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Erik A. Bloom

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by

Erik A. Bloom[1]
Division de Economía
Centro de Investigación y Docencia Económicas
Email: bloome@dis1.cide.mx

ABSTRACT

Using data from a low income region in the Philippines, the paper studies the socio-economic influences on the health of surviving children. Care is taken to avoid bias through the use of reduced form estimation. Endogenous choice variables are excluded from the analysis. Three anthropometric indicators, height-for-age, weight-for-height, and arm circumference-for-age, are used with hemoglobin as proxies for the underlying health of children. Income is shown to play an important role in the determination of child health, as is parental education. Community variables influence child health as well.

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AN ANALYSIS OF CHILD HEALTH

This paper focuses on the determination of child health in the Bicol region of the Philippines. Several indicators are used to measure both the current and the long term health and the nutritional status of children. The results show that differences in child health can partially be explained by differences in relative prices and household income.

1. The Determination and Measurement of Child Health

The household demands health for several reasons. First, good health is an investment in the future. A child with poor health faces the risk of early mortality, and if he survives, he may not be an effective worker. Health may affect the wage that an individual receives (Strauss, 1986, Deolalikar, 1988, Dasgupta, 1993) and thus the child's economic contribution to the household. Second, health is demanded as a consumption good, above and beyond its economic value as an investment.

Economists view health as a commodity produced by an underlying household production function (Rosenzweig and Schultz, 1983).[1] The production function describes the technology that the household (as the producer) utilizes to create good health for its members through its choice of health inputs. Good health requires the expenditure of scarce resources to purchase health improving inputs, including curative drugs, an adequate diet, and an hygienic environment. As such, health is a scarce good and economic agents (individuals and households) will often be limited by economic constraints from improving their current state of health. Health and many health inputs are not priced by the market, although it may be possible to construct a shadow price based on the value of the priced components.

There is no market for health. Differences in health across households reflect differences in relative prices, income, preferences, health affecting technology, and community conditions. The environmental condition of the community may also affect the health of residents both by altering the relative prices of health producing inputs (for example, the marginal cost of potable water) and by producing public goods (or "bads") that improve (worsen) the health of everyone. There are many commodities that inadvertently affect health as well. For example, the household may not recognize the effect of cigarette smoke on both their own health and on the health of their children.[2]

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[1] Household here is taken to be synonymous with family.

[2] Ideally the household should incorporate the negative effect of the commodity in the budget constraint, raising the shadow price of the commodity in question. If the commodity has a positive effect on health, then its shadow price should be lower than its (market) purchase price. Consider the difference between an hour of leisure spent in front of the television versus an hour of leisure engaged in exercise. It is reasonable to assume that households do not take the inadvertent health effects fully into account due to ignorance.

Unlike adults who have some degree of control over their own health and environment, children's health is entirely determined by forces beyond their individual control. The decision makers of the household (typically the mother and father) make critical decisions that affect the health of children and ultimately influence the children's probabilities of survival. The household's capacity to make some decisions is constrained by limited economic resources and understanding of health technology.

A. Conceptual Framework

Many studies have implicitly estimated health production functions, using bio-medical inputs, exposure to environmental hazards, and individual behavior as determining variables. It is also common to include individual and household characteristics, such as education, birth order, and income to create a hybrid production function. These studies have recognized that an individual's underlying health is influenced by certain health inputs (often called "proximate determinants" in the public health literature), such as nutritional intakes, sanitary conditions, individual behavior, and the use of preventative medical services (Mosley and Chen, 1984).

Economists have criticized this method of estimation because it ignores the fundamental endogeneity of many health inputs (Rosenzweig and Schultz, 1983, Behrman and Deolalikar, 1988). If an endogenous health input is treated as an exogenous variable, significant biases in estimation will occur. Studies of child health have often taken child characteristics, such as birth weight and past illness, and family decisions, such as family size, sanitary practices, and breastfeeding behavior, as exogenous. This creates biases in estimation because fertility, health, and other household decisions have a joint error structure. Endogenous inputs may serve as proxies for unobserved variables, such as health knowledge, preferences, and innate individual healthiness. Since these unobserved variables usually influence the choice of the observed inputs, the inclusion of endogenous inputs as if they were exogenous will yield incorrect structural parameters.[3]

To control for the simultaneity bias, it is possible to estimate the level of the health inputs with exogenous variables serving as instruments. This requires a large number of independent instruments that are often not available in many socio-economic surveys. The specification of the production function is not a trivial issue because different specifications can result in different conclusions.

An alternative to the production function approach is reduced form estimation. A health outcome is estimated as a function of all of the exogenous

[3] For example, if pre-natal care is costly, mothers who expect healthy children will be less likely to visit maternity clinics. If these expectations are correct, estimation of a health outcome will often show that children who received pre-natal care are more likely to be unhealthy after birth. In this case, the bias in estimating the technological effect of prenatal care is caused by the fact that $E(x, \mu_i) \neq 0$, where x is a measure of pre-natal care and μ_i are unobserved characteristics.

variables that influence the demand for the inputs and the production of health. Reduced form estimation can be useful for policy purposes, where the goal is to affect the outcome variable, since governments have the ability to influence certain exogenous variables, such as the distance to a health clinic or the cost of drugs. Unlike the estimation of a structural production function, reduced form estimation does not identify the behavioral mechanism that leads to better health, it just identifies exogenous characteristics that are associated with better health. In other words, it does not indicate the mechanism that a close health clinic uses to influence health.

For the determination of child health, reduced form estimation models health outcomes as a function of: (1) Community provided services and the community health environment, C_{HV}. These inputs are generally not controlled by household. It is assumed that households do not migrate among communities in response to a different mix of community services.[4] (2) The health endowment of the individual and other fixed individual characteristics, C_{HC}. These are given at birth and cannot be affected by household or community action and may be associated largely with genetically programmed capacity. Many of these inputs are generally unobserved (by the researcher) determinants of health and ultimately of survival, but may be partially observed by the parents who may alter their behavior in response to their child's endowment. (3) Household characteristics that are assumed to be fixed or exogenous to the health production process, C_{HH}. These include education and other innate characteristics that are specific to the household and its members.

(4) The exogenous prices of potentially purchased inputs, **P**, and the price of time of the household members, **W**. These potential inputs include the use of medical services (drugs, doctor visits), nutritional intakes, the quality of dwelling and of the sanitary environment (presence of a toilet, water quality), and time spent on health related activities (e.g., breastfeeding, care of sick children). Economic theory suggest that the price of other goods, such as education or leisure, may also play a role in the determination of health because the household faces a unified budget constraint and expenditures in one area reduce the possibility to expend in an alternative area. Certain inputs may only be implicitly priced, for example the value of maternal time for non-working mothers. Some inputs are purchased in response to prior health conditions in the household, such as past illness and disability. The endogenous household inputs and outputs can also be priced with shadow prices that capture the value of market purchased inputs and household time used in production. Except under restrictive conditions on the underlying household

[4] This may be a strong assumption. Schultz (1988) finds in Colombia that heterogeneous preferences for family size, child quality, and employment influence the migration decision. Rosenzweig and Wolpin (1988) also find that failure to account for migration selectivity can lead to bias in estimation in the calculation of the effects of public programs.

technology, the shadow prices must be treated as endogenous and cannot form part of the estimation (Pollack and Wachter, 1975, Becker, 1991).[5]

(5) Exogenous measures of income or assets, v. To the extent that an individual can allocate his time to market and non-market activities, income must be treated as an endogenous variable. However, there are many sources of income that are exogenous to health related decisions, such as inherited wealth and unearned income.

The reduced form equation can be written:

(1) $H_i = h(P, W, V, G_{HC}, G_{HH}, G_{HV}; \mu_i) = h^*(P, W, V, G_{HC}, G_{HH}, G_{HV}) + \mu_i$

Where μ_i is unexplained variability, assuming an additive, separate error term.[6]

If a variable in (1) is unobserved, it is implicitly subsumed into the error term. It is for this reason that only exogenous variables should be used on the right hand side.

Estimation depends on the data and the assumptions made about the error, including the relation between the error term and the observed variables. For the purpose of this paper, the variables of interest are nutritional status, proxied by different anthropometric indicators. These observable anthropometric indicators have been shown to provide an indication of the underlying (unobservable) health status, both on the actual health status and on the probability of subsequent mortality (see Dasgupta, 1993 for a review).

B. Measures of Child Health

Height-for-age, the height of the child compared to the height of a healthy population of children of the same age and sex, is frequently used as a measure of the long run health status of children. Stunting (low height) can be an indication of chronic malnutrition and of past incidence of disease. Weight-for-height, the child's weight compared to the weight of children from a healthy population with the same height and sex, is a measure of the short term or current health status. Wasting (low weight) is the result of low dietary (primarily caloric) intake, stress from recent incidence of disease, and work related activities. Unlike stunting, wasting can be reversed. In many societies, wasting is common in "the lean season" before the harvest or when food prices are seasonally high. For children over the age of one, increased caloric intake will lead to an increase of weight to healthy levels (Waterlow, *et al*, 1977, Trowbridge, 1979).

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[5] The primary assumptions are constant returns to scale and no joint production of outputs.

[6] The unexplained term, μ_i can be thought of consisting of four components: an individual specific effect ξ_i, a common household effect α_h, a common community effect υ_c, and a random error ε_i. A common effect is a measure of unobserved heterogeneity that influences all individuals in the household or the community. The individual effect is unobserved persistent heterogeneity.

For children, upper arm circumference is a commonly used measure of malnutrition. It has the advantage that for children between the age of one and five, it is relatively invariant to the child's height, age, and sex. Although there is some increase with age, the percentage increase is much less than the increase in height for children of the same age group (Sommer and Loewenstein, 1975).[7] A small arm circumference indicates reduced muscle mass, which is a sign of protein-energy malnutrition in growing children and can be a signal of severe malnutrition.

Anemia is a common nutritional problem affecting both adults and children in many low income countries.[8] Anemia limits the body's ability to circulate oxygen to the muscles and other tissues, thus reducing the amount of energy that the individual can produce. Anemia is usually caused by a diet that is low in usable iron. Studies suggest that anemic workers are less productive than non-anemic workers; in controlled experiments, iron supplementation has been shown to increase the output of anemic workers. There is also evidence to suggest that non-anemic children perform better in school, although this evidence is less conclusive (for a review of studies, see Levin, 1986 and Behrman, 1993). There are a number of different indicators to measure iron deficiency (see Beaton, *et al*, 1989 for a survey). The most common indicator is hemoglobin (Hb) count in the blood, measured in grams per 100 milliliters (g/100 ml) units. Iron supplementation and fortification programs can usually reverse anemia within several months.

Both weight and final height have a genetically programmed component and are highly correlated with the height and weight of an individual's parents (Sinclair, 1989). However, since much of the variation is caused by food and nutrient deficits and by the incidence of disease, these measures are important tools to estimate the individual's health status. Nutrition experts favor height-for-age, weight-for-height, and arm circumference-for-age over other anthropometric indicators, such as weight-for-age, because many other measures do not adequately control for the ability of humans to partially adapt to a small stature nor do they take into account the different energy requirements of different sized individuals (Waterlow *et al*, 1977).

A number of studies have demonstrated the relationship between anthropometric indicators and the subsequent risk of mortality. Sommer and Loewenstein (1975) using data from Bangladesh show that children aged one to four who suffer from mild or severe malnutrition, as measured by upper arm circumference, have a higher probability of subsequent mortality. Using the same survey from Bangladesh, Chen *et al* (1980) show that the preschool aged children with the lowest anthropometric indicators (height-for-age, weight for height, weight-for-age, arm circumference-for-age, and arm circumference-for-height) have a substantially higher probability of mortality than the children with the highest

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[7] For example, the median arm circumference for girls aged one in the United States is 15.7 cm. compared to the median of 17.1 cm for boy aged five (Frisancho, 1990).

[8] For example, estimates of the prevalence of anemia in the Philippines range as high 70% for pregnant women. 42% of preschool children suffer from anemia (studies cited in Levin, 1986).

anthropometric scores. Trowbridge (1979) compared the anthropometric scores (weight-for-age, height-for-age, weight-for-height, and arm circumference for age) to clinical tests of malnutrition for a sample of young children in El Salvador. He found that all children who had both low weight-for-height and low height-for-age were clinically malnourished as were all pre-school children with very small arm circumferences. Children who were only stunted (but not wasted) were generally not found to be clinically malnourished. Approximately one quarter of the children judged to be malnourished using only weight-for-age were found not to be malnourished using precise clinical measures. This should not be taken to suggest that there is a causal relationship between anthropometric measures and mortality, rather that the same factors that lead to malnutrition also lead to a higher probability of morbidity, stunting, and mortality.

2. Health and Economic Theory: Hypotheses

Economic theory and the empirical health literature provide a number of hypotheses about the determination of child health. Much of the empirical literature ignores the difference between exogenous variables that affect the utility function, the budget constraint, and the production function and endogenous choice variables that are themselves functions of the observed and unobserved exogenous variables. Since endogenous choice variables are correlated with the error term, they will bias the results if they are treated as exogenous explanatory variables.

A. Parental Education and Child Health

Education, particularly mother's education, is credited with playing a major role in the determination of child health. Parental education can affect health through several different avenues and in the absence of a structural model of health production and demand, it is not possible to identify education's different effects.

Schultz's (1984) review suggests at least five distinct routes that mother's education can play to alter child mortality and morbidity. Higher education can: 1) increase the efficiency of health inputs; 2) improve the understanding of the best mix of health inputs; 3) increase income and resources; 4) increase the value of mother's time, which can act to increase mortality; and 5) alter the world view, changing preferences for child health and family size and reducing fatalism and superstition.[9] The first two routes refer to education's potential role improving the household's production of health. The second two underline the often complicated relationship between health and income. Although the time of better educated mothers is more valuable, they may be able to use it more efficiently to produce child health. Changing the value of the mother's time will not only provide more (potential)

[9] Caution must be taken with this interpretation. The purpose here is not to suggest a causal relation between preferences and education. Rather there maybe a correlation between unobserved preferences and education. Education may reduce superstition and thus change the world view.

income, it will alter the shadow prices for all household produced commodities, including health.[10] Father's education may have similar effects on children health as mother's education although the empirical literature has focused on the father's ability to provide more resources on not on other potential routes.

The empirical evidence overwhelmingly shows that increases in mother's education has a positive effect on child health, regardless of how it is measured. Mother's education has been shown to have a positive relation in many studies of anthropometric outcomes, including in Brazil (Thomas *et al*, 1990, 1991), in the Philippines (Horton, 1985, Barrera, 1988,1990), and in many other populations.

Empirical analysis has tried to identify the mechanisms that mother's education takes to improve household health. Barrera (1988,1990), using the same data employed here, argues that maternal education works by improving breast feeding (i.e. optimal number of feedings, weaning at the appropriate age), and by interactions with the public health and sanitary environment. These results suggest that maternal education works through the production function. Barrera did not include father's education as a determining variable in his analysis. Horton (1986), using the same data set, finds in a reduced form analysis that father's education is generally a more significant determinant of child height than mother's education. Using Brazilian data, Thomas *et al* (1990) show that education of both parents is still significant after either unearned income or per capita household expenditures are controlled. This implies that education plays a greater a role than simply increasing the household's cash income. With the same data, Thomas *et al* (1991) show that education affects health outcome through its interaction with the public health environment. They also find that controlling for the sources of information (radio, newspaper, ect.), which they treat as endogenous, the effect of mother's education is completely absorbed, implying that mothers with higher education will take greater advantage of health information. They argue that the primary benefits of maternal education in Brazil is through the production function and not through raising household income or the reallocation of time.

The Cebu Study Team (1991) analyzes different infant health outcomes in the Cebu province of the Philippines using the production function approach. They find that mother's education is associated with greater caloric intake, a higher probability of measles immunization, a lower probability of poor excreta disposal, and increased use of soap. Higher education is associated with a lower probability of breastfeeding. They then find that many of these endogenous variables have the expected effect on the health outcomes. The Cebu Study Team excluded father's education and assumed that mother's education is only effective through the observable health

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[10] This applies to all commodities that the mother produces with the expenditure of her time.

inputs.[11] They found similar results using a similar methodology in Cebu Study Team (1992).

However in many societies, father's education may play a role in the production of child health as well. Many studies have excluded father's education as an independent variable. This may reflect a lack of data, but in many cases where paternal data is available, it suggests that researchers have decided for implicit theoretical reasons to exclude the father's education from the determination of child health.[12] Thomas and Strauss (1993) show that in Brazil, father's education has a similar effect as mother's education on child height and they cannot reject the hypothesis that the two coefficients are equal for several specifications. In a review of the literature, Behrman (1990) argues that the role of mother's education as an input in health production may be exaggerated. His literature review includes a comparison of the results of Barrera (1988, 1990) and Horton (1986).

B. Household Income and Wealth

The role of income in the determination of health is controversial. At issue are the income elasticities of nutritional intake, health inputs, and health itself. Studies differ widely on the estimates of these income elasticities.

Several problems exist with income as a variable in the estimation. First, income is an endogenous variable. To a large extent income is determined by the parent's allocation of time spent in the production of child quality, child quantity, and market work. Given education, prevailing market wages, and unearned income, total income is a choice variable. Many studies that include income as an exogenous variable face the risk of biased results. Second, even if the allocation of time to market work and health production is exogenous, health may affect both the parent's and child's wage.

Father's income or total income minus the mother's income contribution is often treated as an exogenous variable. This can lead to biased results as well. While it is true that most fathers work regardless of their wife's employment status, the choice of job (and thus the wage) and the hours worked may depend on a joint employment decision. Other relatives (particularly children) may also consider the mother's employment when deciding to enter the work force.

Since financial and real assets produce income independent of the allocation of time to labor, leisure, and household production, the flow of unearned income can be used to measure the pure effect of income on household outcomes

In reviews, Behrman (1989), Bhargava (1990), and Strauss and Thomas (1994) report that the income elasticity of caloric intake has been estimated in a range from nearly zero to greater than one. Differences seem to depend on the population of

[11] Mother's education was not included as an input in the production function, so its entire effect was captured by the included inputs.

[12] Justification may include that father's education is not an exogenous variable (due to assortative mating) or that from a structural standpoint, the father has no direct or indirect effect on child health.

interest, the income quintile of the group (poorer people often have higher income elasticities), and the estimation technique. It should also be noted that accurate data on macro- and micro- nutrient intake are rarely collected. Nutritional intake is usually calculated from estimated food consumption. Strauss and Thomas argue that using disaggregated data and careful estimation, the income elasticity for caloric intake is low but positive for low income households.

Barrera (1988, 1990) in an analysis of the demand for health inputs in the Philippines finds that higher income influences health by altering the household environment (the provision of water, toilets, ect.). Barrera subtracts the mother's contribution to household income and treats the remaining income as exogenous.

Ellis and Mwabu (1991) in a study of the demand for health care inputs (outpatient medical care) in Kenya find that while income is associated with a lower probability of reporting an illness, higher income individuals are more likely to seek formal treatment for their illness. Higher income individuals tend to choose higher cost health care facilities. Ellis and Mwabu treat income as exogenous.

C. Parental and Child Characteristics

Child health is affected by the child's own innate endowment and by their parents' characteristics. The household may act differently towards different children depending on each child's endowment. For example, the household might concentrate more resources on boys or on sickly children. Different characteristics might also affect the health production function so it may not be possible to separate the household's adjustment to the child's endowment from the effects of the child's endowment on the health production function.

Research in many countries suggest that there is sex discrimination within the household. For example, Thomas (1993) finds that in the Brazil, Ghana, and the United States, mothers tend to allocate resources to benefit their daughters, and fathers tend to allocate resources to benefit their sons.

Using Philippine data, Barrera (1988,1990) shows that boys are relatively shorter than girls. Thomas and Strauss (1993) found similar results in Brazil. Results from South Asia would likely show that boys are relatively taller than girls.

Parental height should positively affect child height because height is partially determined by the parent's genetic endowment and should be included when available.

D. Environmental and Community Characteristics

A good household sanitary environment is associated with good health. The household chooses (given constraints) its sanitary environment. Although the household may have control over its own environment, households are also part of a community. Local conditions can affect health outcomes, as public goods (or "bads") impose joint consumption by all community members or by altering the relative prices in the community.[13]

There are a number of options to deal with the endogeneity of the household environment. Barrera (1988, 1990) estimated the endogenous household variables using exogenous household and community instrumented variables. These instrumented variables were then used as determinants of height-for-age in the Philippines. This is the production function approach. An alternative approach is to use only exogenous community indicators as measures of the local environment. Community variables are not dependent on household actions and are exogenous. Households do have the option of leaving a community, but this is a less significant factor then the household's ability to influence its own immediate environment.

Both Barrera (1988, 1990) and Horton (1986) use reduced forms to estimate height-for-age in Bicol with community level indicators of sanitary conditions. The results from both of the studies suggest that these variables are not as critical determinants of health as was seen in studies that ignore the endogeneity of household choices.

Thomas and Strauss (1993) find that in Brazil, the presence of basic infrastructure is positively associated with child height. For example, the presence of a sewer leads to an increase in older (age five to nine years) children's height and is also complementary with mother's education. They find that access to medical services is not associated with improved children's health, possibly due to measurement problems or endogenous placement of services.

E. Prices and Child Health

Since health is a commodity that is produced with purchased inputs and since health production inputs are scarce good that must compete with other goods for a share of the household's resources, the price of all goods have a potential effect on health outcomes (Behrman and Deolalikar, 1988). This applies to goods that are not directly related to the production of health.

An important distinction must be made between prices, which are exogenous, and expenses, which are endogenous. The price of a visit to the doctor's office should not be equated with the out of pocket expenses of a doctor's visit, which might include the cost of tests and drugs prescribed. Ideally the price should be a measure of the expected (*ex ante*). An example might be the distance to a free medical clinic.

Some goods may be both produced and consumed by the household. Raising the price of goods produced by the household may directly alter the household's income in addition to the traditional substitution and income effects (Singh *et al*,

[13] For example the presence of a community sewage system might improve the sanitary condition of all of the community's residents and also lower the price for each household to have sanitary disposal of sewage.

1986). Increasing the consumption of some commodities may lead to an inadvertent change in health (for example, cigarettes) and a change in the price of these goods may also affect health.

Thomas and Strauss (1993) interact income with prices to test for differences in price elasticities in different income quintiles in Brazil. They show that the height of urban children is adversely affected by raising the price of meat. Increases in the prices of grains, beans, and meat raise the height of rural children, probably capturing the fact that many rural households produce these commodities. The poorest quintile benefits the most from an increase in the price of grains most likely since they are net producers of grain. Barrera (1988, 1990) in his study of Filipino children generally find prices to be insignificant determinants of child height.

3. Description of Data

The Philippines provides an interesting opportunity to study the household's allocation of investments in human resources. The World Bank (1993) classified the Philippines as a lower middle-income economy, with an annual per capita income of $730 in 1990. Despite its low-income, the Philippines is a well educated country. Its 1990 adult illiteracy rates of 10% is low for a middle income country and school enrollment levels are relatively high. The secondary school enrollment rate in 1990 was 73%. Unlike many Asian countries, there is little difference between male and female education attainment (World Bank, 1993). Life expectancy at birth was 65 years in 1990, which is slightly below average for lower-middle income countries. The proportion of low weight babies is 18%, which is quite high for a middle income Asian country (World Bank, 1993).

A. The Bicol Multipurpose Survey

This analysis is based on a survey conducted in 1978, the Bicol Multipurpose Survey(BMS). The survey was initiated as part of a major development scheme for the Bicol region, the Bicol River Basin Development Program (BRBDP). The Bicol region is one of the poorest regions in the Philippines. In 1974, its per capita income was 49% of the national average. In the 1980's, Bicol had the highest incidence of poverty of any of the 13 regions of the Philippines and the second highest incidence of rural poverty (Balisacan, 1990). Even by current standards, the 1978 BMS is a very comprehensive data set both in terms of its coverage and accuracy.

The Bicol region is located on the island of Luzon and on two adjacent islands. The Bicol region has six provinces: Albay, Camarines Norte, Camarines Sur, Catanduanes, Masbate, and Sorsogon. The population of the Bicol region in the 1980 census was 3,477,000 or 7.2% of the total population of the Philippines.

The infant mortality rate in Bicol was 64.8 per 1000 live births and the life expectancy at birth was 64.3 years in 1980, compared to the national infant mortality rate of 67.6 per 1000 and life expectancy of 60.6 years (Gonzaga-Esclamad *et al*, 1984).

The 1978 BMS interviewed 1903 households in 100 barangays in three of the Bicol Region's six provinces-- Camarines Sur, Albay, and Sorsogon.[14] In 1980, these three provinces had a total population of 2,409,000 in three cities and 68 municipalities. The BRBDP divided the three provinces into Integrated Development Areas (IDAs). Twenty IDAs and sub-IDAs were the sample clusters in the 1978 BMS.[15] The twenty sample clusters cover virtually the entire population of the three provinces.[16] The population of the sample clusters ranges from 1,215 households to 32,450 households, with an average of 16,900 households. The number of respondents in each sample cluster was set at 96, although the final sample was slightly reduced due to last minute attrition.

Since most IDAs and sub-IDAs had both urban and rural areas, the population in each sample cluster was divided into two strata: urban and rural. All of the barangays in each sample cluster were identified as either urban or rural and stratified by size (the number of households). Based on the distribution of population in urban and rural zones, urban and rural barangays were randomly selected for the survey. The number of respondents per selected barangay depended on the barangay's population and the percentage of households in the sample cluster living in urban areas. Many of the rural barangays were extremely isolated without any road or rail connections. Camarines Sur had 1050 respondents living in 61 barangays, Albay had 479 respondents in 24 barangays, and Sorsogon had 374 respondents in 15 barangays.

Most of the households were composed of a single nuclear family. A head of household was identified in each household. In most cases, this was the father of children living in the household. The wife of the head is therefore the mother of the children in the household.

Table 3.1a reports the means and standard deviations for the individuals in the working sample from the 1978 Bicol Survey. The working sample includes all households with anthropometric data on children age 15 and younger (age 13 or younger for arm circumference). 1295 households, with a total of 4064 children had sufficient data for this analysis. The actual number of children used in the analysis is less because many of the parents did not have anthropometric measures taken during the survey. The data omits one or more measurements, for some of the children in the sample[17] Table 3.1b reports the means and standard deviations of the

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[14] Barangays (also known as barrios) are political subdivision in municipalities and cities. In rural areas, they are equivalent to villages and in urban areas they can be thought of as neighborhoods. Barangay population varies widely.

[15] These twenty sample clusters include three chartered cities and eight sub IDAs, which were themselves part of four IDAs.

[16] One IDA in Camarines Sur (the Caramoan Peninsula) was excluded due to its extreme isolation.

[17] Slightly more children have weight measures than height measures, although the difference is never more than 1% in any age class.

hemoglobin measurements for the children in the analysis, stratified by the age of the child (six to 71 months and 72 months to 168 months).

The household expenditure variable is the annualized value of the previous week's spending on food and tobacco, plus the annualized value of the previous month's expenditures on electricity, fuel, water, entertainment, and cleaning products. The value of rental housing is also included and if the household owned its own dwelling, rent is imputed at 12% of the value of the dwelling following North and Griffin (1993). The expenditure variable is divided by the number of adults over the age of 18 in the household. The water variables report the percentage of households that have a private, non-shared source of water (from a pipe, an owned well, or an owned pump) and the average distance to the nearest water supply.

Table 3.2 reports the first order correlations of the variables from the sample used for the analysis of height-for-age. The first order correlations for the other samples are very similar.

Anthropometrics in the Bicol Multipurpose Survey

The Bicol Multipurpose Survey collected anthropometric data on the respondents in the survey. Measures of arm circumference (cm.), weight (kg.), and height (cm.) were taken from the majority of the parents and children living at home. The hemoglobin count was also measured as an indicator of the prevalence of anemia.

Tables 3.3a to 3.6b present descriptive statistics on the anthropometric indicators and hemoglobin count of the children in the Bicol survey. The sample in these tables differ from the sample in the analysis section because the data set is missing the observation of some variables from some of the children.

Table 3.3a reports the percentage of children, age one to five, in the 1978 Bicol survey that fall into one of three categories of malnutrition based on arm circumference: 1) less than 12.5 cm., indicating severe malnutrition; 2) 12.5-13.5 cm., indicating mild malnutrition; 3) children judged not malnourished, with an arm circumference greater than 13.5 cm (Sinclair, 1989). According to this measure, 19% of the children suffer from energy-protein malnutrition, with more than 5% suffering severe malnutrition.

Table 3.3b compares the arm circumferences of the children in the survey to children of the same age and sex in the Untied States (Frisancho, 1990). It is clear that Filipino children are significantly malnourished compared to American children of the same age. Less than 5% of Bicol children have thicker arm circumference than the American median. More than 50% of children fall below the level of the lowest 10th percentile of the American children, with a significant number below the fifth percentile level.

In the first six years of life, there is a definite improvement in the arm circumference figures. As children get older, fewer children fall below the fifth percentile and significantly more children fall in the 10th to 25th percentile. While these children are malnourished compared to American children, they are probably not suffering from severe muscle wastage. After the age of six, there is no clear improvement in child nutrition. It is possible that those children who suffer from severe muscle wastage have died during their first five years of life.

Anthropometric indicators are typically measured using Z-scores, which normalize the measurements using the means and standard deviations from a healthy population, expressing each indicator as a deviation from the mean in units of standard deviations . Because the measurements are normalized, children of different ages can be pooled together for analysis. Table 3.4a reports the average Z-score of height-for-age, weight-for-age, and weight-for-height for Bicol children compared to the NCHS sample of children in the United States (Frisancho, 1990). The results show a number of clear trends. First, Bicol children are substantially shorter than similarly aged American children. The average Filipino child is more than two standard deviations shorter than the average American child. For a five year old boy, this is approximately ten centimeters. Second, although Filipino children are underweight compared to American children, their weight-for-height measures are significantly closer to the American means than their height-for-age measures. This suggests that Filipinos adapt to some degree to their small stature. Third, although height-for-age seems to be relatively invariant to age, there is an increase in weight-for-age after the age of two. It is common to see a large deficit in the weight-for-height for children of the age of one to two that is quickly eliminated even as the height-for-age and weight-for-age deficits are maintained (Waterlow *et al*, 1977). This confirms the trend seen in the arm circumference figures presented in table 3.3b. Only part of this increase is likely to be due to the fact that underweight children face a greater risk of early mortality and thus are less likely to survive into the later age categories in the cross section sample. The standard deviation of weight-for-age and weight-for-height are quite low, which indicates that there are relatively few obese children in the sample.

The Gomez (1956) classification of malnutrition divides children into categories based on their weight as a percentage of the US median weight-for-age.[18] This is a common measure of malnutrition although it is based on weight-for-age, which has been shown to be an inferior indicator of child health status. Based on the Gomez criteria, presented in table 3.4b, a different picture of the nutritional status of Bicol children emerges. After the first year of life, there is a substantial decrease in the number of children who are classified as moderate and severely malnourished. This improvement continues until the age of five, when the percentage of moderately malnourished children starts to rise. After the age of ten, the percentage of severely malnourished children increases dramatically.

[18] Children 90% or greater than the median weight are classified as normal, those with 75% to 90% of the weight are mildly malnourished, 65% to 75% moderately malnourished, and less than 65% of the US standard are severely undernourished. For the sake of comparison approximately 25% of American 10 year boys would be not classified as normally nourished. Fewer than 5% would be classified as moderately malnourished or worse.

Table 3.4c presents the percentage of Bicol children in each age category based on their current weight for height score. The data shows a significant drop in the number of children with weight-for-height below both the 5th percentile and 10th percentile levels as age increase. This is consistent with previous findings in tables 3.4a and 3.4b. Few children are above the median American weight-for-height level, even as the mean weight increases.

Tables 3.5a and 3.5b report the cross tabulation between weight-for-height and height-for-age for children aged 1 to 10 and 11 to 15 respectively, as suggested by Waterlow, *et al* (1977). All children with both of these measures are included in the table. This identifies the children who are both unusually short, due to chronic conditions, and underweight. For older children, approximately 13% of children fall within the four "southeast" cells. These children are the most likely to suffer from clinical malnutrition and face the greatest risk of early mortality from malnutrition and poor health. Only a very small percentage of the population fall in the extreme "northwest" cell, which approaches the United States means.

Studies differ on the proper definition of anemia in children and adults, although the World Health Organization has defined a minimum level of hemoglobin count below which anemia is present: children six to 71 months, 11 g/100 ml; children 72 to 167 months, 12 g/100 ml; male adults, 13 g/100 ml; non-pregnant female adults, 12 g/100 ml; and pregnant female adults, 11 g/ml (Levin, 1986).[19]

Tables 3.6a and V.3.6b report the distribution of hemoglobin count (in g/100 ml) by age groups for girls and boys respectively. It is clear that there is a significant percentage of children in the Bicol region that suffers from anemia. The prevalence of anemia drops with the age of the child. This is not surprising since anemia is typically higher for infants and young children because the iron content of milk is low and the body is rapidly growing, depleting iron reserves (National Research Council, 1989). Anemia appears to be more common among boys than girls in the sample population.

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[19] Beaton, et *al*, (1989) calculate the average hemoglobin count (g./100 ml.) in Canada for children aged zero to thirteen years as: 11.9+.14*age in years, for boys; and 12.1+.11*age in years, for girls (calculated using OLS).

Table 3.1a Means, computed at the individual (child) level.
Households included in the analysis.

	Means and Standard Deviations		
	Sample used in analysis of Height for Age	Sample used in analysis of Weight for Height	Sample used in analysis of Arm C. for Age
Variable	Mean (Standard. Deviation)	Mean (Standard. Deviation)	Mean (Standard. Deviation)
Endogenous variables:			
Z-Score of Height for age	-2.14 (1.30)		
Z-Score of Weight for height		-.700 (.933)	
Z-Score of Arm-Circumference for age			-1.36 (.648)
Household Expenditures per adult in household, Philippine Pesos	1900 (1540)	1900 (1540)	1900 (1530)
Exogenous individual and household variables:			
Years of mother's education	5.75 (2.85)	5.75 (2.85)	5.78 (2.83)
Years of father's education	5.94 (3.13)	5.95 (3.12)	5.95 (3.08)
Z-score of mother's height, compared to US population	-2.25 (.883)	-2.25 (.881)	-2.24 (.883)
Z-score of father's height, compared to US population	-2.40 (.871)	-2.41 (.868)	-2.40 (.871)
Proportion of children male	.509 (.500)	.511 (.500)	.504 (.500)
Age of child, in months	87.9 (49.6)	87.5 (49.5)	81.5 (49.6)
Total value of owned agriculture land	2630 (8450)	2640 (8980)	2600 (9200)
Non-earned income received	17.6 (125)	17.6 (125)	17.8 (125)
Exogenous community variables and indicators:			
Distance to rural health unit, km.	6.48 (6.57)	6.49 (6.57)	6.56 (6.56)
Distance to maternity clinic, km.	10.3 (11.5)	10.2 (11.5)	10.4 (11.6)
Distance to secondary school, km.	3.62 (3.98)	3.62 (3.99)	3.63 (4.00)
% of Households live in urban community	.106 (.308)	.106 (.309)	.102 (.302)
% of Households with own well or pump	.411 (.310)	.411 (.310)	.414 (.310)
Average distance to nearest water supply, meters	272 (827)	274 (831)	283 (849)
Price of kerosene/price of rice	.268 (.0619)	.268 (.0616)	.268 (.0630)
Price of milk/price of rice	6.71 (1.28)	6.71 (1.27)	6.72 (1.27)
Price of cooking oil/price of rice	.786 (.225)	.785 (.226)	.786 (.227)
Number of household	978	976	976
Number of children	3130	3104	2672

Source: 1978 BMS, Frisancho (1990)

Table 3.1b Means, computed at the individual (child) level, hemoglobin count. Individuals included in the analysis.

Means and Standard Deviations		
	Sample used in analysis of hemoglobin younger children	Sample used in analysis of hemoglobin older children
Variable	Mean (Standard. Deviation)	Mean (Standard. Deviation)
Endogenous variables:		
Hemoglobin Count	11.2 (1.56)	12.2 (1.39)
Household Expenditures per adult in household	1870 (1520)	1890 (1520)
Exogenous individual and household variables:		
Years of mother's education	6.06 (2.76)	5.51 (2.81)
Years of father's education	6.14 (3.01)	5.76 (3.14)
Z-score of mother's height, compared to US population	--2.22 (.869)	-2.27 (.887)
Z-score of father's height, compared to US population	-2.38 (.852)	-2.43 (.886)
Proportion of children male	.496 (.500)	.521 (.500)
Age of child, in months	37.4 (49.6)	123 (30.9)
Total value of owned agriculture land	1950 (8638)	2990 (9320)
Non-earned income received	14.0 (103)	19.2 (137)
Exogenous community variables and indicators:		
Distance to rural health unit, km.	6.74 (6.66)	6.36 (6.55)
Distance to maternity clinic, km.	10.5 (11.1)	9.98 (11.4)
Distance to secondary school, km.	3.74 (4.06)	3.55 (3.91)
% of Households living in urban community	.107 (.310)	.106 (.309)
% of Households with own well or pump	.423 (.317)	.402 (.305)
Average distance to nearest water supply, meters	294 (876)	259 (796)
Price of kerosene/price of rice	.296 (.0642)	.268 (.0608)
Price of milk/price of rice	6.73 (1.26)	6.69 (1.27)
Price of cooking oil/price of rice	.771 (.218)	.792 (.229)
Number of household	679	759
Number of children	1249	1837

Source: 1978 BMS, Frisancho (1990)

Table 3.2 First order correlations,
Children included in the analysis of height for age

	Mother's educ.	Father's educ	Age of child, in months	Total Value of ag. land	Unearned income
Mother's education	1				
Father's education	.620	1			
Age of child, in months	-.118	-.070	1		
Total value of ag. land	.146	.148	.057	1	
Unearned income	.137	.137	.002	.207	1
Distance to rural health unit	-.157	-.184	-.017	.030	-.058
Distance to secondary schools	-.127	-.192	-.021	.033	-.021
Distance to maternity clinic	-.086	-.085	-.021	.038	-.040
% of households w/own water	-.167	-.190	-.039	-.008	-.034
Average dist. to water supply	-.057	-.058	-.028	-.031	-.018
Z-score of mother's height	.118	.168	-.021	-.008	.003
Z-score of father's height	.178	.166	.039	.022	.047

	Dist. to RH unit	Dist. to Sec School	Dist. to Mater. C.	% of HH with water	Distance to Water
Distance to rural health unit	1				
Distance to secondary schools	.261	1			
Distance to maternity clinic	.313	.101	1		
% of households w/own water	.305	.293	.064	1	
Average dist. to water supply	.091	.348	-.008	.176	1
Z-score of mother's height	-.051	-.069	.011	-.001	.027
Z-score of father's height	-.063	.046	.003	-.036	-.036

	Mother's Height	Father's Height
Z-score of mother's height	1	
Z-score of father's height	.312	1

Table 3.3a Frequency of Child Malnutrition, Bicol, Philippines. Based on middle arm circumference. Children aged one to five

Measure of Child Malnutrition	Percentage
None, arm circumference greater than 13.5 cm.	81.0
Mild, arm circumference from 12.5 to 13.5 cm.	13.7
Severe, arm circumference less than 12.5 cm.	5.3
Number of children	1182

Table 3.3b Frequency of Child Malnutrition, Bicol, Philippines. Based on middle arm circumference compared to US population. Children aged one to twelve.

Child age, in years	Number of observations	less than 5th pct.	5th to 10th pct	10th to 25th pct	25th to 50th pct	greater than 50th pct
1 to 2	304	54.6	17.4	17.4	8.6	2.0
2 to 3	295	35.3	19.3	27.8	12.2	5.4
3 to 4	311	33.4	20.3	28.0	15.1	3.2
4 to 5	271	32.1	22.5	22.6	15.5	3.3
1 to 5	1181	39.6	19.8	24.8	12.8	3.5
5 to 6	289	24.2	23.5	34.3	15.9	2.1
6 to 7	284	23.9	29.2	36.3	9.5	1.1
7 to 8	325	27.1	27.4	33.9	9.5	2.2
8 to 9	288	33.0	28.8	29.5	8.0	.7
9 to 10	288	27.1	36.1	27.4	8.7	.7
10 to 11	274	29.6	31.8	27.0	9.9	1.8
11 to 12	261	26.1	31.0	36.8	5.8	.4
12 to 13	267	35.2	29.6	28.5	5.2	1.5
5 to 13	2276	28.2	29.6	31.7	9.1	1.3
1 to 13	3457	31.9	26.3	29.4	10.4	2.1

Table 3.4a Comparison of the average Z-scores* for anthropometric indicators of children in the 1978 Bicol Survey.

Child age, in years	Number of observations	Height-for-age	Weight-for-age	Weight for height
1 to 2	305	-2.11 (1.40)	-1.72 (.864)	-1.12 (1.24)
2 to 3	294	-2.08 (1.50)	-1.71 (1.05)	-.864 (1.03)
3 to 4	311	-2.16 (1.39)	-1.52 (.849)	-.682 (.974)
4 to 5	273	-2.15 (1.37)	-1.52 (.779)	-.724 (.933)
5 to 6	289	-2.07 (1.41)	-1.42 (.651)	-.732 (.816)
6 to 7	284	-2.11 (1.19)	-1.54 (.513)	-.774 (.842)
7 to 8	325	-2.01 (1.22)	-1.48 (.666)	-.610 (.920)
8 to 9	288	-2.13 (1.20)	-1.40 (.512)	-.692 (.909)
9 to 10	288	-2.00 (1.09)	-1.28 (.464)	-.519 (.786)
10 to 11	274	-2.16 (1.21)	-1.53 (.558)	-755.(.644)
11 to 12	261	-2.30 (1.25)	-1.38 (.428)	-.680 (.667)
12 to 13	267	-2.49 (1.15)	-1.59 (.570)	-.660 (.659)
13 to 14	220	-2.39 (1.08)	-1.41 (.516)	-.580 (.684)
14 to 15	213	-2.31(1.14)	-1.74 (.670)	-.592 (.612)

Standard deviation in parenthesis.

*Z-Score is the child's age-standardized measurement, compared to US population.

Table 3.4b Frequency of Child Malnutrition, Bicol Philippines. Gomez (1956) classification of malnutrition, based on weight-for-age, compared to US population. Children aged one to fifteen

Child age, in years	Number of observations	Normal	Mild malnutrition	Moderate malnutrition	Severe Malnutrition
1 to 2	305	13.4	38.0	40.0	8.5
2 to 3	294	18.0	50.6	27.2	4.1
3 to 4	311	19.3	51.8	27.0	1.9
4 to 5	273	12.5	52.8	32.2	2.6
5 to 6	289	14.2	51.6	31.5	2.8
6 to 7	284	7.8	43.0	46.1	3.2
7 to 8	325	9.3	39.4	46.5	4.9
8 to 9	288	5.9	26.4	55.2	12.5
9 to 10	288	6.6	34.4	51.4	7.6
10 to 11	274	6.2	23.7	49.3	20.8
11 to 12	261	4.2	24.1	50.2	21.5
12 to 13	267	3	18.4	44.94	33.7
13 to 14	220	6.4	23.6	43.6	26.4
14 to 15	213	4.2	22.1	42.7	31.0

Table 3.4c Frequency of Child Malnutrition, Bicol, Philippines. Weight for height, Z-scores compared to United States , by child age. Children aged one to twelve

Child age, in years	Number of observations	less than 5th pct.	5th to 10th pct	10th to 25th pct	25th to 50th pct	greater than 50th pct
1 to 2	305	32.8	16.1	23.9	15.7	11.5
2 to 3	295	18.0	11.9	29.2	23.7	17.3
3 to 4	312	14.7	8.0	26.9	29.5	20.8
4 to 5	273	12.5	9.9	30.0	27.5	20.2
5 to 6	290	13.1	7.9	30.7	34.1	14.1
6 to 7	284	13.0	14.1	30.3	26.1	16.6
7 to 8	325	10.2	9.2	30.2	30.2	20.3
8 to 9	288	13.9	7.6	28.1	17.4	22.9
9 to 10	288	4.9	8.9	31.9	33.3	21.2
10 to 11	274	7.7	11.3	27.2	35.0	8.8
11 to 12	261	7.3	11.5	35.3	36.4	9.6
12 to 13	267	10.9	10.1	311	36.7	11.2
13 to 14	220	3.2	6.8	38.9	38.5	12.7
14 to 15	213	4.2	6.5	37.9	39.7	11.7

Z-Score is the child's age-standardized measurement, compared to US population.
Source: BMS, Frisancho (1990)

Table 3.5a Frequency of Child Malnutrition Bicol, Philippines. Cross tabulation of height-for-age and weight-for-height Z-scores. Children aged 1 to 10.

Z-Score of height-for-age (percentage of population)	Z-Score of weight-for-height (percentage of population)				
	Greater than -.50	-.50 to -1.00	-1.00 to -1.50	Less than -1.50	Total
Greater than -1.25	10.4	5.5	4.1	4.7	24.6
-1.25 to -2.50	15.3	9.9	8.4	5.7	39.9
-2.50 to -3.75	10.4	6.3	5.4	5.1	27.3
Less than -3.75	3.11	1.5	1.7	2.4	8.7
Total	39.2	23.2	19.6	17.8	100.0

number of observations: 3188

Z-Score is the child's age-standardized measurement, compared to a healthy population.

Table 3.5b Frequency of Child Malnutrition, cross tabulation of height-for-age and weight-for-height Z-scores. Children aged 11 to 15.

Z-Score of height-for-age (percentage of population)	Z-Score of weight-for-height (percentage of population)				
	Greater than -.50	-.50 to -1.00	-1.00 to -1.50	Less than -1.50	Total
Greater than -1.25	4.1	4.7	3.3	2.7	14.7
-1.25 to -2.50	17.0	16.0	7.1	1.8	41.9
-2.50 to -3.75	14.4	10.8	6.5	1.9	33.5
Less than -3.75	3.5	2.2	2.5	1.7	9.9
Total	38.9	33.7	19.4	8.0	100.0

number of observations: 1135

Table 3.6a Frequency of hemoglobin count (g./100 ml.),by age. Girls, aged 1 to 14 years.

Girl age, in years	Number of observations	less than 9 g./ 100 ml.	9 to 11 g./100 ml.	11 to 12 g./100 ml.	12 to 14 g./100 ml.	greater 14 g./100 ml.
1 to 2	155	12.3	39.4	27.7	18.1	2.6
2 to 3	144	8.3	28.5	27.8	30.6	4.9
3 to 4	147	4.8	23.8	34.0	32.7	4.8
4 to 5	132	3.0	19.7	26.5	50.0	.8
5 to 6	145	1.4	15.9	30.3	47.6	4.8
6 to 7	136	1.5	12.5	22.8	55.2	8.1
7 to 8	143	.7	14.7	22.4	50.4	11.9
8 to 9	134	2.2	14.2	20.9	58.2	4.5
9 to 10	136	2.9	7.4	27.2	52.9	9.6
10 to 11	127	.8	8.7	25.2	56.7	8.7
11 to 12	121	0	5.8	22.3	56.2	15.7
12 to 13	122	.8	4.1	13.1	74.6	7.4
13 to 14	110	0	.9	21.8	63.6	13.6
14 to 15	84	3.6	8.3	15.5	58.3	14.3

Table 3.6b Distribution of hemoglobin count (g./100 ml.),by age. Boy, aged 1 to 14 years.

Boy's age, in years	Number of observations	less than 9 g./ 100 ml.	9 to 11 g./100 ml.	11 to 12 g./100 ml.	12 to 14 g./100 ml.	greater 14 g./100 ml.
1 to 2	147	20.4	46.3	20.4	12.2	.7
2 to 3	139	5.0	32.4	27.3	33.1	2.2
3 to 4	155	1.9	21.9	29.7	44.5	1.9
4 to 5	138	2.9	16.7	32.6	41.3	6.5
5 to 6	132	1.5	21.2	26.5	47.0	3.8
6 to 7	135	2.2	25.2	24.4	42.2	5.9
7 to 8	173	1.7	17.3	23.1	48.0	9.8
8 to 9	149	2.0	10.7	28.9	53.0	5.4
9 to 10	144	3.5	16.6	27.8	48.6	5.6
10 to 11	142	1.4	11.3	24.7	53.5	9.2
11 to 12	136	2.2	8.1	22.8	52.9	14.0
12 to 13	140	3.6	12.1	19.3	53.6	11.4
13 to 14	106	1.0	9.4	28.3	52.8	8.5
14 to 15	127	3.2	6.3	10.2	59.8	20.5

4. Estimation of Child Health

Child health status is measured using different health indicators as proxies for underlying health. Height-for-age is the main variable of interest since it is a proxy for the long term, cumulative health of the child. It captures the cumulative effects of malnutrition, which may be the result of past incidence of disease and food deficits. Separate analysis is performed on arm circumference-for-age, weight-for-height, and hemoglobin count, which are measures of current nutritional status. Arm circumference is a measure of severe malnutrition and muscle wastage. Weight-for-height measures the caloric adequacy of the current diet. These measures are expressed in *z*-scores, which indicate the standardized deviation from the means of children of the same age (or height) and sex from a healthy population. Hemoglobin count measures the presence of hemoglobin (i.e. iron) in the blood as grams per 100 milliliters.

A number of different specifications are estimated for each of the dependent variables. Tables 4.1-4.3 estimate the anthropometric indicators (height, weight, and arm circumference) incorporating only exogenous individual and household characteristics and proxies for wealth, along with a number of community prices and indicators. Hemoglobin count is estimated in table 4.4. Since there is no internationally accepted standard for hemoglobin count (with a set of means and standard deviations from a healthy population), the sample is partitioned by age to control partially for the natural increase in hemoglobin with the increase in child's age. The age categories are six to 71 months and 72 to 167 months, which match the World Health Organization's definition of anemia by age. Tables 4.5a and 4.5b report the estimation of anthropometric indicators stratified by sex of the child. Permanent income (proxied by household expenditures per adult) is incorporated in a set of specifications, in tables 4.6a and 4.6b. Income is a function of the allocation of time in market and non-market activities and thus is treated as an endogenous variable in the analysis.

Much of the empirical literature on the determination of health includes only maternal variables (for example, mother's education and height). The first specification is therefore estimated without any paternal variables. Variables for the father's education and height is then included to investigate the effect of the father's characteristics on child health.

A. Education

With mother's height and the father's variables excluded, mother's education has the expected positive sign for height-for-age and arm circumference-for-age although it is insignificant for weight-for-height (column 1 in tables 4.1-4.3). This result implies that higher mother's education works to increase the child's height without increasing weight-for-height; that is the child's weight is proportional to his height.

The inclusion of mother's height reduces the effect of mother's education on height-for-age while the arm circumference-for-age results are unaffected. The hemoglobin count (columns 1 and 3 in table 4.4) show that mother's education (with mother's height added) has a positive effect on younger children (six months to six years) and no effect on older children (six years to fourteen years).

The inclusion of father's education has a substantial effect on the results. With the height of both parents excluded, father's education dominates for the estimation of all three anthropometric indicators and mother's education becomes an insignificant determinant (column 3 in tables 4.1-4.3). The same is true for hemoglobin count in both age classes (Columns 2 and 4 of table 4.4).

This result is somewhat surprising given the key role assigned to mother's education in the theoretical and empirical literature. Although mother's education and father's education are highly correlated (the correlation is approximately .65), multicollinearity is not a likely explanation. Father's education has a negative effect on weight-for-height. This implies that an increase in father's education leads to an increase in height but not in weight, so that the relative weight (to height) drops. In Bicol, children with better educated parents are more likely to have higher education (King, 1982), and the children are also more likely to have sedentary employment. These factors will tend to keep weight down, compared to children performing more manual labor.

The analysis of anthropometric indicators by sex does not conclusively show discrimination against either boys of girls. For girls, parental education's effect on height-for-age and weight-for-height (columns 1 and 3, table 4.5a) is similar to the effect parental education has on the entire sample, while the effects of education on boys (columns 2 and 4) are insignificant. The opposite is true for arm circumference-for-age, where parental education's effect in the boy's sample (column 2, table 4.5b) mirrors the results of the pooled sample. This suggests that there is no consistent discrimination against either sex (for example, girls "benefit" from father's education in height, boys in arm circumference, and girls are "harmed" by it in weight). This does not reflect a clear pattern in upbringing favoring either sons or daughters.

Tables 4.6a-4.6b include household expenditures per adult as a proxy for permanent income. This variable is instrumented by all of the exogenous variables, plus the total value of agricultural land, non-earned income, and the father's age.[20] For the height-for-age estimates, the effect of mother's education is negative, which matches the results for mother's education in table 4.1 (column 4). Father's education is insignificant, which suggests that father's education is primarily a proxy for income. Both mother's and father's education have a negative effect on the child's arm circumference when the income proxy is included, but these are not significant at the 10% level. Father's education is a negative, although not significant, determinant for

[20] The estimated expenditure equation is jointly significant. The education of both parents, total value of land, and non-earned income are significant determinants.

weight-for-height, as it was when the income proxy was excluded. Father's education is a positive determinant of hemoglobin count for children aged 6 months to six years, but not for older children (columns 1 and 2, table 4.6b), which is the same result when the income proxy was excluded.

The results suggest that the one of the most important effects of education is the provision of income and greater economic resources. Mother's education is shown to have no effect or a negative effect on health when father's education is included and father's education loses its significance when the endogenous income proxy is included. This differs from the findings in many other studies that argue that education (particularly, mother's education) serves as a production input providing more health knowledge and a better use of existing resources. There are a number of explanations for this result. Time is a potential input into the production of child health, and it is possible that when mother's wages increase (as happens when education increases), mother's will spend less time on the production of child health and more time working in the market. If mother's education reduces infant mortality then it is possible that the weaker children of more educated women survive, they are less healthy than the surviving children of less educated mothers.

B. Income and Wealth

Tables 4.1-4.5b incorporate the total value of owned agricultural land as a measure of household wealth and the amount of unearned income as a measure of the pure effect of income. Parents' education also plays a major role in determining household income. Tables 4.6a-4.6b include household expenditures per adult as a proxy for household income; income is treated as an endogenous variable.

The value of agricultural land consistently has a positive effect on child's height and arm circumference (tables 4.1 and 4.2). In addition to agricultural land's effect on increasing household resources, agricultural households may face lower relative prices for food due to home consumption.[21] If this is the case, agricultural households will increase their relative expenditures on food (primarily rice), which is probably beneficial to producing height and muscle. Children in households with agricultural land may have to work which probably makes them stronger compared to non-working children. This variable has no measurable effect on weight-for-height (table 4.3), which is surprising since weight-for-height is a measure of short term health and dependent on caloric consumption. It also has no significant effect on the level of hemoglobin in the blood (table 4.4). Higher income may increase the demand for food, but the ownership of land may shift this demand away from food with a high source of iron and towards grains.

In most specifications for height-for-age and arm circumference-for-age, unearned income is a significant positive determinant of health (the exception is column 3 in table 4.1). This confirms the hypothesis that income has a direct role in

[21] If there is a price wedge between the producer's and consumer's price of food.

improving child health, since non-earned income is not affected by the household's allocation of time and does not alter the relative prices of home produced commodities, as the ownership of agricultural land or an increase in wage might. Non earned income is not a significant determinant for weight-for-height or the for hemoglobin count.

The sample stratified by sex (tables 4.5a-4.5b) shows that agricultural land has a positive effect on the heights of children of both sexes, while it only appears to benefit the arm circumference of boys. Unearned income, on the other hand, only positively affects the height of boys and the weight and arm circumference of girls. In a rural society where boys tend to work and girls tend to stay in school, there may be reason to expect that boys would benefit more from the ownership of agricultural land than girls. It is not clear why non-earned income would affect children differently, although it is possible that households might use non-earned income to compensate girls for the benefits that boys receive from land ownership. Quisumbing (1994) finds that parents in the Central Luzon region of the Philippines do attempt to equalize inheritances among children.

Household expenditures per adults is treated as an endogenous variable with all of the exogenous variables as instruments.[22] The results, in tables 4.6a-4.6b, show that higher income has a positive effect on child's height and arm circumference. The effect of household expenditures on weight-for-height and on hemoglobin count is generally not significant.

From these results, it appears that income is a major determinant of child health. Controlling for education and other household and community variables, increases in household income have a positive effect on long term child health measured by height-for-age. This does not support the claim that increases in income by themselves are insufficient to produce better child health-- better nutrition and health appear to have positive income elasticities. Weight-for-height does not respond to any of the measures of income, which is surprising since weight is dependent upon caloric consumption. Since height does respond to income-related variables, this suggests that increases in income only cause an increase in weight only in proportion to the increase in height and not in excess of this.[23]

C. Parent and Child Characteristics

Maternal and paternal height are consistently significant positive determinants of child's height and arm circumference. Adding parent's height does not change the

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[22] The assumption of endogeneity was tested using the Hausman (1978) specification test. The null hypothesis of exogenous household income can be rejected at the 1% level for height-for-age and arm circumference-for-age. The null hypothesis cannot be rejected for weight-for-height or for either sample of the hemoglobin count although neither predicted or actual household expenditure were significant for these outcomes

[23] Regressions of weight-for-age controlling for parental height show that an increase in income lead to significant increase in weight.

sign of any of the other significant variables but it does increase the standard errors of several variables, including mother's education. Since the genetic component of child height is inherited from both the father and the mother, it is beneficial to include father's height, when this variable is available.

Parental height has a modest negative effect on weight-for-height, most likely because it tends to increase the height of the child without necessarily increasing the weight of the child. Mother's height has a positive effect on the hemoglobin count of younger children but not of older children (table 4.4).

The results suggests that, relative to US children, Filipino boys are less healthy than girls when measured by anthropometric indicators, either for genetic reasons or because they receive relatively less attention and resources than girls.. Anemia is also more common among Bicol boys than girls in the 6 to 14 years age category.[24]

As Filipino children age it appears that their relative height falls further behind that of American children. This may be the cumulative result of health problems and low nutritional intake. However arm circumference and weight increase with age relative to American children. The hemoglobin count also increases with age, as expected for biological reasons.

D. Community Characteristics

The effective price of potable water is proxied by the distance to water supply and the availability of a private source of water. The condition of the local water supply may also cause externalities that affect health in addition to influencing the effective price of potable water.

Height-for-age does not respond to any of the community environmental variables. This is surprising since more developed communities are expected to have lower incidence of disease and therefore healthier children. Weight-for-height does respond to these variables, but the signs are not as expected. Increased access to water is associated with a decrease in weight. For arm circumference, increased access to water is associated with smaller arm circumferences (although only significant at the .10 level in column 2 of table 4.3). A greater distance to water is also associated with a worsening of health, as measured by arm circumference-by-age (column 2, table 4.3), as expected.

For the hemoglobin level, the percentage of owned water exerts a positive effect as expected for children aged six months to six years (columns 1 and 2, table 4.4), although it is insignificant for older children. The distance to water has a negative effect on the hemoglobin count, as expected, for children of all ages.

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[24] If boys are more prone to health problems than girls, an equitable distribution of resources might favor girls relative to boys.

It is possible that these services increase weaker children's probability of survival, which might partially explain the negative association between an improved water supply and child heath (i.e. thinner arm circumferences).

E. Prices

Prices here are measured in terms of the prices of three commodities relative to the consumer price of rice. The price of health care is proxied by the distance to the nearest public health facility and the distance to the nearest maternity clinic. The price of education (another measure of child quality) is proxied by the distance to secondary schools.

The height of children does not appear to be significantly affected by any of the prices. Weight-for-height appears to be affected by the relative changes in the prices of kerosene. An increase in the price of kerosene is associated with an increase of health, as measured by weight. It is not clear why this would be the case. Kerosene is presumably a consumer good brought into rural communities. Thus the high price (compared to rice) would prevail in isolated rice producing communities. Arm circumference-for-age is affected by the price of cooking oil in all specifications. An increase in the relative price of cooking oil is associated with a deterioration of child health. This may imply a shift in consumption from meat to rice, which might lower caloric and protein intake.[25] However, an increase in the price of cooking oil are associated with an increase in the hemoglobin count in children of all ages. Because meat is a major source of iron, it is difficult to explain why an increase in the price of this commodity is associated with a decrease in health measured by arm circumference and an increase in hemoglobin count.

An increase in the distance to health clinics is expected to have a negative impact on health, since it raises the relative price of health care. It was found to be insignificant for most of the specifications for all four measures of child health. If child health and education are complements then an increase in the distance to schools should be associated with a decrease in health. The results are contrary to expectation. Greater distance to secondary schools is associated with more weight-for-height in most of the specifications (columns 1-3 in table 4.2) and thicker upper-arm circumferences. It is expected that a greater distance to maternity clinic is associated with a decrease in health. It is generally insignificant except for one specification of weight-for-height (column 2, table 4.2) and for the hemoglobin count of children age six months to six years (columns 1 and 2, table I4.4), where it is positive.

[25] Specifications including the price levels instead of the relative prices (not reported here), show similar results, with prices of kerosene positively affecting weight and arm circumference and the price of cooking oil negatively affecting arm circumference.

Table 4.1 Reduced Form estimates of height-for-age, BMS sample of children.

Variable	Z-score for height-for-age: Mother's variables only (1)	(2)	Father's variables included (3)	(4)
Intercept	-2.06 (12.06)***	-1.12 (6.14)***	-2.19 (12.36)***	-.715 (3.75)***
Mother's education, years	.0223 (2.59)***	.00849 (1.01)	-.00850 (.81)	-.0207 (2.06)**
Mother's height, z-score		.372 (14.64)***		.288 (10.95)***
Father's education, years			.0497 (5.19)***	.0316 (3.43)***
Father's height, z-score				.251 (9.36)***
Child male (yes=1)	-.118 (2.57)**	-.124 (2.79)***	-.113 (2.47)**	-.122 (2.88)***
Child's age, months, * 10^{-2}	-.265 (5.68)***	-.262 (5.79)***	-.262 (5.23)***	-.251 (5.62)***
Value of agricultural land, pesos, * 10^{-3}	.0105 (3.95)***	.0111 (4.34)***	.00949 (3.58)***	.0106 (4.17)***
Non-earned income, pesos, * 10^{-3}	.376 (1.98)**	.400 (2.19)**	.290 (1.54)	.299 (1.66)*
Dist. to rural health unit, km	-.00137 (.34)	.00336 (.86)	.00254 (.63)	.00146 (1.23)
Dist. to secondary school, km.	-.0106 (1.48)	-.00462 (.67)	-.00792 (1.11)	-.00558 (.81)
Dist. to maternity clinic, km.	-.000619 (.28)	-.00161 (.75)	-.000443 (.20)	-.00163 (.78)
Urban (yes=1)	-.00428 (.05)	.0142 (.19)	-.0166 (.20)	-.0511 (.64)
% of households in barangay with own water supply	-.0739 (.88)	-.128 (1.56)	-.0497 (.59)	-.107 (1.35)
Average distance in barangay to household water-, m., * 10^{-3}	.0134 (.43)	-.00545 (.18)	-.0111 (.36)	-.00349 (.12)
Price of kerosene/price of rice	.291 (.64)	.537 (1.23)	.491 (1.08)	.689 (1.59)
Price of milk/price of rice	-.0111 (.55)	-.0202 (1.04)	-.0164 (.82)	-.0180 (.94)
Price of cooking oil/price of rice	.0137 (1.07)	-.0963 (1.04)	.101 (.79)	-.0523 (.04)
Number of observations	3130	3130	3130	3130
F-value	6.16	20.45	7.59	24.59
R-square	.0269	.0897	.0353	.118

Absolute value of student t statistics in parenthesis

*** significant at .01 level, ** significant at .05 level, * significant at .10 level

Table 4.2 Reduced Form estimates of weight-for-height, BMS sample of children.

Z-score for weight-for-height				
Variable	Mother's variables only		Father's variables included	
	(1)	(2)	(3)	(4)
Intercept	-.937 (7.30)***	-1.04 (7.06)***	-.900 (6.94)***	-1.00 (6.89)***
Mother's education, years	-.00389 (.62)	.00239 (.38)	-.00476 (.63)	.00521 (.68)
Mother's height, z-score		-.0414 (2.17)**		-.0368 (1.83)*
Father's education, years			-.0139 (1.99)**	-.0123 (1.75)*
Father's height, z-score				-.00245 (.12)
Child male (yes=1)	-.0977 (2.92)***	-.0966 (2.90)***	-.0991 (2.92)**	-.0979 (2.94)***
Child's age, months, * 10^{-2}	.144 (4.23)***	.143 (4.21)***	.143 (4.02)***	.143 (4.18)***
Value of agricultural land, pesos, * 10^{-3}	-.00121 (1.09)	-.00217 (1.12)	-.00183(.95)	.00193 (1.00)
Non-earned income, pesos, * 10^{-3}	.0981 (.71)	.0939 (.68)	.122 (.88)	.116 (.84)
Dist. to rural health unit, km	.00339 (1.15)	.00317 (1.08)	.00307 (1.04)	.00290 (.98)
Dist. to secondary school, km.	.00966 (1.86)*	.00903 (1.74)*	.00893 (1.71)*	.00846 (1.62)
Dist. to maternity clinic, km.	-.000619 (.28)	.00265 (1.65)*	.00203 (1.56)	.00260 (1.62
Urban (yes=1)	.00255 (1.58)	-.0721 (1.20)	-.0668 (1.10)	-.0683 (1.12)
% of households in barangay with own water supply	-.190 (3.10)***	-.184 (3.01)***	-.196 (3.20)***	-.190 (3.10)***
Average distance in barangay to household water-, m., * 10^{-3}	-.0181 (.80)	-.0160 (.71)	-.0175 (.78)	-.0158 (.70)
Price of kerosene/price of rice	1.01 (3.05)***	.980 (2.96)***	.956 (2.88)***	.934 (2.81)***
Price of milk/price of rice	.0160 (.11)	.00268 (.18)	-.0317 (.22)	.00391 (.27)
Price of cooking oil/price of rice	.112 (1.20)	-.107 (1.5	-.102 (1.10)	-.0982 (1.05)
Number of observations	3104	3104	3104	3104
F-value	4.32	4.35	4.30	4.02
R-square	.0192	.0207	.0205	.0217

Absolute value of student t statistics in parenthesis

*** significant at .01 level, ** significant at .05 level, * significant at .10 level

Table 4.3 Reduced Form estimates of arm circumference-for-age, BMS sample of children.

	Z-score for arm circumference-for-age			
Variable	Mother's variables only		Father's variables included	
	(1)	(2)	(3)	(4)
Intercept	-1.45 (15.08)***	-1.31 (12.80)***	-1.48 (15.26)***	-1.24 (11.38)***
Mother's education, years	.0147 (3.14)***	.0129 (2.75)***	.00726 (1.28)	.00535 (.94)
Mother's height, z-score		.0541 (3.83)***		.0363 (2.44)**
Father's education, years			.0120 (2.30)**	.00926 (1.76)*
Father's height, z-score				.0509 (3.67)***
Child male (yes=1)	-.120 (4.73)***	-.118 (4.97)***	-.116 (4.69)***	-.117 (4.74***
Child's age, months, $* 10^{-2}$	.144 (3.97)***	.119 (3.95)***	.121 (4.01)***	.122 (4.07)***
Value of agricultural land, pesos, $* 10^{-3}$	.00253 (1.81)*	.00265 (1.90)*	.00230 (1.64)*	.00253 (1.81)*
Non-earned income, pesos, $* 10^{-3}$	.214 (2.11)**	.217 (2.15)**	.193 (1.89)*	.191 (1.88)*
Dist. to rural health unit, km	.000432 (.20)	.000748 (.34)	.000701 (.32)	.00105 (.49)
Dist. to secondary school, km.	.00914 (2.37)**	.00994 (2.59)**	.00971 (2.51)**	.00982 (2.55)**
Dist. to maternity clinic, km.	.00187 (1.57)	.00178 (1.50)	.00192 (1.62)	.00176 (1.50)
Urban (yes=1)	-.0879 (1.92)*	-.0865 (1.89)*	-.0915 (2.00)**	-.101 (2.21)**
% of households in barangay with own water supply	-.0692 (1.52)	-.0781 (1.71)*	-.0640 (1.40)	-.0720 (1.58)
Average distance in barangay to household water-, m., $* 10^{-3}$	-.0248 (1.51)	-.0278(1.71)*	-.0253 (1.55)	-.0261 (1.60)
Price of kerosene/price of rice	.283 (1.18)	.308 (1.28)	.330 (1.37)	.346 (1.44)
Price of milk/price of rice	.00123 (.11)	.000380 (.04)	-.0000378 (0)	.000328 (.03)
Price of cooking oil/price of rice	-.188 (2.71)***	-.190 (2.75)***	-.196(2.83)***	-.213(3.08)***
Number of observations	2672	2672	2672	2672
F-value	6.18	6.77	6.13	6.88
R-square	.0315	.0368	.0334	.0422

Absolute value of student t statistics in parenthesis

*** significant at .01 level, ** significant at .05 level, * significant at .10 level

Table 4.4 Reduced Form estimates of hemoglobin count, BMS sample of children.

	Hemoglobin count (g./100 ml.)			
Variable	Children aged six to 71 months		Children aged 72 to 167 months	
	(1)	(2)	(3)	(4)
Intercept	9.74 (29.19)***	9.51 (27.07)***	10.7 (37.34)***	10.6 (35.12)***
Mother's education, years	.0297 (1.91)*	-.00787 (.42)	.0130 (1.07)	-.00350 (.24)
Mother's height, z-score	.103 (2.14)**	.0831 (1.64)*	.0230 (.64)	.0136 (.36)
Father's education, years		.0620 (3.55)***		.0273 (2.08)**
Father's height, z-score		-.00900 (.18)		.00424 (.11)
Child male (yes=1)	-.107 (1.32)	-.107 (1.33)	-.222 (3.49)***	-.217 (3.42)***
Child's age, months, * 10^{-2}	2.95 (13.79)***	2.96 (13.88)***	.732 (7.12)***	.732 (7.11)***
Value of agricultural land, pesos, * 10^{-3}	.00623 (.95)	.00407 (.62)	.00461 (1.39)	.00411 (1.24)
Non-earned income, pesos, * 10^{-3}	-.00497 (.13)	-.159 (.39)	.0382 (.16)	-.0116 (.04)
Dist. to rural health unit, km	-.00278 (.39)	-.00260 (.37)	.00562 (.98)	.00644 (1.14)
Dist. to secondary school, km.	-.00196 (.15)	-.00125 (.10)	-.00696 (.70)	-.00517 (.57)
Dist. to maternity clinic, km.	.0117 (2.86)***	.0124 (3.04)***	-.00438 (1.42)	-.00433 (1.41)
Urban (yes=1)	-.141 (.97)	-.146 (1.00)	-.248 (2.07)**	-.257 (2.15)**
% of households in barangay with own water supply	.345 (2.37)**	.357 (2.46)**	.105 (.88)	.126 (1.06)
Average distance in barangay to household water-, m., * 10^{-3}	-.237 (4.34)***	-.239 (4.54)***	-.163 (3.94)***	-.162 (3.68)***
Price of kerosene/price of rice	.254 (.32)	.549 (.69)	.858 (1.35)	.953 (1.50)
Price of milk/price of rice	.000222 (.01)	-.00281 (.08)	.0325 (1.18)	.0289 (1.04)
Price of cooking oil/price of rice	.329 (1.36)	.241 (.97)	.429 (2.49)**	.420 (2.43)**
Number of observations	1249	1249	1837	1837
F-value	16.46	15.39	7.10	6.53
R-square	.1668	.1753	.0552	.0575

Absolute value of student t statistics in parenthesis

*** significant at .01 level, ** significant at .05 level, * significant at .10 level

Table 4.5a Reduced Form estimates of anthropometric indicators, by sex of child, BMS sample of children.

Variable	Anthropometric Indicators			
	Height-for-age		Weight-for-height	
	Girls	Boys	Girls	Boys
	(1)	(2)	(3)	(4)
Intercept	-.833 (3.12)***	-.729 (2.70)***	-.872 (4.31)***	-1.24 (6.03)***
Mother's education, years	-.0342 (2.30)**	-.00738 (.54)	.00977 (.86)	.000977 (.09)
Mother's height, z-score	.241 (6.64)***	.344 (8.91)***	.0431 (1.57)	-.0322 (1.09)
Father's education, years	.0426 (3.21)***	.00200 (1.55)	-.0291 (2.89)***	.00399 (.41)
Father's height, z-score	.229 (6.02)***	.270 (7.10)***	.0147 (.51)	-.0203 (.70)
Child's age, months, $* 10^{-2}$	-.300 (4.66)***	-.205(3.31)***	.184 (3.76)***	.106 (2.23)**
Value of agricultural land, pesos, $* 10^{-3}$	.00928 (2.24)**	.0112 (3.43)***	-.0303 (.97)	-.00578 (.23)
Non-earned income, pesos, $* 10^{-3}$	.518 (1.68)*	.173 (.77)	-.186 (.78)	.321 (1.87)*
Dist. to rural health unit, km	.00926 (1.72)*	-.00554 (.10)	.00447 (1.06)	.00101 (.24)
Dist. to secondary school, km.	.0140 (1.38)	.0232 (.25)	.0134 (1.75)*	.00485 (.67)
Dist. to maternity clinic, km.	.00143 (.51)	-.00120 (.37)	-.00206 (.97)	.00298 (1.21)
Urban (yes=1)	-.0223 (.28)	-.0730 (.65)	-.0261 (30)	-.107 (1.26)
% of households in barangay with own water supply	-.0657 (.56)	-.149 (1.32)	-.158 (1.79)*	-.225 (2.61)***
Average distance in barangay to household water-, m., $* 10^{-3}$	-.00881 (.18)	-.00969 (.26)	-.0641 (1.77)*	-.0104 (.36)
Price of kerosene/price of rice	1.04 (1.71)*	.239 (.38)	.384 (.83)	1.43 (2.99)***
Price of milk/price of rice	-.0292 (.24)	-.00174 (.04)	.00499 (.25)	.0546 (.26)
Price of cooking oil/price of rice	-.0420 (.24)	.0363 (.21)	.0286 (.21)	-.156 (1.20)
Number of observations	1536	1594	1518	1586
F-value	11.43	15.17	3.01	2.21
R-square	.1047	.1334	.0311	.0220

Absolute value of student t statistics in parenthesis

*** significant at .01 level, ** significant at .05 level, * significant at .10 level

Table 4.5b Reduced Form estimates of arm circumference, by sex of child, BMS sample of children.

Health proxy		
Variable	Arm circumference for-age	
	Girls (1)	Boys (2)
Intercept	-1.17 (7.89)***	-1.46 (9.30)***
Mother's education, years	.00495 (.60)	.00656 (.84)
Mother's height, z-score	.0376 (1.89)*	.355 (1.61)
Father's education, years	.00529 (.72)	.0124 (1.66)*
Father's height, z-score	.0360 (1.72)*	.0650 (2.77)***
Child's age, months, * 10^{-2}	.128 (3.03)***	.112 (2.64)***
Value of agricultural land, pesos, * 10^{-3}	.000691 (.31)	.00430 (2.34)**
Non-earned income, pesos, * 10^{-3}	.427 (2.57)**	.0795 (.61)
Dist. to rural health unit, km	.00646 (2.13)**	-.00492 (1.58)
Dist. to secondary school, km.	.00387 (.70)	.0169 (3.15)***
Dist. to maternity clinic, km.	.000622 (.40)	.00388 (2.14)**
Urban (yes=1)	-.101 (1.54)	-.0986 (1.54)
% of households in barangay with own water supply	-.0208 (.32)	-.148 (2.28)**
Average distance in barangay to household water-, m., * 10^{-3}	-.0283 (1.15)	-.00252 (1.18)
Price of kerosene/price of rice	.634 (1.92)*	.00460 (.01)
Price of milk/price of rice	-.0145 (.99)	-.0213 (1.34)
Price of cooking oil/price of rice	-.310 (3.15)***	-.112 (1.15)
Number of observations	1325	1347
F-value	3.42	4.35
R-square	.0401	.0497

Absolute value of student t statistics in parenthesis
*** significant at .01 level, ** significant at .05 level, * significant at .10 level

Table 4.6a Estimates of anthropometric indicators, with endogenous income proxy (household expenditures per adult.) included, BMS sample of children.

Variable	Z-score for height for age	Z-score for weight-for-height	Z-score for upper arm circumference for age
	(1)	(2)	(3)
Intercept	-1.08 (5.26)***	-1.02 (6.47)***	-1.38 (12.03)***
Mother's education, years	-.0528 (3.72)***	.00268 (.25)	-.0113 (1.36)
Mother's height, z-score	.261 (9.47)***	.00383 (1.85)*	.0255 (1.68)*
Father's education, years	-.0186 (1.04)	-.0156 (1.17)	-.0143 (1.41)
Father's height, z-score	.229 (8.27)***	.00340 (.16)***	.0411(2.65)***
Child male (yes=1)	-.121 (2.76)***	-.0988 (2.96)***	-.118 (4.76)***
Child's age, months, * 10^{-2}	-.231 (5.19)***	.141 (4.14)***	.128 (4.26)***
Household Expenditures per adult * 10^{-3} [a]	.338 (3.60)***	.0236 (.29)	.181(2.91)***
Dist. to rural health unit, km	.0149 (3.16)***	.000334 (.94)	.00556 (2.10)**
Dist. to secondary school, km.	-.00997 (1.41)	.00785 (1.47)	.00698 (1.74)*
Dist. to maternity clinic, km.	-.00409 (1.83)*	.00234 (1.37)	.000543 (.43)
Urban (yes=1)	-.0994 (1.22)	-.0732 (1.18)	-.138 (2.61)***
% of households in barangay with own water supply	.0667 (.71)	-.180 (2.53)**	.149 (.28)
Average distance in barangay to household water-, m., * 10^{-3}	.0112 (.38)	-.0142 (.63)	-.0218 (.1.33)
Price of kerosene/price of rice	.761 (1.75)*	.926 (2.79)***	.355 (1.48)
Price of milk/price of rice	-.0336 (1.71)*	.00304 (.20)	-.00748 (.68)
Price of cooking oil/price of rice	.00308 (.03)	-.0971 (1.04)	-.215 (3.10)
Number of observations	3130	3104	2672
F-value	25.39	4.19	7.32
R-square	.1154	.0213	.0423

a- endogenous. Instruments include all exogenous variables, plus the total value of owned agricultural land, non-earned income, and father's age.

Absolute value of student t statistics in parenthesis

*** significant at .01 level, ** significant at .05 level, * significant at .10 level

Table 4.6b Estimates of anthropometric indicators, with endogenous income proxy (household expenditures per adult.) included.

Variable	Hemoglobin count (g./100 ml.) Child age six to 72 months	Hemoglobin count (g./100 ml.) Child age 72 to 167 months
	(1)	(2)
Intercept	9.46 (26.22)***	10.5 (31.5)***
Mother's education, years	-.0131 (.61)	-.00565 (.26)
Mother's height, z-score	.0756 (1.44)	.0107(.28)
Father's education, years	.0501 (1.65)*	.0244 (1.05)
Father's height, z-score	-.00975 (.19)	.00109 (.03)
Child male (yes=1)	-.107 (1.32)	-.214 (3.37)***
Child's age, months, * 10^{-2}	.0296 (13.85)***	.0741 (7.08)***
Household Expenditures per adult * 10^{-3} [a]	.0828 (.50)	.0322 (.23)
Dist. to rural health unit, km	-.0000370 (.01)	.00739 (1.14)
Dist. to secondary school, km.	-.000165 (.01)	-.00542 (.54)
Dist. to maternity clinic, km.	.0116 (2.60)***	-.00432 (1.37)
Urban (yes=1)	-.152 (1.03)	-.262 (2.18)**
% of households in barangay with own water supply	.381 (2.47)**	.147 (1.06)
Average distance in barangay to household water-, m., * 10^{-3}	-.234 (4.35)***	-.165 (3.75)***
Price of kerosene/price of rice	.717 (.86)	.932 (1.40)
Price of milk/price of rice	-.00999 (.26)	.0285 (1.03)
Price of cooking oil/price of rice	.207 (.85)	.430 (2.46)**
Number of observations	1249	1837
F-value	16.35	6.84

a- endogenous. Instruments include all exogenous variables, plus the total value of owned agricultural land, non-earned income, and father's age.

Absolute value of student t statistics in parenthesis

*** significant at .01 level, ** significant at .05 level, * significant at .10 level

5. Conclusion

This study investigated the determinants of child health, using anthropometric and nutrition outcomes as proxies for underlying child health. Four outcomes were studied: height-for-age, interpreted as a proxy for long term health; and arm circumference-for-age, weight-for-height, and hemoglobin count, all as indicators of the child's current health status.

Economic variables, such as income and household assets, were found to be significant determinants of health. Tables 5.1a-d show the effects of changing several policy variables on the endogenous outcomes. Education has a positive effect on health, although it was not clear whether father's or mother's education is the more effective determinant of child health. The estimation that includes both maternal and paternal variables (used for the calculations in tables 5.1a-d) show that the father's education is significant while the mother's education is not. The ownership of agricultural land has a positive effect on child health. Agricultural land is not only a source of income, it is also a source of employment and of nutrition. Non-earned income also benefits child health in some of the specifications. Community characteristics have an effect on health, although not always as expected.

The sample was partitioned by sex to test for evidence of discrimination on the basis of sex. There appears to be no evidence of systematic discrimination.

When treated as an endogenous variable, higher income was found to lead to better health when measured by height-for-age and arm circumference-for-age. Since education generally loses part its significance, at least part of education's beneficial effect on health should be attributed to an increase of economic resources.

The results show that weight-for-height is relatively invariable to changes in economic variables, including those that influence height-for-age. This implies that weight only increase to maintain the same relative weight for each height. Filipino children are relatively thin regardless of their height.

This study suggests a number of policy implications that can be explored in future research. It appears that in the Philippines, fathers do play a role in promoting good child health. Health programs should attempt to incorporate their inputs as well as those of the mother and future studies should not ignore the father's potential role.

Income also plays a major role in determining health, as might be expected in an area where caloric consumption can be quite limited. The provision of sanitary inputs or additional medical services may be wasted if the household does not have the economic means to provide for their children's nutrition.

One clear message from this analysis is that health does depend on the household's actions and that household's action can be a more important determinant of health than government's inputs. Government policy should not ignore the household's fundamental role nor should they assume that households do not react to policy changes.

Table 5.1a Predicted Z-score of Height-for-Age
Calculated at the sample mean from estimates in column 4, table 4.1

Variable	worse situation	bad situation	sample mean	good situation	best situation
Mother's Education	No education (0) -2.08	Low Education (3) -2.14	Sample Mean (5.75) -2.20	High School completed (10): -2.29	Post Graduate Education (15) -2.39
Father's Education	No education (0) -2.39	Low Education (3) -2.29	Sample Mean (5.49) -2.20	High School completed (10): -2.07	Post Graduate Education (15) -1.92
Value of agricultural land	No land (0) -2.23	Small land (2000): -2.21	Sample mean (2630): -2.20	Medium land holding (15000): -2.07	Large land holding (30000): -1.91
Unearned Income	None (0) -2.21	Limited (10) -2.20	Sample Mean (17.6) -2.20	Moderate (150) -2.16	Large Earnings (270) -2.13
Distance to Rural Health Clinic*	RHU Very Distant (25) -2.17	RHU Distant (13) -2.19	Sample Mean (6.48) -2.20	RHU Near (4) -2.21	RHU in Barangay (0) -2.21
Distance to Maternity Clinic*	Clinic Very Distant (36) -2.22	Clinic Distant (21) -2.21	Sample Mean (10.3) -2.20	Clinic Near (4) -2.19	Clinic in Barangay (0) -2.18
Distance to Secondary Schools*	School Very Distant (16) -2.24	School Distant (7) -2.22	Sample Mean (3.62) -2.20	School Near (2) -2.19	School in Barangay (0) -2.18
% of HHolds with Own Water Supply	None (0%) -2.15	Limited (20%) -2.18	Sample Mean (41.4%) -2.20	Moderate (65%) -2.23	All Holds (100%) -2.26
Distance to HHold Water Supply*	HHolds Very Distant from Water (2500) -2.21	HHolds Distant from Water (1000) -2.20	Sample Mean (272) -2.20	HHolds Close to Water (100) -2.20	HHolds at Water (0) -2.20

* Not significant at the .20 level.

Table 5.1b Predicted Z-score of Weight-for-height
Calculated at the sample mean from estimates in column 4, table 4.2

Variable	worse situation	bad situation	sample mean	good situation	best situation
Mother's Education*	No education (0) -.72	Low Education (3) -.70	Sample Mean (5.75) -.69	High School completed (10): -.66	Post Graduate Education (15) -.64
Father's Education	No education (0) -.61	Low Education (3) -.65	Sample Mean (5.95) -.69	High School completed (10): -.74	Post Graduate Education (15) -.80
Value of agricultural land*	No land (0) -.69	Small land (2000): -.69	Sample mean (2640): -.69	Medium land holding (15000): -.64	Large land holding (30000): -.63
Unearned Income*	None (0) -.69	Limited (10) -.69	Sample Mean (17.6) -.69	Moderate (150) -.66	Large Earnings (270) -.64
Distance to Rural Health Clinic	RHU Very Distant (25) -.63	RHU Distant (13) -.67	Sample Mean (6.49) -.69	RHU Near (4) -.69	RHU in Barangay (0) -.70
Distance to Maternity Clinic	Clinic Very Distant (36) -.61	Clinic Distant (21) -.64	Sample Mean (10.2) -.69	Clinic Near (4) -70	Clinic in Barangay (0) -.71
Distance to Secondary Schools	School Very Distant (16) -.58	School Distant (7) -.66	Sample Mean (3.62) -.69	School Near (2) -.70	School in Barangay (0) -.72
% of HHolds with Own Water Supply	None (0%) -.61	Limited (20%) -.65	Sample Mean (41.1%) -.69	Moderate (65%) -.73	All HHolds (100%) -.80
Distance to HHold Water Supply*	HHolds Very Distant from Water (2500) -.72	HHolds Distant from Water (1000) -.70	Sample Mean (274) -.69	HHolds Close to Water (100) -.68	HHolds at Water (0) -.68

* Not significant at the .20 level.

Table 5.1c Predicted Z-score of Arm Circumference
Calculated at the sample mean from estimates in column 4 in table 4.3

Variable	worse situation	bad situation	sample mean	good situation	best situation
Mother's Education	No education (0) -1.38	Low Education (3) -1.36	Sample Mean (5.78) -1.35	High School completed (10): -1.32	Post Graduate Education (15) -1.30
Father's Education	No education (0) -1.40	Low Education (3) -1.37	Sample Mean (5.95) -1.35	High School completed (10): -1.31	Post Graduate Education (15) -1.26
Value of agricultural land	No land (0) -1.35	Small land (2000): -1.35	Sample mean (2600): -1.35	Medium land holding (15000): -1.31	Large land holding (30000): -1.28
Unearned Income	None (0) -1.35	Limited (10) -1.35	Sample Mean (17.8) -1.35	Moderate (150) -1.35	Large Earnings (270) -1.35
Distance to Rural Health Clinic	RHU Very Distant (25) -1.33	RHU Distant (13) -1.34	Sample Mean (6.56) -1.35	RHU Near (4) -1.35	RHU in Barangay (0) -1.30
Distance to Maternity Clinic	Clinic Very Distant (36) -1.31	Clinic Distant (21) -1.33	Sample Mean (10.4) -1.35	Clinic Near (4) -1.36	Clinic in Barangay (0) -1.37
Distance to Secondary Schools	School Very Distant (16) -1.22	School Distant (7) -1.31	Sample Mean (3.63) -1.35	School Near (2) -1.36	School in Barangay (0) -1.38
% of HHolds with Own Water Supply	None (0%) -1.32	Limited (20%) -1.33	Sample Mean (41.4%) -1.35	Moderate (65%) -1.36	All HHolds (100%) -1.39
Distance to HHold Water Supply	HHolds Very Distant from Water (2500) -1.34	HHolds Distant from Water (1000) -1.34	Sample Mean (283) -1.35	HHolds Close to Water (100) -1.36	HHolds at Water (0) -1.40

* Not significant at the .20 level.

Table 5.1d Predicted Hemoglobin Count, children aged six months to six years
Calculated at the sample mean from estimates in column 2 in table 4.4

Variable	worse situation	bad situation	sample mean	good situation	best situation
Mother's Education*	No education (0) -11.3	Low Education (3) 11.3	Sample Mean (6.06) 11.2	High School completed (10): 11.2	Post Graduate Education (15) 11.2
Father's Education	No education (0) 10.9	Low Fducation (3) 11.0	Sample Mean (6.16) 11.2	High School completed (10): 11.5	Post Graduate Education (15) 11.8
Value of agricultural land*	No land (0) 11.2	Small land (1000): 11.2	Sample mean (1950): 11.2	Medium land holding (15000): 11.3	Large land holding (30000): 11.4
Unearned Income*	None (0) 11.2	Limited (10) 11.2	Sample Mean (14.0) 11.2	Moderate (150) 11.2	Large Earnings (270) 11.2
Distance to Rural Health Clinic*	RHU Very Distant (25) 11.2	RHU Distant (13) 11.2	Sample Mean (6.74) 11.2	RHU Near (4) 11.2	RHU in Barangay (0) 11.3
Distance to Maternity Clinic	Clinic Very Distant (36) 11.5	Clinic Distant (21) 11.4	Sample Mean (10.5) 11.2	Clinic Near (4) 11.2	Clinic in Barangay (0) 11.1
Distance to Secondary Schools*	School Very Distant (16) 11.2	School Distant (7) 11.2	Sample Mean (3.74) 11.2	School Near (2) 11.2	School in Barangay (0) 11.2
% of HHolds with Own Water Supply	None (0%) 11.1	Limited (20%) 11.2	Sample Mean (41.4%) 11.2	Moderate (65%) 11.3	All HHolds (100%) 11.4
Distance to HHold Water Supply	HHolds Very Distant from Water (2500) 10.7	HHolds Distant from Water (1000) 11.1	Sample Mean (294) 11.2	HHolds Close to Water (100) 11.3	HHolds at Water (0) 11.3

* Not significant at the .20 level.

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