Limited Resource Families and Child Health Status: A Case Study in Montero, Bolivia

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Abstract

Child malnutrition is a problem that poses social and economic costs to individuals, households, communities, and nations, like Bolivia. Childhood malnutrition can be reduced through effective policy and health interventions such as those of the Consejo de Salud Rural Andino (CSRA) in Montero, Bolivia. The CSRA is a non-profit, private organization that operates three health care clinics in Montero, Bolivia. Low-income mothers and their children are provided with free or minimal-cost public health education and basic pre- and post natal medical services . Three separate clinic areas serve three different populations in terms of child nutritional status and demographic and socioeconomic characteristics. Effectiveness and priority intervention points for reducing childhood malnutrition can be identified by a thorough understanding of socio-economic and demographic characteristics as they relate to child nutrition status.

Survey data were collected from 180 women with children under the age of five living in the CSRA clinic coverage area. Data focused on child health, nutrition, anthropometric data, and household socioeconomic and demographic characteristics. Multivariate regression analysis was used to explain child nutrition status as indicated by anthropometric indices. The regression models included child-specific, maternal, and household factors. Regression models were estimated for three anthropometric indices: weight-for-age, height-for-age, and weight-for-height.

CSRA initiatives were found to have made a positive contribution to child and maternal health care. However, child malnutrition remains which is inversely associated with critical demographic and socioeconomic characteristics of the various households such as maternal education and household income and wealth.

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Malnutrition poses large socio-economic costs to individuals, households, communities, and nations. Globally, more than 220 million years of productive life are lost annually as a result of undernourishment and mineral and vitamin deficiencies, as estimated in the Food and Agricultural Organization's 2004 State of Food Insecurity in The World report. These losses occur as a result of shortened life spans or disabilities related to malnutrition, related health care costs, and reduced cognitive abilities. It was estimated that 96%, or 815 million, of the 852 million undernourished people live in developing countries.

Among the undernourished, children represent one of the most vulnerable groups according to the World Health Organization (2005). Poor infant and child nutrition can result in developmental retardation, increased risk of infection, anemia, goiter, and blindness. Malnutrition causes 60% of the 10.9 million deaths annually among children under-five in developing countries.

The negative effects of poor childhood nutrition span into adulthood and across generations. If a child consumes inadequate calories, experiences low protein intake, or has deficiencies in key vitamins and minerals, their future mental and physical capacities can be limited. Additionally, women who have suffered from malnutrition as children are more likely to give birth to low birth-weight babies themselves, who face higher risk of malnutrition and infant mortality, continuing the cycle of malnutrition. For these reasons, it is important to evaluate patterns in childhood malnutrition and evaluate the effects of nutrition intervention programs.

Study Site

This study was conducted in Bolivia, a landlocked country in South America. Bolivia is one of the poorest countries in Latin America, with a Gross National Income of US$900 per capita (World Bank). Infant mortality rates in Bolivia are among the highest in South America, at 56 deaths per 1,000 live births, compared to a Latin America and Caribbean average of 27 (World Bank). Correspondingly, Bolivians face elevated levels of child malnutrition, with 7.4% of children under-five considered underweight nationally (Instituto Nacional de Estadistica), compared to 7% in the Latin America and Caribbean Region and only 2% in the United States (UNICEF, 2006).

The specific study site is Montero, Bolivia, located the Department of Santa Cruz in the eastern lowland area of Bolivia. In the 2001 national census conducted by the Bolivian National Statistics Institute, Montero had a population of 80,341 people with 19,112 (29%) considered as living in poverty, meaning that basic needs were not met. The study population consisted of three neighborhoods of approximately 25,000 served by the Consejo de Salud Rural Andino (CSRA). The CSRA clinics provide free or minimal-cost public health education and basic pre- and post natal care services to low-income mothers and their children. The CSRA uses a Census-Based, Impact-Orientated health care approach, which consists of identifying the population area through at a minimum biennial visits and focusing programs on the most prevalent and serious health problems among the most vulnerable populations (Perry et al, 1999).

The population served by CSRA can be broken into three sub-populations, the Villa Cochabamba clinic, the Cruz Roja clinic, and the CLEM clinic. The populations of these three clinic areas were 11,423, 9,581, and 4,195, respectively, according to the 2003

CSRA census. There are notable differences between the three populations in terms of socioeconomic and demographic characteristics.

Survey Design

Input for the survey design was received from faculty in the Public Health Program at Nur University in Santa Cruz, Bolivia; medical doctors and nurses with the CSRA; and faculty in the Department of Foods and Nutrition at Purdue University.

Due to the unique cultural, socio-economic, and educational status of the sample population, oral rather than written consent was approved by Purdue University's Human Subjects Committee. This procedure also was approved by the Bolivian Ministry of Public Health, the Bioethics Committee at Nur University in Santa Cruz, Bolivia, which offers a Masters degree in Public Health, and the director of the CSRA clinics in Montero, Dr. Dardo Chavez (M.D. and Masters in Public Health). The survey instrument consisted of four principle parts; child medical record information, household demographic and socioeconomic characteristics, child nutrition and feeding practices, and child anthropometric measurements.

The child health information was obtained from a combination of interview questions and access to clinic child health records. Examples of health history information include: vaccination coverage, prenatal care of the mother, child birth weight, and clinical nutritional classification of each child. Information about child morbidity was obtained during the interview.

The household demographic and socioeconomic characteristic portion of the survey instrument included both maternal and household information. Maternal information included maternal years of schooling, number of children under the age of five, and maternal income. Measures of paternal education and income also were obtained. The household information included the number of people living in the household, the geographic location of the household, and household characteristics.

The child nutrition section included information about breastfeeding duration, first foods, transition foods, and a 24-hour diet recall for each child in the survey sample. The 24-hour diet recall is a food consumption survey in which the types and quantities of foods consumed the day prior to the interview are carefully recorded. Such surveys are conducted with the purpose of identifying or predicting acute and chronic nutrition problems (FAO, 2004a). A three-pass method, previously used in the United States National Health and Nutrition Examination Survey was used (Raper, 2004).

The last section of the survey instrument focused on the anthropometric data, which were used to estimate anthropometric indices. Height, weight, and age are the basic data necessary to calculate "the three most commonly used anthropometric indices" for assessing child growth according to the World Health Organization (see WHO, 1986, for details). They include weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ).

Two height instruments were used: one for standing height and another for recumbent height or length. The instrument used for standing height was a portable wall-mount height measurement device. For recumbent height or length, an apparatus consisting of a tape measure and two clipboards was used. These methods are somewhat less reliable than other height measurement procedures, but are portable and therefore more suitable for field research than instruments used in a medical clinic or doctor's office. For the weight measurements, a UNICEF issued scale was used.

The interviews were conducted in Spanish by the surveyor with assistance and clarification by assisting clinic nurses and workers fluent in Spanish, Quechua, and/or Aymara. A Spanish script for the survey was developed and tested twice with women of similar educational and social-economic status to those in the Montero target population. Input also was received from CSRA nurses who routinely collect similar health and socioeconomic data from the target population

Sampling Procedure

Due to perceived differences between the three clinic populations, the sample was divided into three sub-samples, of comparable sizes to enable statistical comparisons between the three areas. The final sample of 180 households consists of 61 households from Villa Cochabamba (VC), 59 from Cruz Roja (CR), and 60 from CLEM.

The geographical organization of the clinics facilitated the random selection of survey participants. Each clinic has a designated geographical area of coverage that is divided into neighborhoods. Within these neighborhoods, each block is numbered. Additionally, the houses as well as the families living in each house are numbered. A multistage, clustering sampling procedure was used. Sixty blocks were chosen randomly from each of the clinic areas. Then a list of all households with children under the age of five within an individual block was made using the clinic household files. Next, one of the households was randomly chosen from the list for an interview. This process was repeated for all of the blocks selected in the first step of the sampling procedure.

There were a few instances where there were no families with children under the age of five living on a sampled block. In these cases, the next closest block was substituted into the sample, a list of eligible households made, and one family randomly chosen to be interviewed.

Occasionally during the interview process the mother chosen in the sampling procedure was unavailable or declined to be interviewed (three women declined to be interviewed). When this occurred, the next closest household on that particular block with children under the age of five was used as an alternate. This is the standard procedure practiced by the staff at CSRA for their routine health surveys. They pointed out that neighboring families very rarely differ greatly in housing and socioeconomic status.

Data Preparation

The 24-hour diet recall data required special software for entry and processing, the Nutrition Data System, Version 5.0 (NDS). The Department of Foods and Nutrition at Purdue University was consulted for the entry and processing of these data. The Nutritional Database Software uses nutritional specifications more appropriate in industrialized countries, such as the United States, in calculating nutritional content. For this reason, it is possible that nutritional intakes are overestimated. For example, a serving of a homemade dish by U.S. standards likely has higher nutritional value than one prepared in Bolivia, where the average employed worker earns less than $7 per day (World Bank).

One limitation of the diet recall data is related to children being breastfed at the time of the interview. No data could be collected relative to quantity and quality of maternal milk ingested. Methods of obtaining accurate measurements, such as weighing infants before and after breastfeeding, or having mothers use a breast pump, then bottle feeding the children and recording the quantity consumed, are too intrusive and involved given the purpose of the study. Because of this, the quantity of maternal milk consumed by nursing infants and children is not considered in the Nutritional Database Software's calculations of diet quality.

Three anthropometric indices, weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) were calculated using Epi-Info (available at no cost at the Center for Disease Control website). The anthropometric measurements, along with child birth date, measurement date, and gender, were arranged in an Excel spreadsheet and imported into Epi-Info to determine Z-scores for weight-for-age, height-for-age, and weight-for-height. The above indices are generally reported in terms of standard deviation scores (Z-scores) from an age and sex specific reference population (WHO, 1986). The 1978 NCHS/CDC growth curves were used as the reference, in accordance with the 1978 WHO recommendation.

Summary statistics for all survey questions were calculated using Microsoft Excel. Data were tested for statistical differences between clinic areas and gender using student-t tests performed with SAS software. Child nutritional status, as denoted by Z-scores for weight-for-age, height-for-age, and weight-for-height, were selected as the dependent variables for regression analysis to ascertain what exogenous variables best explain differences in child nutrition and health status as reflected by the Z-scores. SPSS was used to conduct the stepwise multiple regression analysis.

Multivariate Analysis: Factors Associated with Child Health and Nutrition

Hypothesized relationships between anthropometric indices and appropriate socio-economic, medical, and nutrition factors reported in other studies and identified by economic and nutrition theory as contributing to child nutrition status were explored with the data from this study using multivariate analysis. The selected variables are divided into thee categories; child factors, maternal factors, and household factors. The anthropometric indices discussed in this study -- weight-for-age, height-for-age, and weight-for-height-- were the dependent variables. Three separate series of models were constructed, one for each of the three dependent variables. Independent variables were added to the model in a stepwise fashion by category, first the child variables, then the maternal variables, and lastly the household variables. This provided additional insights into the contribution to child health of the various categories of explanatory variables.

Explanatory Variables

Mean values and standard deviations are reported for two distinct sample sizes (Table 1). The first represents the children with complete anthropometric data (247), and the second represents children (188) for whom a clinical nutrition classification, birth weight data, and complete anthropometric information were available. There is little difference between the mean values of the two sample sizes. Using the smaller sample size allows for the inclusion of several key explanatory variables in the regression analysis.

Child Variables

Eight child-level explanatory variables were included in the regression models. The first two, Energy Recommended Daily Intake (RDI) and Protein (grams) per Energy (Kcals), were derived from the 24-hour diet recall data. These two variables were selected from the diet recall data because the quantity of calories and grams of protein consumed should directly affect child nutritional status as measured by anthropometric indices (Scrimshaw,1996). Gender is included to test for differences in nutritional status indicating differences in feeding and care practices between boys and girls. Child age was chosen as a variable to consider the effects of different feeding stages on nutrition, as well as the contribution of child age to stunting as indicated by height-for-age, a measure of long-term malnutrition more prevalent in older children. The next two explanatory variables are related to child morbidity. They indicate reported incidence of diarrhea or a fever in the two weeks prior to the interview. The seventh child-level variable, clinic nutritional classification, comes from the child health record maintained by the clinic staff. The classification was made by a CSRA health care provider when the child was most recently examined at the local clinic or during a home visit. The clinical nutritional classification is based on a growth chart using child weight and age information. This variable has either a value of one or zero to indicate if by the clinical classification on the child's health card, the child is considered malnourished or not, with children who are malnourished with a value of one and those who are not considered malnourished with a value of zero. The last child-level explanatory variable considered is low birth weight. This variable indicates if a child was above or below 2.5 kilograms of weight at birth, with those weighing less than 2.5 kilograms at birth considered low birth-weight babies.

Maternal Variables

The next group of variables includes maternal-level factors. The first is the number of children a woman has under the age of five. This variable allows for consideration of quantity-quality interactions among children, in accordance with Gary Becker's theory in *A Treatise on the Family*. The second maternal-level explanatory variable is maternal schooling measured as the number of years of school attended. Maternal education has been suggested as one of the most important factors in child health and nutrition status

(Young et al., 1983; Frost et al., 2004). Child nutritional status is expected to improve as maternal education increases, a positive relationship. The third maternal-level explanatory variable is the mother's work outside the home. When mothers work, it generally means an additional wage earner in the family. Also women, who are in most cases responsible for childcare and household food purchasing, may have more control over family financial resources.

Household Variables

Household factors can have important impacts on child nutrition. Four household explanatory variables were included in the regression models. The first two explanatory variables, Villa Cochabamba (VC) and CLEM, are dummy variables used to indicate in which of the three clinic regions the child lives. Cruz Roja (CR) is the reference population since this neighborhood seems to be the best of the three clinic areas in terms of higher levels of education, smaller family size, and higher wealth status. The other two clinics are worse off in terms of household income, education levels, and housing quality, with VC representing a more migrant population from the highland interior of the country and CLEM a population of migrants who have moved from rural areas of the Santa Cruz Department in search of employment and educational opportunities (Taulman, 2006). The next variable, family income, indicates the combined maternal and paternal incomes in 1000 Bolivianos. Households make decisions on the allocation of resources based on their micro-level production functions where households are involved in both production and consumption (Offutt, 2002). Refrigerator in the household is another explanatory variable which serves as a proxy for accumulated wealth.

Ownership of a refrigerator also may have diet and nutritional benefits because the family can purchase perishable foods in larger quantities and safely store them in a refrigerator.

Interaction Variables

Two interaction variables were used to evaluate how the affects of income and illness on child nutrition varied as maternal education level varied (Table 1). The first interaction variable is schooling times family income. This variable shows if income is more important to child health among lower educated women than among more highly educated woman. The second interaction variable appearing in the models is schooling times fever. It is possible that more highly educated women have more knowledge in terms of child care and can provide better care for a child with a fever or is more apt to seek timely medical assistance than a less educated mother.

Diet Recall Variable Complications

Diet recall data for this study are difficult to interpret, as calorie and protein consumption are skewed to the right within a sample population which has clear indications of malnutrition based on the clinical child nutrition assessment and the field anthropometric measurements. When the explanatory variables Energy RDI and protein per energy are used in multivariate regression analysis, counterintuitive results occurred, with a significant negative relationship between energy and protein RDI and child nutrition status for most of the regression models. The major limitation of 24 hour diet recall data is that it is seldom representative of actual food intake (FAO, 2004a; Bloss et al., 2004). Several possible explanations for the surprisingly high values for energy consumption relate to the mothers over-reporting or over-estimating actual child food consumption in the 24-hour diet recall and the general level of difficulty in capturing accurate diet recall data that is representative of actual average food intakes. The researcher even noted a case of respondent bias when a mother saw the long list of possible foods and began to name off additional foods that the child had not consumed. Recall bias and respondent bias are problems frequently reported in the human nutrition literature (Bloss et al., 2004).

Weight-for-age Multivariate Regression

Four regression models are reported for the weight-for-age anthropometric index (Table 2). The first two models show the effects of child-level variables on nutrition status. The first model includes diet recall variables, gender, age, and morbidity. The second model includes these variables, but also controls for clinic nutritional classification and low weight at birth. The third model adds maternal-level variables. The last column represents the full model, including child, maternal, and household variables.

In model one, three of the variables have statistically significant regression coefficients, although only two have the expected signs. Energy RDI is statistically significant, but has a negative sign. The two morbidity variables, diarrhea and fever, are statistically significant with negative coefficients as hypothesized. The coefficient for fever is of a higher magnitude than that of diarrhea, indicating that given the other variables in the model, fever has more impact on underweight than diarrhea. The non-significant variables are protein per energy, gender, and child age. A child’s probability of being underweight does not appear to be affected by gender or age for this model specification.

Model two controls for clinic nutritional classification and low birth weight. The portion of underweight status explained by the model, as expressed by the R-square, increases with five statistically significant regression coefficients. Clinic nutritional classification, which is principally determined by a weight-for-age growth chart, has the highest value, as would be expected. Its sign is negative, indicating that children who were identified in the CSRA clinic records as underweight are at greater risk for having low weight-for-age Z-scores. Controlling for this, low birth-weight, diarrhea, fever, and energy RDI also appear to affect child weight-for-age status. All variables, except energy RDI, have the expected coefficient sign. Children who had low birth-weights, or were sick with diarrhea or fever are at higher risk for being underweight. In this model specification, the diarrhea variable has a larger regression coefficient than fever. Energy RDI continues to have a negative coefficient, and protein per energy, gender, and child age remain non-significant.

Maternal independent variables were introduced into the regression equation in Model three (Table 2). The R-square value increases slightly to 0.477 with six statistically significant explanatory variables. Energy RDI, diarrhea, clinic nutritional classification, and low birth-weight remain significant. Two maternal variables, number of children under five and schooling, as well as the interaction variable, schooling times fever, enter the equation as statistically significant explanatory variables. The number of children under the age of five has a negative sign, indicating that the more children a woman has under the age of five, the higher the risk of a child being underweight. Increased maternal schooling contributes to better nutritional status of the children. The magnitude of the clinic nutritional classification variable decreases slightly, while the magnitude of low birth-weight increases.

The schooling-fever interaction variable has a negative sign and fever is no longer significant. The interpretation of the interaction coefficient is that schooling is less important when children have fever, which is a more obvious sign of illness, but more important when children do not exhibit a fever. Mothers with higher educational levels are better able to identify more subtle signs of illness.

Variables dealing with household factors were added to the regression equation for the final weight-for-age model (Model four, Table 2). The R-squared value increased to 0.503 with eleven statistically significant variables. Being able to account for one-half the variation with this type of cross-sectional data is quite good. Of the four household variables, three are statistically significant. The refrigerator variable is significant and positive, indicating that children living in households with refrigerators are less likely to be underweight. Also both of the clinic area variables are significant with negative coefficients. Children in the VC and CLEM neighborhoods are more likely to be underweight than those living in the CR clinic area. This confirms the existence of differences between the three clinic areas in terms of underweight children when other child, maternal, and household factors are controlled for. Fever becomes significant again and protein per energy becomes significant, although with an unexpected sign. Maternal schooling, the number of children under the age of five, low birth-weight, clinic nutritional classification, diarrhea, and energy RDI remain significant and retain the same coefficient sign. Family income is not significant nor is the schooling – family income interaction variable.

Height-for-age Multivariate Regression

Height-for-age is a measure of long-term or chronic malnutrition. Because of this, the statistically significant explanatory variables for height-for-age differ somewhat from those for weight-for-age even though the two measures of nutritional status are highly correlated. The same variables that appeared in the weight-for-age models (Table 2) are used in the height-for-age models (Table 3). Four models are reported for the height-for-age anthropometric index.

The first model for height-for-age has an R-squared value of only 0.122 with three statistically significant variables, of which two have the expected signs (Model one, Table 3). Diarrhea, the explanatory variable with the largest regression coefficient, has a negative sign. As stunting is a sign of chronic malnutrition, it appears that diarrhea is a proxy for chronic illness and/or poor hygienic living conditions. Child age is also significant with a negative coefficient, indicating that older children are more likely to be stunted. This is consistent with the chronic nature of low height-for-age. Energy RDI is also significant, but with a negative sign which cannot be logically interpreted. Gender is not statistically significant, indicating that boys are no more likely than girls to be stunted.

The second child-factor regression model controls for clinic nutritional classification and low birth-weight (Model two, Table 3). The R-square more than doubles to 0.281 as clinic nutritional classification enters the equation as a statistically significant explanatory variable. The clinic nutritional classification, based on weight-for-age, has a large, negative coefficient, indicating that children classified as malnourished by the CSRA are more likely to be stunted. The other explanatory variables remain statistically significant with an increase in magnitude for diarrhea and a decrease for child age.

When maternal factors are included in the regression model, the R-square increases to 0.371 with five statistically significant explanatory variables. Two of the maternal factors significantly affect child height-for-age, the number of children under the age of five and maternal schooling. The variable for the number of children under-five has a negative regression coefficient, meaning that the more children a woman has under the age of five, the more likely her children are to be stunted. Maternal schooling has a positive regression coefficient, as more highly educated mothers are less likely to have children who suffer from stunting. The other statistically significant variables, energy RDI, diarrhea, and clinic nutritional classification retain the same signs. The interaction variable, schooling – fever, is not statistically significant, meaning that maternal education is equally important whether or not children show signs of fever.

The final model includes household explanatory variables and has an R-square of 0.449 (Model four, Table 3). Again, explaining approximately 45% of the variation in cross-sectional data suggests a good model specification. Four of the household variables are statistically significant with the expected regression coefficient signs. One of the clinic region variables, VC, is significant with a negative sign. This means that children living in the VC area are more likely to be stunted than those living in CR. Family income, as well as refrigerator, are statistically significant and have positive regression coefficients. Both higher income and increased household wealth contribute to decreased levels of stunting. Controlling for household factors causes child age to become statistically significant again with a negative regression coefficient. The other explanatory variables do not change in terms of significance. The school – family income interaction variable is statistically significant with a negative regression coefficient. This suggests that schooling and income are substitutes in the case of height-for-age.

Weight-for-Height Multivariate Regression Analysis

Weight-for-height Z-scores are a measure of short-term malnutrition and are commonly used to monitor growth changes with multiple measurements for the same child compared across time to evaluate the short-term effects of illness, and food shortages on nutritional status as well as obesity among children under the age of five (FAO, 2004). Regression analysis results in this study for weight-for-age are not as robust as for the other two anthropometric indices. Wasting, or low weight-for-height, shows large seasonable variability and is not recommended for evaluating nutritional status in non-emergency situations (Cogill, 2003). Several studies have questioned the accurateness of wasting, or low weight-for-height, in accessing nutritional status of poorly nourished children, stunted children, and Latin American children (Martorell, 2001; Victora, 1992). Four models are reported for the weight-for-height dependent variable using the same progression of variable additions as for the other anthropometric indices (Table 4).

The first model for weight-for-height includes child-level explanatory variables and has an R-square of 0.285 (Table 4). In this study, as in others, less of the variability of height-for-weight can be explained than that of height-for-height (Frongillo et al., 1997). Three variables are statistically significant, energy RDI, child age, and fever. The energy RDI variable continues to have a negative regression coefficient. Child age has a positive sign, which may seem counterintuitive, but is explainable. In calculating weight-for-height, height is in the denominator. From the previous set of regression equations, we know that as children become older, they are more likely to have lower height-for-age Z-scores. This means that as children become older, they are more likely to have shorter heights relative to the standards used to calculate the anthropometric indices. This results in a positive regression coefficient for child age when considering weight-for-age Z-scores.

The third statistically significant explanatory variable is fever with a negative regression coefficient. This is consistent with theory related to morbidity and its affects on short term growth, although diarrhea was expected to have a more significant affect on wasting. When clinical nutritional classification and low birth-weight are included in the regression equation the R-square increases to 0.401. This is the largest R-square among the wasting regression models. Again, explaining 40% of the variation in cross-sectional data of this type suggests that several critical factors have been included in the model specification. Clinic nutritional classification is significant and negative, again indicating that children classified by the CSRA as malnourished are more likely to be wasted. When clinic nutritional classification and low birth-weight are controlled for, fever is no longer statistically significant, although it retains a negative sign. Child age and energy RDI continue to be statistically significant with no changes in the regression coefficient signs.

When maternal factors are added to the regression model for weight-for-height, the R-square falls to 0.173. Five variables are statistically significant. The number of children under the age of five is significant, but has a positive sign. This seems counterintuitive, as generally having more children under the age of five translates into poorer child nutritional status. Considering again the role that height plays in the calculation of weight-for-height Z-scores, and the results from the height-for-age regression models, where the number of children under five has a negative regression coefficient, provides an explanation. The higher the number of children under the age of five, the more likely a child is to be stunted. This means that these children are more likely to be shorter for their age, which would result in a positive regression coefficient for children under five and weight-for-height.

The clinic nutritional classification is statistically significant, as are energy RDI and child age, all retaining the same regression coefficient signs as in the previous model. Gender becomes significant with a negative regression coefficient. This is the only model where gender is statistically significant suggesting that girls are at a disadvantage relative to boys in the weight-for-height model.

When household factors are included in the weight-for-height regression model, the R-square increases only slightly to 0.199. None of the household explanatory variables are statistically significant, except for the schooling – income interaction variable, which has a positive regression coefficient. This can be interpreted as meaning that schooling and income are complements for weight-for-height Z-scores. Gender is once again not significant, and energy RDI, child age, and the number of children under five remain significant with the same regression coefficient signs.

Conclusions and Implications

By considering child, mother, and household variables, a more complete understanding of the factors contributing to childhood malnutrition in Montero, Bolivia is possible. The clinical nutritional classification made by the CSRA medical staff was confirmed as an accurate indicator of both short-term and long-term malnutrition with a significant correlation with the anthropometric data collected in the areas served by the clinic[3]. It is very effective in identifying nutritionally at-risk children with little intrusion; however, it can be expanded upon by considering other child, maternal, and household factors. The clinical nutritional classification is used as a reference point for child nutrition status, then the regression analysis specifies what other variables significantly contribute to child nutrition status.

According to the regression results, child morbidity (diarrhea), the number of children under the age of five, maternal education, and household wealth significantly influence both short-term (weight-for-age) and long-term (height-for-age) malnutrition. Additional contributing factors to short-term malnutrition were found to be child morbidity (fever), and low birth-weight, while child age and family income are significant contributors to low height-for-age. It is also interesting to note that children living in the Villa Cochamba and CLEM clinic areas are more likely to suffer from short-term malnutrition, while children living in Villa Cochabamba are more likely to suffer from long-term malnutrition. This should provide some guidance to CSRA staff as they refocus their nutrition and health intervention efforts.

Recommendations for the CSRA based on the study results include the following. First, special attention should be given to the Villa Cochabamba and CLEM clinic areas since children under five in these two areas are more likely to be malnourished. They should focus more resources and time in the form of additional child nutritional supplements and vaccination coverage, maternal nutrition education, pre-natal check-ups,

[3] Clinic Nutritional Classification is significantly correlated with all three anthropometric indices at the .01 significance level with Pearson Correlation Coefficients of -0.566 for WAZ, -0.474 for HAZ, and -0.275 for WHZ.

and house visits. Second, the CSRA should focus more of its public health efforts towards the prevention of diarrhea and fever among young children. This may be done through ensuring safe drinking water for families or food safety and household hygiene education. Third, special health and nutrition educational initiatives should focus on the less educated segments of the population. Children of mothers with fewer years of schooling are at a greater health and nutritional risk, and hence merit extra attention. Additional child health checkups and nutrition education should be targeted to these households. Lastly, because of the relative success of CSRA in improving child health and nutrition relative to the rest of Bolivia[4], CSRA should consider expanding its approach to other communities in Bolivia.

Recommendations for larger-scale community interventions and actions in Bolivia and other low-income Latin American countries based on this study include the following. First, a community-level intervention that consist of a child feeding program with a maternal education component should target children living in households where mothers have low levels of education and two or more children under the age of five. The program could be modeled after the Women Infants and Children program in the United States in terms of inclusion of nutrition education along with supplemental food. Second, measures should be taken to attract sources of higher paying employment to the community, which could result in higher family incomes and a reduction in the prevalence of child stunting. A final recommendation is to expand local and national governmental programs to increase the education of girls through increasing accessibility and retention rates for females. Such efforts can have very positive long term benefits to

[4] Summary statistic results show that children in this study sample are better off than most children in Bolivia in terms of nutrition status and health. Women also receive better prenatal attention, receiving more pre-natal visits and maternal tetanus shots, than the average Bolivian woman (Taulman, 2006).

families and their communities through increased income potential, fewer children, and enhanced health and nutritional status of their children.

Survey-related recommendations include obtaining more detailed information for family composition, family income, and breastfeeding; including a food frequency survey to validate the 24-hour diet recall data; obtaining information on maternal nutrition through anthropometric data; and using more standard height-measurement equipment. Also, software with nutrient content information more appropriate for a specific developing country setting should considered. Finally, one suggestion for further research would be to conduct in two or three years a follow-up study to determine changes in child health status in the community of Montero, Bolivia since this initial study was conducted. Other households outside the CSRA area of influence should be included as a point of reference.

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Table 1 Variable definitions of regression variables[a]

Variable	**Mean Full Sample**	**Mean Sub-Sample**
WAZ	-0.108	-0.083
(weight-for-age Z-score)	(1.178)	(1.181)
HAZ	-0.776	-0.694
(height-for-age Z-score)	(1.436)	(1.477)
WHZ	0.483	0.455
(weight-for-age Z-score)	(1.108)	1.101
Energy RDI	124.287%	125.922%
(Percent of RDI Kilocalories)	(80.164%)	(77.662%)
Protein per Energy	3.065	3.042
(grams protein/100 kilocalories)	(1.529)	(1.300)
Gender	0.518	0.505
(0=male, 1=female)	(0.501)	(0.501)
Child Age	26.648	26.144
(months)	(17.333)	(16.980)
Diarrhea	0.283	0.282
(0=no, 1=yes)	(0.452)	(0.451)
Fever	0.300	0.340
(0=no, 1=yes)	(0.459)	(0.475)
Clinic Nutrition Class	0.195	0.186
(0=normal, 1=malnourished)	(0.397)	(0.390)
Low Birth Weight	0.031	0.032
(0=normal birth weight, 1=low birth weight)	(0.174)	(0.176)
Number Children	1.676	1.612
(children <5 yrs)	(0.644)	(0.623)
Schooling of Mother	6.804	6.790
(years)	(3.934)	(3.983)
Mother Work	0.344	0.303
(0=doesn't work, 1=works)	(0.476)	(0.461)
VC	0.332	0.324
(0=not from VC, 1=from VC)	(0.472)	(0.469)
CLEM	0.360	0.367
(0=not from CLEM, 1=from CLEM)	(0.481)	(0.483)
Family Income	0.899	0.905
(1000 Bolivianos)	(0.802)	(0.699)
Refrigerator	0.449	0.484
(0=no, 1=yes)	(0.498)	(0.501)
Schooling * Family Income	6.558	6.664
	(8.423)	(8.718)
Schooling * Fever	2.073	2.309
	(3.887)	(3.991)
n	247	188

[a] = Standard deviation in parenthesis

Table 2 Determinants of Weight-for-Age[a]

	Model one	Model two	Model three	Model four
Constant	0.796***	1.138***	1.070***	1.328**
	(0.217)	(0.214)	(0.320)	(0.419)
Child Variables				
Energy RDI	-0.005***	-0.004***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Protein per Energy	-0.009	-0.024	-0.046	-0.087*
	(0.048)	(0.056)	(0.055)	(0.059
Gender	0.038	-0.074	-0.071	-0.055
	(0.142)	(0.137)	(0.134)	(0.136)
Child Age	-0.005	-0.002	0.000	0.000
	(0.004)	(0.004)	(0.004)	(0.004)
Diarrhea	-0.274**	-0.380**	-0.367**	-0.356**
	(0.162)	(0.154)	(0.153)	(0.153)
Fever	-0.342**	-0.285**	0.051	-0.280*
	(0.160)	(0.146)	(0.276)	(0.144)
Clinic Nutrition Class		-1.436***	-1.333***	-1.295***
		(0.179)	(0.176)	(0.175)
LBW		-0.639*	-0.749*	-0.750**
		(0.397)	(0.393)	(0.400)
Mother Variables				
Number Children <5			-0.189**	-0.188**
			(0.112)	(0.111)
Schooling			0.060**	0.050**
			(0.021)	(0.029)
Work			0.060	0.115
			(0.147)	(0.147)
Household Variables				
VC				-0.410**
				(0.174)
CLEM				-0.280**
				(0.168)
Family Income				0.271
				(0.237)
Refrigerator				0.239*
				(0.155)
Interaction Variables				
Schooling * Fever			-0.053*	
			(0.035)	
Schooling * Family Income				-0.028
				(0.022)
n	247	188	188	188
R^2	0.144	0.435	0.477	0.503
F	6.720***	17.215***	13.301***	10.798***

a: Standard error is in parentheses.
* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level

Table 3 Determinants of Height-for-Age[a]

	Model one	Model two	Model three	Model four
Constant	-0.050	0.210	0.551	0.581
	(0.268)	(0.301)	(0.438)	(0.551)
Child Variables				
Energy RDI	-0.003**	-0.003**	-0.004***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Protein per Energy	0.079	0.069	0.023	-0.028
	(0.060)	(0.079)	(0.076)	(0.078)
Gender	0.190	0.140	0.158	0.173
	(0.175)	(0.193)	(0.184)	(0.178)
Child Age	-0.190***	-0.013**	-0.007	-0.008*
	(0.005)	(0.006)	(0.006)	(0.006)
Diarrhea	-0.488**	-0.510**	-0.501**	-0.513**
	(0.200)	(0.217)	(0.209)	(0.201)
Fever	-0.121	-0.154	0.231	-0.104
	(0.197)	(0.206)	(0.379)	(0.189)
Clinic Nutrition Class		-1.517***	-1.327***	-1.206***
		(0.252)	(0.242)	(0.231)
LBW		-0.163	-0.435	-0.426
		(0.560)	(0.538)	(0.527)
Mother Variables				
Number Children <5			-0.503**	-0.520***
			(0.153)	(0.146)
Schooling			0.083**	0.123**
			(0.029)	(0.039)
Work			0.094	0.231
			(0.201)	(0.193)
Household Variables				
VC				-0.692**
				(0.229)
CLEM				-0.219
				(0.221)
Family Income				0.660**
				(0.312)
Refrigerator				0.479**
				(0.204)
Interaction Variables				
Schooling * Fever			-0.064	
			(0.048)	
Schooling * Family Income				-0.091**
				(0.029)
n	247	188	188	188
R^2	0.122	0.281	0.371	0.449
F	5.566***	14.302***	8.603***	8.726***

a: Standard error is in parentheses

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

Table 4 Determinants of Weight-for-Height [a]

	Model one	Model two	Model three	Model four
Constant	0.926***	1.109***	0.690**	0.964**
	(0.212)	(.243)	(0.375)	(0.495)
Child Variables				
Energy RDI	-0.003**	-0.003**	-0.003**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Protein per Energy	-0.062	-0.054	-0.043	-0.051
	(0.047)	(0.064)	(0.065)	(0.070)
Gender	-0.121	-0.223	-0.229*	-0.218
	(0.138)	(0.155)	(0.157)	(0.160)
Child Age	0.010**	0.009**	0.008*	0.008*
	(0.004)	(0.005)	(0.005)	(0.005)
Diarrhea	0.037	-0.077	-0.054	-0.034
	(0.158)	(0.175)	(0.179)	(0.181)
Fever	-0.293**	-0.195	-0.108	-0.231
	(0.156)	(0.166)	(0.324)	(0.170)
Clinic Nutrition Class		-0.695***	-0.713***	-0.766***
		(0.203)	(0.207)	(0.207)
LBW		-0.543	-0.479	-0.505
		(0.451)	(0.460)	(0.474)
Mother Variables				
Number Children <5			0.198*	0.212*
			(0.131)	(0.131)
Schooling			0.016	-0.027
			(0.025)	(0.035)
Work			-0.036	-0.082
			(0.172)	(0.174)
Household Variables				
VC				0.065
				(0.206)
CLEM				-0.176
				(0.199)
Family Income				-0.220
				(0.281)
Refrigerator				-0.115
				(0.183)
Interaction Variables				
Schooling * Fever			-0.012	
			(0.041)	
Schooling * Family Income				0.040*
				(0.026)
n	247	188	188	188
R^2	0.285	0.401	0.173	0.199
F	3.526***	4.298***	3.046***	2.651***

a: standard error is in parentheses.

* Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.