram. By using the height and weight percent of reference median for each month old, I standardized their difference in height and weight by age.

<Table 2 about here>

Explanatory variables

Measurement of Maternal Education

[6] In the cross national studies of child malnutrition, a child under age five is considered stunted and underweight if the child falls below an anthropometric cut-off of 2 standard deviations below the median height- for- age and weight-for-age Z- score of the United States' National Center for Health Statistics/World Health Organization international reference (Smith & Haddad, 2000).

Maternal education is one of the major explanatory variables in this study. The DHS data provide indicators for the level of maternal education in several ways. Among those measures, I represent maternal education in six categories based on the questions about the highest level and years of education attained, instead of using the total number of years as a continuous variable. The six categories of maternal schooling are: no education, some primary school, primary graduate, some secondary school, secondary graduate, and more than secondary school. From the Table 3, proportion of women with higher education than secondary school is relatively small compared to other levels of education. Accordingly, I don't make subdivisions of highest education group. The average of maternal education attained by women included in my sample is 7.36 and standard deviation is 4.45 years.

Regional and communal variables

To control regional variation, I categorized regions of Peru into 7 areas: Lima metropolitan area, urban coast, urban sierra, urban selva, rural coast, rural sierra, and rural selva following the categorization of Elo (1992). In my preliminary OLS regression, urban-rural variation had significant effect on child health. However, each of coastal, Andean mountain, and jungle area has very distinctive regional and residential characteristics, as described in previous section. For this reason, I suppose that specifically divided regional variable may present more significant result than simple urban-rural control.

In the fixed effect models, unobserved community specific characteristics are controlled. The DHS data doesn't offer community level information to predict regional variation in the availability of health or nutritional utilities shared by residences; for example, in one village everyone had easy access to public health services, while in the other few did; and in each village sanitary conditions, and even access to food, might be similar for all inhabitants regardless of socio-economic characteristics and education.

Utilization of Health Care Service

'Utilization of health care service' is indicated as prenatal care, number of hospital visiting during her pregnancy, and preventive inoculation such as BCG, DPT and Polio to explain mother's health seeking behavior and systemic accessibility to health care services. Prenatal care and number of hospital visiting are mother's retrospective information during her pregnancy of a child who is included in my sample. Therefore, they don't necessarily show mother's present health care behavior. However, I assume that health care utilization during pregnancy has positive relationship to current health care behavior; a mother who had used health care services or visited hospital more often during her pregnancy is more likely to use health care services and concern for health of her child in present as well. Furthermore, the survival of infants and children is heavily depend on the nurturing provided by mother both during the pregnancy and childhood of children (Mosley and Chen, 1984) For this reason, prenatal care and number of visiting during mothers' pregnancy are used as proxy for mother's utilization of health care services for their children.

Prenatal care is coded 1 if a woman has ever received modern prenatal care or assistance from a trained health professional, such as doctor, trained nurse, and midwife during her pregnancy, and coded 0 if she hasn't got any modern prenatal care or ever received prenatal care from her relatives or neighbors. The number of hospital visiting presents the number of visiting of modern health care institutes by a mother during her pregnancy.

Other variables

The first group of other explanatory variable is mother's background and includes mother's childhood place of residence and ethnicity. The DHS data contains the question about women's reported childhood place of residence as a categorical explanatory variable classified into city, town, and countryside. To distinguish indigenous population from non-indigenous one, I used the language used in questionnaire because in DHS questionnaire there is no question asking the ethnic group affiliation of women. The majority of Peruvians use at least one of three languages: Spanish, Quechua, and Aymara. I categorize women who speak Quechua, Aymara, and other languages except foreign language into 'indigenous' people, and Spanish speakers into Spanish.

The second variable group includes socioeconomic factors such as husband's or partner's occupation, number of children living in the household, woman's marital status, piped water, and flush toilet[7]. The DHS data doesn't offer information about household income. However, as shown table 2, the percentage of the household with piped water and flush toilet is relatively low, which indicates that those variables may be proxy measure for household income. Table 2 presents summary statistics of the variables used for analysis.

<Table 3 about here>

[7] In my preliminary OLS regression, mother's occupation and husband's education were not significant at 0.1 level. Hence, I excluded those variables from the analysis although those variables might have significant effect in different context.

5. Model and Methodology

Multiple-Partial Coefficient[8]

The generalized R^2 is a measure of the predictive power of a variable after partialing out another. Let's suppose that we have two explanatory variables x_1 and x_2, and response variable y included in model. The square of the partial correlation is defined as;

$$r^2_{yx_2x_1} = \frac{SS(x_2 \mid x_1)}{TSS - SS(x_1)} = \frac{SS(x_1, x_2) - SS(x_1)}{TSS - SS(x_1)} \quad (1)$$

[9]

where $r^2_{yx_2x_1}$ is the proportion of variation in y explained by x_2, controlling for x_1. In this equation, $TSS - SS(x_1)$ presents the variations remaining in y after having been explained by x_1. Accordingly, this squared measure $r^2_{yx_2x_1}$ is the portion of the total sum of squares (TSS) in Y that is explained by x_1, and then finding the proportion of the remaining unexplained variation in y that is explained by x_2.

Now, this notion of partial coefficient can be applied to the analysis of multiple variables;

$$r^2_{yx_3x_4 \cdot x_1x_2} = \frac{SS(x_3, x_4 \mid x_1, x_2)}{TSS - SS(x_1, x_2)} = \frac{R^2_{yx_3x_4x_1x_2} - R^2_{yx_1x_2}}{1 - R^2_{y \cdot x_1x_2}} \quad (2)$$

The above formula for the multiple partial coefficients is a simple extension of the formula (1) to assess the effect of a group of variables. First, this formula introduces control variables x_1 and x_2, and let these control variable do all of the explaining they can

[8] The multiple partial desn't have been used very frequently in sociological research because of the lack of familiarity to people in the field (Blalock, 1979). However, it is very useful tool in this study in that it is possible to compare a explanatory power of a variable group to others.
[9] I employed the explanations in Ip (2001) for multiple partial coefficient formulas (1) and (2).

($R^2_{y\cdot x_1 x_2}$). $R^2_{yx_3x_4x_1x_2}$ represents the proportion of variation explained by all of the four independent variables taken together. Now the difference presented as $R^2_{yx_3x_4x_1x_2} - R^2_{yx_1x_2}$ must be due to variables x_3 and x_4. The numerator represents the proportion of variation explained by x_3 and x_4 over and above that explained by x_1 x_2. But since we must work only on that variation left unexplained by the control variable, we divide by the quantity $1 - R^2_{y\cdot x_1 x_2}$.

Multivariate analysis and fixed effect model

To assess the effect of my covariates of interest on child health, I estimate a OLS regression. The model may be expressed simply as:

$$\mathrm{Y}_{ij} = \alpha + \beta \mathrm{X}_{ij} + \upsilon_{ij} \qquad (3)$$

where *i*=individual and *j*= each community (cluster). One of the basic assumptions of OLS estimation is that there is no correlation between each X and υ_{ij} , which is error term. Thus, only observed measures are considered in this model. However, the usual assumption of this model that there are no unobserved inputs in children health might lead to an bias in the estimated impact of various factors on children health even if there is good control for the endogeneity of community variables and measurement error. Therefore, in my framework, I assume that there are community specific factors affect on child health as well as Xs, which had not been observed in this data, but included in υ_{ij} . In this case, OLS estimation might be biased and υ_{ij} is heteroscedastic.. For that reason, in addition to estimating OLS model, I also estimate a fixed effect model to eliminate the influence of unobserved differences among sampling clusters and compare changes in coefficient. Fixed Effect Model is expressed in simple way as:

$$Y_{ij} = \alpha + \beta X_{ij} + \nu_j + \varepsilon_{ij} \qquad (4)$$

In this model, υ_{ij} divided into two components; ν_j and ε_{ij}. ν_j is the unit-specific residual and differs between units but, for any particular unit, its value is constant. ε_{ij} is the usual residual of individual within the cluster with the usual properties that mean is 0, uncorrelated with itself, uncorrelated with x, uncorrelated with ν, and homoskedastic.

$$(Y_{ij} - \overline{Y}_j) = \alpha + (X_{ij} - \overline{X}_j)\beta + (\varepsilon_{ij} - \overline{\varepsilon}_j) \qquad (5)$$

where $\overline{Y}_j = \frac{\sum_{i=1}^{n} Y_{ij}}{n}$, $\overline{X}_j = \frac{\sum_{i=1}^{n} X_{ij}}{n}$, and $\overline{\varepsilon}_j = \frac{\sum_{i=1}^{n} \varepsilon_{ij}}{n}$ in each cluster with n observations.

As shown in equation (5), fixed-effects linear regressions are estimated for continuous dependent variables using OLS estimation by subtracting the cluster-specific mean from the value of each variable of interest and regressing deviations from the mean for the dependent variable on deviations from the mean in the independent variables. This method is to estimate the effect of each variable within the cluster. The interpretation of the coefficients obtained from the fixed-effects regression is the same as in the case of OLS regression.

6. Results

OLS regression models

This study employs 4 OLS regression models to compare the effect of each variable group; maternal education, region, and utilization of health care service. As seen in table 4, model 1 is nested model including all these variables as well as other control variables such as socioeconomic factors. Model 2 includes all variables except mother's education, model 3 includes all but regional variable, and model 4 includes all except utilization of health care service.

<Table 4 about here>

From the model 1, the effect of some primary school level of education on height percentage of reference median of the child is not statistically significant. However, maternal education has strong positive effect on height of child in group with primary education, and educational effect is stronger as education level becomes higher. The height percentage of median is 0.8 percent higher for children from mother with some primary level of schooling than the children with never educated mother at the same age. Thus, the height percentage of median for the children from mother with higher than secondary school education increase 2.4 percent compared to the children with not educated mother.

Place of residence presents highly significant effect on the height of children compared to Lima metropolitan area, except urban and rural coast area. Most of other regions of residence have negative effect on children height. Children whose family lives in urban sierra area, which is Andean mountain area of Peru, are 1.84 percent lower in their height percentage of median than children in Lima. The height percentage reduces 0.98 percent for children in urban selva, which is tropical rainforest area, 2.04 percent in rural sierra, and 1.09 percent in rural selva area, controlling other variables. The insignificance of urban and rural coast area seems to be from the geographical and cultural characteristics of these area, which means that those two area shares similar economic development process with Lima metropolitan area.

Utilization of health care service, being stood for by prenatal care and the number of hospital visiting, is highly significant for height of children. The children from mother who has ever utilized modern prenatal care services during her pregnancy experience 0.49 percentage changes in their height percentage from median. Also, as mother visit one more time this percentage increases 0.02. The vaccination doesn't have direct effect on children health except BCG, although vaccination is one of the most important child surviving programs in developing countries. (Cowley and Mosley, 1991; Hoberaft, 1993)

As indicators of socioeconomic status, occupation of husband or partner of surveyed woman is important in children health outcome. When father of children is working as professional worker, children go through 0.7 percent increase in their height percentage from median from the children with father working in agriculture. There are significant differences in child height according to whether there is a flush toilet in the house used as proxy for household income, however not for piped water.

Model 1 estimates child height and weight as a function of maternal background characteristics too (mother's childhood place of residence and mother's ethnicity affiliation). Mother who came from town and countryside has negative effect on child health compared to whom from city. Mother's ethnicity affiliation is also significant. Height percent of child decreases by 0.75 percent in indigenous mother compared to Spanish mother.

Partial coefficient

As shown in nested model for children height percentage of median, maternal education holds strong influence on children health even net several important variables, such as regional and utilization of health service. However, this is the case for other variables too. To specify the explanatory power of each variable group, partial coefficients need to be introduced.

Table 4 also presents 3 different models that each of variable group of model 1 is omitted for the purposed of comparing partial coefficients. Model 2 includes all variables considered in model 1 except mother's education, model 3 presents the effect of all the variables except regions, and model 4 except the utilization of health care service. R^2 of each model is a measure of the predictive power of multiple variables after partialing out other variables. From the equation (2), the partial coefficient of the education is 0.014, which means education explains 1.4 % of unexplained variation in height percentage of children by other variables. In the same way, the predictive power of regional variable is 0.020 (or 2%), and 0.46 % is explanatory power of the health care service in the same model restriction.

<Table 5 about here>

This result confirms that regional variable explains the variation in the height percentage of median among children better than other two variable groups. The influence of region is greater in case of children weight. A look at the models in table 5 reveals similar trends in the effect of various factors on the child health indicated by weight percent of median in that mother's education, regional variation, and utilization of health care service continue to be significant in nested model. However, the R^2 of each model and partial coefficients offer the evidence of regional effect as a precursor to other factors. The partial coefficient of region is 0.037 in the case of children weight while education is 0.0077. Thus, regional differences explain the variation in the children weight about 5 times of education.

Fixed effect model

The results from the fixed effects model (Table 6), which captures unobserved differences between communities, shows an attenuation in the effects of maternal schooling compared to the results from Model 1. Unobserved community characteristics might be culture and value such as to what extent education is valued by community, how prevalent the emphasis on modern health care is in community etc. It also might include accessibility such as physical distance to modern health care facility, transportation, systemic difficulties of using health care service, or other infrastructures. These factors can influence the variables included in the model, however don't be observed in data.

<Table 6 about here>

Controlling unobserved community specific characteristics, the effect of maternal education on height of child decreased to 0.57 percent from 1.1 percent of nested model, and 1.42 percent from 2.3 percent on weight in case of the mothers with some secondary education. For higher than secondary category, the effect on height decreases to 1.67

percent of fixed effect model from 2.36 percent of nested model, and to 4.07 percent from 5.1 percent on weight. Even though maternal education retains its significant effect on child health in Model 1, fixed effect model in table 6 shows some interesting findings. Controlling unobserved community specific characteristics, the effect of maternal education on height and weight of children is no longer significant at primary education level. Also the effect of higher levels of education is significantly reduced. For example, increase in height percentage of child whose mother has secondary school level of education compared to not being educated mother reduced to 0.51 percent in fixed effect model from 0.99 percent in model 4. Similar result is shown in weight of child.

As a result, community fixed effects estimates suggest that the direction of the bias in OLS regression estimates is upward and that the true effects of the range of observed maternal education on child health not significant as much as being considered despite the strong association that leads to the appearance of an effect in OLS.

6. Discussion

In this paper I have examined the hypothesis that predictive power of regional variable for the variation in child health outcome is greater than that of maternal education and utilization of the health care service by employing partial coefficient. Also, I controlled the unobserved community specific characteristics not being measured in the data to investigate if the effect of maternal education on child health holds its explanatory power within a community. From the results shown in fixed effect model, controlling community specific characteristics makes the link between maternal education and child health weak, presenting the importance of unobserved community characteristics in determining child health.

Table 7 shows that that percent of women who utilizes prenatal care in Lima is higher than in rural Sierra area even in highest education group. This supports an assumption that regional variation in distribution of health care facilities and resources affects health care behavior, thus also health outcome. Therefore, my results, taken together with findings from other studies, suggest that much greater efforts to redistribute health care resources are required if modern maternal health care services are to reach women especially in rural area of Peru.

Nevertheless, the effect of mother's education is in the expected direction and continues to be statistically significant even when fixed effect model applied, above all in higher education level. Furthermore, in fixed effect model, communities may differ in the average level of maternal education. That community average may have a real effect on child health. In addition, it will mediate part of the effect of a mother's own education, for two reasons. First, the individual's education is a component of the mean estimated for the community. Second, well-educated mothers may be more able to raise their families in healthier communities. In other words, they may choose to live in healthier communities and may be more effective at getting and keeping residence in healthier communities. Moreover, as many other studies have showed, maternal education itself potentially has positive effects on child health outcome in community level. Educated mothers can mobilize the power to post health care facilities within the community, by this means improving the level of health of children overall in the communities. Also, "spill over effect (Desai and Alva, 1998:80)" which implies that educated mothers can reduce the probability of disease and improve the nutritional condition is expected within community.

Furthermore, the findings in this study suggest a need for further research considering the interaction of maternal education with regional and community level of variables. The conclusion reached by Shonaba (1996) is that maternal schooling interacts positively or negatively on health seeking behavior depending on whether the region of residence is rural or urban area. Also, multi-level model that tests the interaction of a mother's own level of education and the average maternal education in her community and residence for more dynamic analysis. The fixed effect model employed in this study considers the mother's own education and community level of maternal education in separate ways.

Table 1. Distribution of the number of children

Number of children within 5 years	Observations	Percent (%)
1	10,499	76.65
2	2,859	20.87
3	326	2.38
4	13	0.09
Total	**13,697**	**100**

Table 2. Height and weight percent of reference median for age

Variable	Observation	Mean	Std. Dev.	Min	Max
Height for Age	8127	95.38	5.13	76.61	123.12
Weight for Age	8127	96.03	14.05	47.91	183.3

Table 3. Characteristics of the sample used in the analyses of height and weight for age

Variable	Percentage	Variable	Percentage
Mother's education		**Prenatal Care[a]**	
None	8.72	Yes	78.26
Some primary	24.52	No	21.74
Primary	18.19		
Some secondary	16.78	**Number of Hospital Visiting[b]**	5.57[c]
Secondary	16.74		
Higher	15.05	**Husband's Occupation**	
		Agriculture	45.69
Mother's Age		Manual	20.04
Under 19	5.48	Service	19.75
20-29	46.01	Professional	14.19
30-39	37.85		
40-49	10.15	**Number of Children**	1.53[d]
Childhood Place of Residence		**Piped water**	
City	34.27	No	37.58
Town	27.63	Yes	62.42
Countryside	38.00		
		Flush toilet	
Ethnicity		No	67.01
Spanish	79.90	Yes	32.99
Indigenous	20.1		
Place of Residence			
Lima Metropolitan	7.70		
Urban coast	17.49		
Urban Sierra	12.81		
Urban Selva	10.86		
Rural Coast	4.83		
Rural Sierra	31.93		
Rural Selva	14.37		

a Prenatal care coded yes if a woman received prenatal are or assistance from a trained health professional (a doctor or a trained nurse/midwife) accordingly
b Number of hospital visiting is for during women's pregnancy
c and d is mean value.

Table 4. OLS Estimates: Effects of Maternal Education, Region, and Utilization of Health Care Service on Height of Children

	Model 1		Model 2		Model 3		Model 4	
Mother's Age (under 20)[e]								
20~29	0.26	(0.23)	0.39*	(0.23)	0.26	(0.23)	0.27	(0.23)
30~39	0.37	(0.24)	0.40*	(0.24)	0.43*	(0.24)	0.39	(0.24)
40~	0.51	(0.28)	0.38	(0.28)	0.52	(0.28)	0.52*	(0.28)
Mother's Education (no education)[e]								
Some primary	0.14	(0.20)			0.20	(0.20)	0.22	(0.20)
Primary	0.78**	(0.22)			0.88**	(0.22)	0.88**	(0.22)
Some secondary	1.10**	(0.24)			1.24**	(0.24)	1.26**	(0.23)
Secondary	1.46**	(0.25)			1.71**	(0.25)	1.64**	(0.25)
Higher	2.36**	(0.27)			2.47**	(0.27)	2.57**	(0.27)
Place of Residence (Lima)[e]								
Urban coast	-0.24	(0.22)	-0.20	(0.22)			-0.25	(0.22)
Urban Sierra	-1.84**	(0.23)	-1.82**	(0.23)			-1.86**	(0.23)
Urban Selva	-0.98**	(0.24)	-1.00**	(0.24)			-1.05**	(0.24)
Rural Coast	-0.25	(0.32)	-0.14	(0.32)			-0.23	(0.32)
Rural Sierra	-2.04**	(0.26)	-2.09**	(0.26)			-2.06**	(0.26)
Rural Selva	-1.09**	(0.27)	-1.13**	(0.27)			-1.22**	(0.27)
Prenatal Care (no)[e]	0.49**	(0.14)	0.66**	(0.14)	0.53**	(0.14)		
Hospital Visiting	0.02**	(0.01)	0.02**	(0.01)	0.02**	(0.01)		
Vaccination								
BCG	0.30**	(0.12)	0.33**	(0.12)	0.20	(0.12)		
DPT	-0.06	(0.09)	-0.06	(0.09)	-0.07	(0.09)		
POLIO	0.04	(0.07)	0.03	(0.07)	0.08	(0.07)		
Husband's Occupation (agriculture)[e]								
Manual	0.38*	(0.16)	0.50**	(0.16)	0.53**	(0.15)	0.42	(0.16)
Service	0.49**	(0.17)	0.78**	(0.17)	0.70**	(0.16)	0.52**	(0.17)
Professional	0.70**	(0.20)	1.43**	(0.19)	0.73**	(0.20)	0.76**	(0.20)
Childhood Place of Residence (city)[e]								
Town	-0.12	(0.15)	-0.37**	(0.14)	-0.40**	(0.14)	-0.14	(0.15)
Countryside	-0.38*	(0.15)	-0.74**	(0.15)	-0.69**	(0.15)	-0.44**	(0.15)
Number of Children	-0.56**	(0.08)	-0.65**	(0.08)	-0.58**	(0.08)	-0.59**	(0.08)
Married (not married)[e]	0.07	(0.19)	0.06	(0.19)	0.09	(0.19)	0.08	(0.19)
Piped water (no)[e]	-0.07	(0.12)	-0.01	(0.12)	-0.14	(0.12)	-0.03	(0.12)
Flush toilet (no)[e]	0.99**	(0.15)	1.24**	(0.15)	1.17**	(0.14)	0.99**	(0.15)
Other characteristics								
Male(female)[e]	-0.10	(0.10)	-0.09	(0.10)	-0.11	(0.10)	-0.10	(0.10)
Indigenous (Spanish)[e]	-0.75**	(0.16)	-0.96**	(0.16)	-1.34**	(0.14)	-0.70**	(0.16)
Child Age	-0.25**	(0.01)	-0.25**	(0.01)	-0.24**	(0.01)	-0.24**	(0.01)
Child Age^2	2.90E-3**	(0.00)	2.84E-3**	(0.00)	2.89E-3**	(0.00)	2.88E-3**	(0.00)
Constant	98.78**	(0.48)	99.60**	(0.44)	97.70**	(0.43)	99.50**	(0.46)
R_squared	**0.2405**		**0.2297**		**0.2254**		**0.237**	
N=	**8127**		**8127**		**8127**		**8127**	

Note: standard errors are in parentheses.
** P<.01, * P<.05 significance level respectively (two-tailed test)
e is reference category for each variable
Coefficients are unstandardized regression coefficients with their t-values below.

Table 5. OLS Estimates: Effects of Maternal Education, Region, and Utilization of Health Care Service on Weight of Children

	Model 1		Model 2		Model 3		Model 4	
Mother's Age (under 20)[e]								
20~29	0.63	(0.64)	0.90	(0.64)	0.87	(0.65)	0.63	(0.64)
30~39	0.70	(0.66)	0.80	(0.65)	1.27	(0.67)	0.74	(0.66)
40~	1.20	(0.77)	0.95	(0.76)	1.62*	(0.78)	1.22	(0.77)
Mother's Education (no education)[e]								
Some primary	0.62	(0.56)			0.59	(0.57)	0.79	(0.56)
Primary	1.78**	(0.60)			1.81**	(0.61)	2.04**	(0.60)
Some secondary	2.30**	(0.65)			2.40**	(0.66)	2.68**	(0.64)
Secondary	3.12**	(0.68)			3.92**	(0.69)	3.59**	(0.68)
Higher	5.10**	(0.74)			5.29**	(0.75)	5.65**	(0.74)
Place of Residence (Lima)[e]								
Urban coast	-2.36**	(0.60)	-2.26**	(0.60)			-2.41**	(0.60)
Urban Sierra	-8.22**	(0.64)	-8.18**	(0.64)			-8.33**	(0.64)
Urban Selva	-8.40**	(0.67)	-8.43**	(0.67)			-8.55**	(0.67)
Rural Coast	-3.87**	(0.88)	-3.64**	(0.88)			-3.88**	(0.88)
Rural Sierra	-7.14**	(0.71)	-7.22**	(0.71)			-7.31**	(0.71)
Rural Selva	-7.50**	(0.75)	-7.56**	(0.75)			-7.91**	(0.74)
Prenatal Care (no)[e]	1.35**	(0.38)	1.70**	(0.38)	1.74**	(0.38)		
Hospital Visiting	0.06**	(0.02)	0.07**	(0.02)	0.07**	(0.02)		
Vaccination								
BCG	0.58	(0.32)	0.63*	(0.32)	0.48	(0.32)		
DPT	-0.50*	(0.25)	-0.49	(0.25)	-0.51*	(0.26)		
POLIO	0.02	(0.19)	0.00	(0.20)	0.11	(0.20)		
Husband's Occupation (agriculture)[e]								
Manual	0.97*	(0.45)	1.19**	(0.44)	1.43**	(0.42)	1.05*	(0.45)
Service	1.23**	(0.47)	1.82**	(0.47)	1.94**	(0.45)	1.30**	(0.47)
Professional	1.22*	(0.56)	2.72**	(0.52)	1.13*	(0.55)	1.36*	(0.56)
Childhood Place of Residence (city)[e]								
Town	-0.13	(0.40)	-0.66	(0.40)	-1.11**	(0.40)	-0.17	(0.40)
Countryside	0.47	(0.43)	-0.25	(0.42)	-0.38	(0.42)	0.35	(0.43)
No. of Children	-1.33**	(0.21)	-1.49**	(0.21)	-1.41**	(0.22)	-1.41**	(0.21)
Married (not married)[e]	0.80	(0.52)	0.80	(0.52)	0.86	(0.53)	0.90	(0.52)
Piped water (no)[e]	0.68*	(0.33)	0.80*	(0.34)	0.83*	(0.33)	0.79*	(0.33)
Flush toilet (no)[e]	2.58**	(0.41)	3.10**	(0.40)	3.41**	(0.40)	2.61**	(0.41)
Other characteristics								
Male(female)[e]	-0.31	(0.27)	-0.29	(0.28)	-0.33	(0.28)	-0.30	(0.28)
Indigenous	-2.21**	(0.44)	-2.64**	(0.43)	-2.72**	(0.40)	-2.09**	(0.44)
Child Age	-0.88**	(0.03)	-0.88**	(0.03)	-0.88**	(0.03)	-0.89**	(0.03)
Child Age^2	0.01**	(0.00)	0.01**	(0.00)	0.01**	(0.00)	0.01**	(0.00)
Constant	108.54**	(1.32)	110.36**	(1.22)	101.93**	(1.19)	110.01**	(1.27)
R_squared	**0.2287**		**0.2227**		**0.1995**		**0.2257**	
N=	**8127**		**8127**		**8127**		**8127**	

Note: standard errors are in parentheses.
** P<.01, * P<.05 significance level respectively (two-tailed test)
e is reference category for each variable
Coefficients are unstandardized regression coefficients with their t-values below.

Table 6. Fixed Effect Model for Weight for Age and Height for Age

	Weight for Age		Height for Age	
Mother's Age (under 20)[e]				
20~29	0.42	(0.67)	0.30	(0.24)
30~39	0.27	(0.70)	0.29	(0.25)
40~	1.09	(0.81)	0.45	(0.29)
Mother's Education (no education)[e]				
Some primary	0.47	(0.60)	-0.08	(0.22)
Primary	1.25	(0.66)	0.40	(0.24)
Some secondary	1.42*	(0.72)	0.57*	(0.26)
Secondary	2.22*	(0.77)	0.95*	(0.28)
Higher	4.07**	(0.83)	1.67**	(0.30)
Prenatal Care (no)[e]	0.63	(0.42)	0.22	(0.15)
Hospital Visiting	0.05*	(0.02)	0.02*	(0.01)
Vaccination				
BCG	0.34	(0.34)	0.17	(0.13)
DPT	-0.51	(0.27)	-0.05	(0.10)
POLIO	-0.15	(0.21)	-0.02	(0.08)
Husband's Occupation (agriculture)[e]				
Manual	0.88	(0.52)	0.47*	(0.19)
Service	1.20*	(0.54)	0.53**	(0.20)
Professional	1.46	(0.62)	0.73**	(0.23)
Childhood Place of Residence (city)[e]				
Town	0.30	(0.47)	0.12	(0.17)
Countryside	0.10	(0.50)	-0.02	(0.18)
Number of Children	-0.87**	(0.23)	-0.41**	(0.08)
Married (not married)[e]	0.70	(0.56)	0.24	(0.20)
Piped water (no)[e]	0.74	(0.49)	0.13	(0.18)
Flush toilet (no)[e]	1.26*	(0.54)	0.44*	(0.20)
Other characteristics				
Male(female)[e]	-0.48	(0.29)	-0.15	(0.11)
Indigenous (Spanish)[e]	-2.07**	(0.71)	-0.80**	(0.26)
Child Age	-0.89**	(0.04)	-0.26**	(0.01)
Child Age2	0.01**	(0.00)	3.05E-3**	(0.00)
Constant	104.58**	(1.31)	98.00**	(0.48)
R_squared	**0.1222**		**0.1224**	
N=	**8127**		**8127**	

Note: standard errors are in parentheses.
** P<.01, * P<.05 significance level respectively (two-tailed test)
e is reference category for each variable
Coefficients are unstandardized regression coefficients with their t-values below.

Table 7. Percentage of women who took prenatal care in Peru in 2000

Mother's Education	Rural Sierra	Lima
No education	0.54	0.60
Some primary	0.68	0.80
Primary	0.72	0.92
Some primary	0.76	0.93
Secondary	0.83	0.99
Higher	0.94	0.99
Total	0.69	0.96

<Reference>

Adetunji, J. A., “Infant mortality and mother’s education in Ondo state, Nigeria,” Social Science and Medicine. Vol. 40, No.2, 253-263

Baffigo, V., Albinagorta, J., Nauca, L., Rojas, P., Alegre, R., Hubbard, B., and John Sarisky, 2001, “Community Environmental health Assessment in Peru’s Desert Hills and Rainforest.” American Journal of Public Health, vol.91, No. 10. 1580-1582

Bender, D. E., and Margaret F. McCann, 2000, “The influence of maternal intergenerational education on health behavior of women in peri-urban Bolivia,” Social Science and Medicine. Vol. 50, 1189-1196

Blalock, Jr., Hubert M., 1979, Social Statistics, 2nd edition, McGraw-Hill book company.
Caldwell, J. C., 1979, “Education as a Factor in Mortality Decline: An Examination of Nigerian Data.” *Population Studies*, 33:395-413

Case, A., Lubotsky, D., and Paxon, C. 2002, “Economic Status and Health in Childhood: The Origins of the Gradient”, *The American Economic Reviews*, Vol. 92, No. 5

Desai, S & Alva, S, 1998, “Maternal Education and Child Health: Is There a Strong Causal Relationship?”, *Demography,* Vol. 24, No.1 p.71-81

Elo, I. T. 1992, “Utilization of maternal health-care services in Peru: the role of women’s education”, *Health Transition Review,* Vol. 2:1, p.1-20

Gross, R., and Britta Landfried, and Susilowati Herman, 1996, “Height and Weight as a Reflection of the Nutritional situation of school-aged children working and living in the streets of Jakarta,” Social Science and Medicine. Vol.43, No.4, 453-458

Hobcraft, John, 1993, “Women’s Education, Child Welfare and Child Survival: a review of the evidence”, *Health Transition Review,* Vol. 3, No.2 p.159-173

Ip, Edward H. S., 2001, “Visualizing Multiple Regression”, Journal of Statistics Education Vol. 9, No.1

Joshi, A. R. 1994, “Maternal schooling and child health: preliminary analysis of the intervening mechanisms in rural Nepal”, *Health Transition Review*, Vol. 4 No.1

Martorell, R. and Ho, T. 1984. “Malnutrition, morbidity and mortality.” Pp. 49–68 in *Child Survival: Strategies for Research,* ed. W. Henry Mosley and Lincoln C. Chen.

Mosley, W. H. and Lincoln C. C. 1984, “An analytic framework for the study of child survival in developing countries.” *Population and Development Review* 10 Suppl. New York: The Population Council.

Mosley, W. Henry and Cowley, Peter. 1991, “The Challenge of World Health”, *Population Bulletin* vol. 46, No.4

Muhuri, Pradip K., 1995, “Health program, maternal education, and differential child mortality in Matlab, Bangladesh.” Population and Developmental Review 21, No. 4; 813-834

Raghupathy, Shobana. 1996, Education and the use of maternal health care in Thailand, Social Science and Medicine. Vol. 43. No. 4. 459-471

Rebecca Din-Dzietham and Hertz-Picciotto, 1998, Infant mortality differences between whites and Africans: The effect of Maternal education. American Journal of Public Health. April. Vol.88, No.4 651-656

Rosenzweig, M., and T.P. Schultz, 1982, “Child mortality and fertility in Colombia: individual and community effects,” Health Policy and Education 2:305-348

Sastry, Narayan., 1997, “What explains rural-urban differentials in child mortality in Brazil?” Social Science and Medicine. Vol. 44, No. 7, 989-1002

Schultz, T.P. 1984, “Studying the impact of household economic and community variables on child mortality”. *Population and Development Review.* Suppl. 10:215-235

Smith, L. C. and Haddad, L. 2000, *Explaining Child Malnutrition in Developing countries: A Cross Country Analysis,* International Food Policy Research Institute, Washington D.C.

Supplement to *Population and Development Review*10. New York: The Population Council.

The World Bank, 1993, *World Development Report: Investing in Health*. New York
V.M.R. Marins and R.M.V.Almeida, 2002, Undernutrition prevalence and social determinants in children aged 0±59 months, Niterói, Brazil, Annals of Human Biology. Vol. 29 No.6, 609-618

Ware, Helen, 1984, “Effects of maternal education, women’s roles, and child care on child mortality”. *Population and Development Review* Suppl. 10:191-214

Wolfe, Barbara L. and Behrman, Gere R. 1987a, “Women’s schooling and children’s health: Are the effects robust with adult sibling control for women’s childhood background?” Journal of Health Economics 6, 239-254

Wolfe, Barbara L. and Behrman, Gere R., 1987b, “How Does Mother’s Scholling Affect Family Health, Nutrition, Medical Care Usage, and Household Sanitation?” Journal of Health Economics 36, 185-204

Young, M.E. 1997, *Early Child Development: Investing in the Future, Human Development Department*, The World Bank

FNUAP, Estado de la poblacion Peruana,2000, Lima 11 de julio, INEI

Kim, Jim., Aaron, Sharkow., and Jaime, Bayona., 2000, “Market Failure and Moral Failure: The Privatization of Health in Peru”, Dying for growth : global inequality and the health of the poor, Kim, Jim Young (eds.) Monroe, Me. : Common Courage Press