The Developing Economies, XLII-4 (December 2004): 494–509

# THE DETERMINANTS OF GRADE ATTAINMENT IN LOW-INCOME COUNTRIES: EVIDENCE FROM RURAL BANGLADESH

HAYFA GRIRA

*First version received February 2004; final version accepted September 2004*

This paper presents an econometric analysis of the effects of child health on school enrollment and grade attainment in Bangladesh. It improves on past studies in a number of ways mainly by incorporating into its analysis the endogenous nature of child health. The results challenge the conclusions found in the literature. First, it finds that in Bangladesh, a child's health and his/her probability of being enrolled in school are at best weakly related. Second, it shows that once enrolled, nutritional deficiencies retard substantially school progress: Underweight children tend to be in lower grades than well-fed children of the same age. It is estimated that a one standard deviation improvement in weight-for-age would be expected to reduce the grades behind by about 0.25 years or about 13.5 percent of the actual years completed. Finally, the estimates suggest that the weight-for-age indicator appears as the best predictor of nutritional status.

## I. INTRODUCTION

WHY do children in poor countries perform less well than those in more developed ones? Why do they often delay school enrollment?

Education is one of the cornerstones of economic development. To enhance investment in human capital and remove barriers faced by families in low-income countries, one has to investigate the determinants of school enrollment and attainment, a question that has produced a large body of research.[1]

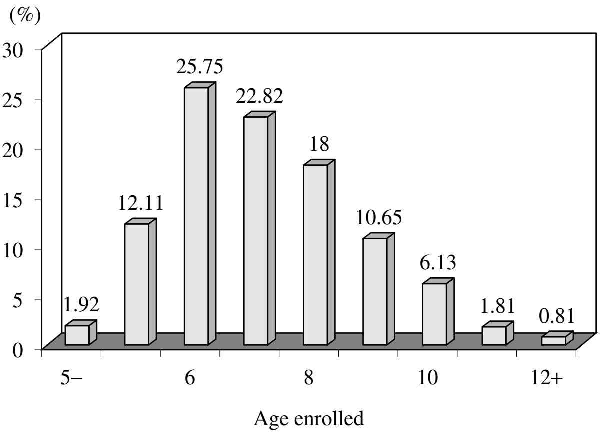
It is commonsense to state that poor health and nutrition are detrimental to a child's educational achievement. Improving child health would improve child education which would have long-run positive effects on labor productivity.

However, although there are a number of studies based on socioeconomic surveys that indicate the importance of child health, as measured by anthropometric indicators, on child schooling success,[2] the supporting evidence is still very limited.

[1] Among the many studies are Rosenzweig and Evenson (1977), Birdsall (1985), Psacharapoulos and Arriagada (1989), and Harbison and Hanushek (1992).

[2] There are also some experimental studies on the nexus between health and school achievement that focus on micro nutrients such as iron or on specific parasitic infections, e.g., Nokes et al. (1992). For an extensive review of the literature see Behrman (1996).

Fig. 1. School Enrollment for Children 6–17 in Bangladesh




Source: Rahman et al. (1999).

These studies also suffer from serious statistical problems as they fail to control for the probable endogeneity of child health, thus leading to biased estimates.

This paper will look at the case of Bangladesh and will examine a particular feature of child health as it affects schooling, namely delayed enrollment in primary school. Figure 1 shows the percentage of children enrolled by age. Less than half have done so by age six, the average delay (beyond average six) is about three and a half years.

Bangladesh is among the poorest countries in South Asia. Thirty-six percent of its people lived below the national poverty line in 2001. This is indirectly revealed by the anthropometric results of its children. The WHO Global Database on Child Growth gathered between 1999 and 2000 covers 87 percent of the total population under age five and reveals that Bangladesh has the highest prevalence of stunting, 64.5 percent, and underweight, 58.9 percent. The prevalence of wasting, however, was relatively low at 26.2 percent.

All the previous studies represent careful attempts at identifying the impact of child health on child schooling, but all of them are open to criticism for one of a variety of reasons. This study improves on these previous ones in a number of ways. First, it uses three anthropometric indicators: height-for-age, weight-for-age, and the body mass index, a short-run index of malnutrition; most of the previous research used a single common measure. Second, this study incorporates into its analyses the endogenous nature of child health. Finally it controls for the problem of censored data using the Moock and Leslie (1986) method.

The paper is structured as follows: after reviewing the main findings in the existing literature, Section III describes the main features of the data and discusses the methodology used. Section IV presents and discusses the results of the research. Finally, the concluding section will summarize the main findings of this study.

## II. PREVIOUS RESEARCH

There have been a number of past attempts to examine the correlation between anthropometric indicators of child health and child schooling achievement.

Edwards and Grossman (1980) examined the effects of a variety of child health indicators on the cognitive development of white children 6–11 years of age from cycle II of the Health Examination Survey (1963–65). They found significant effects of child health on cognitive development in cross sectional analyses. Similarly other studies have reported significant association between child health (including nutritional studies) and child schooling as indicated by cognitive achievement tests, mainly in the work of Florencio (1988) on the Philippines, Johnston et al. (1987), Pollit et al. (1993) on Guatemala, and a less strong association demonstrated by Gomes-Neto et al. (1997) on Brazil. Grade attainment is also positively associated with height in the studies by Chutikul (1986) in Thailand, Moock and Leslie (1986) in Nepal, Jamison (1986) in China, and by Harbison and Hanushek (1992) in Brazil. However these authors found no significant impacts when using child health indicators such as weight-for-age or the body mass index.

More recently Corman and Chaikind (1998) found a high probability to repeat a grade or to obtain very poor examination results for children 6–15 years of age with low or very low birth weight (2.5 and 1.5 kg). Blau and Grossberg (1992) used data from the National Longitudinal Survey of Youth (NLSY) to examine the effect of maternal employment on children's cognitive achievement. They also included the mother's evaluation of her child's current health in their model. They found an insignificant negative impact of poor child health on the cognitive development of children aged three to four years old.

Although the previous studies represent careful examination of the health-schooling nexus, all of these papers are open to criticism as they did not control for potential selectivity bias. Glewwe and Jacoby (1993) attempted to correct for such bias using the World Bank's Living Standards Measurement Survey (LSMS) when they sampled 1,700 children in Ghana aged 6–15 years, but they did not provide a convincing answer to the question of whether malnutrition is harmful to school attainment as the effect of height-for-age in their study is not significant and does not have the expected sign.

Behrman and Lavy (1994) addressed the issue of the impact of the endogenous determination of child health on child schooling success demonstrating why ordinary least squares estimates are likely to lead to biased results:

- If there is any (i) heterogeneity in unobserved predetermined family and community endowments that affect the promotion of child health and education, (ii) heterogeneity in tastes regarding child health and education versus parental consumption, (iii) unobserved heterogeneity across households in access to credit markets or unobserved favorable child characteristics that affect their intellectual and sanitary development, then the estimation results will lead to an upward bias.

- However if there is any (i) unobserved heterogeneity in parental tastes or community endowments regarding cognitive achievement versus health promotion, (ii) heterogeneity across households in the expected returns on education and health, or (iii) heterogeneity in unobserved parental capabilities regarding their efficiency in promoting child health and education, then the usual estimates will be biased downward.

Using the Ghanaian LSMS, the authors estimated cognitive achievement–health promotion relations in which child health was one of the inputs, and they found that malnutrition had an insignificant impact when controlling for unobserved family and community characteristics using within-family estimates.

Thus, the main studies that have explored the impact of child health and nutrition on child schooling success do not provide a definite answer as their results are ambiguous: sometimes positive and sometimes negative, due to the weakness of the econometric procedure used or the lack of high quality data suitable for such study.

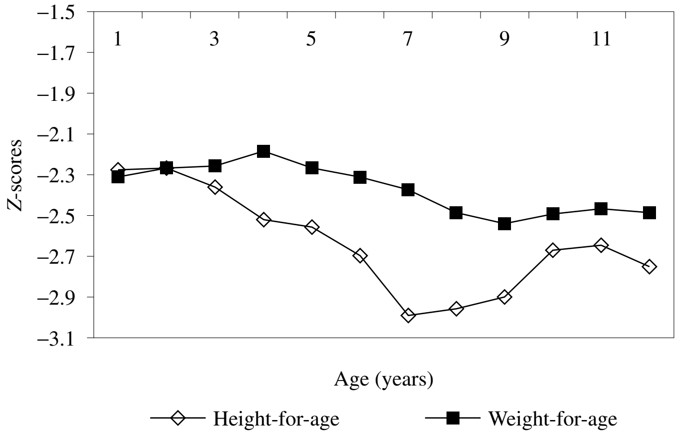
## III. DATA AND ECONOMETRIC STRATEGY

### A. *Data*

The data used in this study for the empirical analyses come from the Matlab Health and Socio-Economic Survey (MHSS) carried out in 1996 in the Matlab region of rural Bangladesh. The survey consists of a wide range of household questionnaires with detailed information on demographic characteristics, and household income and consumption. Respondents were also asked about the location of their health provider, pregnancy outcomes, and infant feeding. In addition, information concerning children was gathered regarding educational history, morbidity, medications, and the utilization of inpatient/outpatient care. All individuals in the household present on the date of interview had their weight and height recorded using the standard anthropometric procedure.

An extensive community questionnaire from 140 villages obtained information on the presence of various types of health care providers as well as on infrastructure and services. Questions also covered the availability of facilities, water sources and sanitation, and information from primary and secondary schools on characteristics such as school hours, administration, admission fees, tuition, and the number of students and teachers.

Fig. 2. Average $Z$-Scores for Height and Weight by Age




The evaluation of growth attainment requires the use of a reference population that allows for normal variation at any age as recommended by the World Health Organization. In order to be able to compare the growth attainment of children of different ages by sex, the anthropometric measurements of this study were converted into three indexes: height-for-age, weight-for-age, and the body mass index using the WHO/NCHS/CDC[3] curves. These curves are interpreted as indicative of chronic, total, and acute malnutrition respectively. The growth attainment of each child was then expressed as standard deviations from the median $z$-scores. The height-for-weight index was not included in this study as it is considered a weak variable according to nutritionists for children approaching their teens. Moreover, the prevalence of wasting (low height-for-weight) is relatively rare in Bangladesh.

The standardizing calculations were done using ANTHRO (Software for Calculating Paediatric Anthropometry) provided by the National Center for Chronic Disease Prevention and Health Promotion and the Nutrition Unit of the World Health Organization. The $z$-score measures the degree to which a child's measurements deviate from those expected based on a reference population. Figure 2 shows the mean $z$-scores by age for height-for-age and weight-for-age in the Matlab region of Bangladesh. Thirty percent of the children are extremely malnourished as determined by the height-for-age $z$-score of more than two standard deviations below the WHO/NCHS/CDC reference median (−3).

The formula for calculating the height-for-age $z$-score is:

$$z_i = (Y_i^{s,a} - H^{s,a}) \,/\, \sigma^{s,a},$$

[3] WHO/NCHS/CDS refer to the World Health Organization, the U.S. National Center for Health Statistics, and the Centers for Disease Control and Prevention.

where $z_i$ is the $z$-score for child $i$; $Y_i^{s,a}$ is the measured height (in cm) for child $i$ of sex $s$ and age $a$; $H^{s,a}$ is the median height (in cm) for children of sex $s$ and age $a$ in the reference population; and $\sigma^{s,a}$ is the standard deviation in height (in cm) for children of sex $s$ and age $a$ in the reference population.

The body mass index is calculated as: $bmi_i = \dfrac{H_i}{w_i^2}$,

where $H_i$ is the height (in cm) for child $i$ and $w_i$ is his weight (in kg).

B. *Econometric Strategy*

The height-for-age (weight-for-age) variable is exogenous in a linear regression framework provided that $E(h_i \varepsilon_i) = 0$. However, if parents have a positive effect on child height-for-age (weight-for-age) prior to the school enrollment decision, then this orthogonality condition is unlikely to hold and $h_i$ is then endogenous. For example, as mentioned by Behrman and Lavy (1994), highly motivated parents provide their children with a more nutritious diet as well as enroll them earlier. The presence of child specific endowments in the residual component is another source of simultaneity bias. Parents may offer less food to low ability children. In these cases we need instruments that are correlated with the anthropometric indicators but do not directly influence school enrollment decision. The availability and distance to health facilities and the prices of medicines are good candidates for such instruments under the assumption that the location of the health provider is exogenous to the household. However these instruments would not be valid if delays are caused by temporary illness when children are at the minimum age for school enrollment, since the probability of illness may be correlated with the cost and quality of the local health provider. However, in Matlab, the average duration of child illness is relatively short (0.38 months), so it would not lead to many delays.

Alderman et al. (2001) argue that in the usual static household model, child health and schooling performance both reflect household decisions regarding investments in children's human capital. So in general all demands are a function of the same set of instruments. However, the claim in this study is that height-for-age and weight-for-age are determined prior to the primary school enrollment decision, and hence cannot be a direct substitute for educational investments.

The main objective of this study is to assess the relationship between child health and school performance. This will be examined in two steps:

(1) Since a child's grade in school is conditional on having been enrolled, the first analysis is a probit of the binary dependant variable, enrollment. This probability is modeled below as a function of a set of theoretical relevant determinants of school participation. These include child characteristics such as age, sex, and nutritional status, and parental and family characteristics mainly educational attainment, number of siblings and income, as well as community characteristics such as distance to school.

$$F(Y_i) = prob(S_i = 1) = P_i$$

and

$$1 - F(Y_i) = prob(S_i = 0) = 1 - P_i,$$

where $S_i$ denotes the dichotomous variable of school enrollment which takes the value 1 if the child is enrolled, 0 if not enrolled. $Y_i$ is some linear combination of the independent variables summarized above.

(2) The second focus is on schooling delay. To address this issue, I experimented using an instrumental variable procedure in which child health is treated as endogenous. The dependant variable is considered as a continuum variable indicating the child's age-adjusted grade attainment. Not entering school at all is seen as an extreme value of this variable delay. It is constructed following the Moock and Leslie (1986) procedure by first running an OLS regression of the natural log of grade in school on the natural log of age:

$$\ln G_i = \alpha + \beta \ln A + \varepsilon_i,$$

then subtracting the predicted grade $\hat{G}$ from the child's observed grade level.[4] This provides the dependant variable known as grades-ahead-given-age: $GH = G - \hat{G}$. A positive (negative) value of $GH$ indicates that the child is ahead (behind) in school relative to other children of the same age. Even though the delay variable is adjusted for age, the age variable should be included in the regressions as it may affect the potential delay of enrollment.

Ideally longitudinal data is needed to produce results with family and community fixed effects estimates. Such estimates is not completely excluded using the present data, but great demand is placed on the data as instruments are needed that correlated with within-household differences in the anthropometric indicators which has been impossible to obtain. This limitation will be kept in mind when drawing conclusion from this study.

Finally, the means and standard deviations of the variables used in the regressions are shown in Appendix Table A.

## IV. ESTIMATION RESULTS

### A. *Probit Analysis of School Enrollment*

The probit results of whether children are enrolled in school are given in Table I. The first stage estimates for the determination of the $z$-score for child height, weight, and the body mass index are given in Appendix Table B.

The first two columns show the results only for a child's age, sex, and the anthro-

[4] $\hat{G}$ is used for simplicity and should be read as the predicted values of the logarithm of $G$.

TABLE I

PROBIT ANALYSIS OF SCHOOL ENROLLMENT

| Independent Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Constant | 1.51$^{***}$ | 1.98$^{***}$ | −0.23 | −0.12 | 0.58 | 0.7 | 1.35$^{*}$ | 1.54$^{*}$ | 0.61 |
| | (2.70) | (2.86) | (−0.35) | (−0.15) | (0.74) | (0.75) | (1.90) | (1.77) | (0.57) |
| Age | 0.08$^{***}$ | 0.1$^{***}$ | 0.09$^{***}$ | 0.09$^{***}$ | 0.09$^{***}$ | 0.09$^{***}$ | 0.10$^{***}$ | 0.106$^{***}$ | 0.09$^{***}$ |
| | (4.18) | (4.74) | (4.41) | (4.17) | (4.27) | (4.07) | (5.74) | (5.32) | (3.89) |
| Sex | −0.03 | 0.08 | −0.08 | −0.06 | −0.07 | −0.05 | −0.07 | −0.07 | −0.08 |
| | (−0.34) | (0.71) | (−0.63) | (−0.48) | (−0.54) | (−0.38) | (−0.58) | (−0.52) | (−0.59) |
| *Ht*/*AZ* | 0.33$^{**}$ | — | 0.03 | — | 0.03 | — | −0.03 | — | — |
| | (2.13) | | (0.16) | | (0.18) | | (−0.2) | | |
| *Wt*/*AZ* | — | 0.67$^{**}$ | — | 0.09 | — | 0.1 | — | 0.04 | 0.10 |
| | | (2.34) | | (0.27) | | (0.29) | | (0.12) | (0.30) |
| BMI | 0.02 | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | — | — | 0.03 |
| | (0.87) | (0.81) | (1.01) | (1.00) | (0.94) | (0.93) | | | (0.093) |
| Outcome order | — | — | — | — | — | — | −0.05$^{**}$ | −0.054$^{**}$ | −0.06$^{***}$ |
| | | | | | | | (−2.29) | (−2.27) | (−2.70) |
| Mother's schooling (years) | — | — | 0.44$^{***}$ | 0.43$^{***}$ | 0.47$^{***}$ | 0.46$^{***}$ | 0.472$^{***}$ | 0.45$^{***}$ | 0.43$^{***}$ |
| | | | (2.95) | (2.89) | (3.04) | (2.99) | (3.04) | (2.94) | (2.70) |
| Father's schooling (years) | — | — | 0.355$^{**}$ | 0.351$^{**}$ | 0.359$^{**}$ | 0.355$^{**}$ | 0.36$^{**}$ | 0.358$^{**}$ | 0.3$^{**}$ |
| | | | (2.53) | (2.49) | (2.52) | (2.47) | (2.58) | (2.51) | (2.03) |
| Head is Muslim | — | — | — | — | — | — | −0.36$^{*}$ | −0.35$^{*}$ | −0.3 |
| (1 = Yes, 2 = No) | | | | | | | (−1.67) | (−1.65) | (−1.34) |
| Head works in food processing | — | — | — | — | — | — | — | — | −0.06 |
| | | | | | | | | | (−0.46) |
| Family size | — | — | — | — | — | — | — | — | 0.28 |
| | | | | | | | | | (1.39) |
| Crop value ($10^{-4}$) | — | — | — | — | — | — | — | — | 2.57$^{*}$ |
| | | | | | | | | | (1.76) |
| Log income/capita | — | — | — | — | 0.09$^{**}$ | 0.096$^{**}$ | 0.09$^{**}$ | 0.097$^{**}$ | 0.095$^{**}$ |
| | | | | | (2.26) | (2.27) | (2.27) | (2.27) | (2.18) |
| School in village | — | — | 1.48$^{***}$ | 1.47$^{***}$ | 1.483$^{***}$ | 1.48$^{***}$ | 1.49$^{***}$ | 1.496$^{***}$ | 1.43$^{***}$ |
| | | | (6.21) | (6.21) | (6.19) | (6.19) | (6.22) | (6.22) | (6.01) |
| Log likelihood | −266.27 | −265.74 | −210.76 | −210.74 | −207.88 | −207.85 | −210.28 | −210.29 | −201.14 |
| Sample size | 2,203 | 2,203 | 2,176 | 2,176 | 2,168 | 2,168 | 2,237 | 2,237 | 2,160 |

Note: School enrollment is the dependant variable. $t$-statistics are in parentheses and are asymptotically normally distributed.
$^{*}$ Significant at 10 percent level, $^{**}$ Significant at 5 percent level, $^{***}$ Significant at 1 percent level.

pometric indicators. Boys are less likely to be enrolled than girls as the gender coefficient is negative but is not significant and hence it does not appear as determinant of school decision-making. However, older children are found to be significantly more likely to be enrolled in school. Of the interest variables, the body mass index does not perform at all, even though it has the right sign. A priori, the positive and significant coefficients on height-for-age and weight-for-age support this study's hypothesis that children with better nutritional status are more likely to be enrolled. The effect of weight-for-age (a measure of general malnutrition) is particularly strong compared to the height-for-age (a measure of chronic malnutrition), which is an unexpected result. Based on this study's hypothesis, this means that the former indicator best captures school enrollment. This holds for the results in Table I where the coefficient of height-for-age is sometimes positive and sometimes negative. Parents' education, availability of a school in the child's village and per capita income are added to the analysis. They all are found to be highly significant especially the variable related to school location: the further the primary school is from the household, the lower is the probability to be enrolled in school. While a few studies[5] claim a greater significant impact of the father's education on a child's schooling, the results of this study confirm the greater role of the mother's education as the estimated coefficient is significant and higher in magnitude. Meanwhile, it found no support for the influence of nutritional status: neither the height-for-age nor weight-for-age significantly influences the schooling decision when family and community variables are introduced as controls. The religion of the household head seems to be negatively and significantly related to a child's schooling: all else being equal, being Muslim increases the child's probability of being enrolled in school.

The regression, reported in the last column of Table I, shows that the order in which a child is born has a significant impact on the schooling decision indicating robust support for the theoretic trade off between the quantity and quality of children. Finally, as expected this study found a strong positive impact of household income on the probability of being enrolled in school.

## B. *Instrumental Variables Analysis of the Delay in Enrollment*

This section will examine the role of a child's health on his/her progress in school. Nutritional deficiencies are expected to be positively related to lower grade attainment and hence to greater enrollment delay. In contrast, household income should have a negative impact on delays. The existence of admission fees is a very important variable as parents who have no savings and cannot borrow against the future earnings of their children would be expected to keep them out of school longer. The data show that the average registration fee for primary school enrollment is about 50 taka. On top of this there are other costs such as uniforms, books, and school

[5] Moock and Leslie (1986), Kaestner and Corman (1995), and Dumont (2000)

TABLE II

TESTS FOR EQUALITY BETWEEN MEANS AND MEDIANS

| Variables | Mean | | Median | |
|---|---|---|---|---|
| $Ht/AZ^{-}$ | $-2.716^{***}$ | (6.14) | $-2.71^{***}$ | {7.96} |
| $Ht/AZ^{+}$ | $-2.446^{***}$ | (6.14) | $-2.34^{***}$ | {7.96} |
| $Wt/AZ^{-}$ | $-2.44^{***}$ | (7.92) | $-2.49^{***}$ | {8.52} |
| $Wt'AZ^{+}$ | $-2.23^{***}$ | (7.92) | $-2.27^{***}$ | {8.52} |

Notes: 1. $t$-statistic in parentheses, Wilcoxon-Mann-Whitney statistic in brackets.

2. $Ht/AZ^{-}(Wt/AZ^{-})$, $Ht/AZ^{+}(Wt/AZ^{+})$ indicate the height-for-age $z$-scores (weight-for-age $z$-scores) for children with negative and positive "grade deviations" respectively.

$^{***}$ Significant at 1 percent level.

supplies (pens, pencils, notebooks, etc.). The probable impact of the quality of a school on a child's progress also has to be taken into consideration.

Firstly to check the influence of child health on grade attainment in the Matlab region of Bangladesh, the sampled group was divided into two sub-samples: children who were ahead and children who were behind in school, and these were tested for the equality of means and medians of the main nutritional status variables of height-for-age and weight-for-age. The test results are summarized in Table II. They are highly significant and a priori strengthen the hypothesis that malnutrition has a detrimental effect on age-adjusted grade attainment. Children with lower nutritional status tend to be behind in school relative to where they should be given their age. Regarding the height-for-age indicator, this means that taller children tend to be in higher grades than shorter children of the same age.

Turning to the instrumental variable regressions, Table III reports estimates of grade attainment. Of immediate note is the highly significant and positive coefficient on weight-for-age and height-for-age. Again the impact of the former is larger and appears as a better predictor of school performance. Negative weight-for-age in Bangladesh almost always goes with negative height-for-age. A one standard deviation improvement in weight-for-age is associated with a child's being about 0.25 years less behind. The body mass index is nowhere significant. This finding supports the hypothesis that lower nutritional status retards the age of school enrollment and the educational advancement of children.

Parents may choose to invest more in one child or another conditional on his/her future ability. This behavior represents one potential source of bias justifying the treatment of health indicators as endogenous. Therefore health prices are generally good candidates as instrumental variables and refer to the availability of and distance to health facilities under the assumption that their placement is exogenous to the household. Hence, these estimates are consistent under the assumption that the

TABLE III

INSTRUMENTAL VARIABLES ANALYSIS OF GRADE ATTAINMENT

| Independent Variables | (1) | | (2) | |
|---|---|---|---|---|
| Constant | −1.81*** | (−3.34) | −0.36 | (−0.43) |
| Age | 0.21*** | (11.55) | 0.22*** | (10.90) |
| Sex | 0.03 | (0.48) | 0.14 | (2.04) |
| *Ht/AZ* | 0.28** | (2.34) | — | |
| *Wt/AZ* | — | | 0.66*** | (2.69) |
| BMI | 0.01 | (0.75) | −0.04 | (−1.47) |
| Mother's schooling (years) | 0.08*** | (5.92) | 0.07*** | (5.42) |
| Father's schooling (years) | 0.06*** | (7.27) | 0.06*** | (6.89) |
| Family size | −0.14 | (−1.32) | −0.14 | (−1.28) |
| Agricultural land ($10^{-3}$) | −9.40 | (−0.64) | −2.82 | (−0.19) |
| Log income/capita ($10^{-3}$) | 8.64 | (0.44) | 7.41 | (0.37) |
| School flooring type | 0.09 | (1.37) | 0.06 | (0.96) |
| School expenses/income ($10^{-6}$) | 1.66 | (1.11) | 1.61 | (1.07) |
| Sample size | 1,338 | | 1,339 | |
| Adj. $R^2$ | 0.26 | | 0.25 | |
| $F$ | 45.04 | | 42.19 | |
| Durbin-Wu-Hausman test | 20.88** | | 26.41*** | |

** Significant at 5 percent level.
*** Significant at 1 percent level.

instruments are not correlated with the disturbance term. The same assumption has been made in other recent studies (e.g., Pitt, Rosenzweig, and Hassan [1990]).

Ideally, it would be best to use a fixed effect instrumental variables estimator to produce more consistent coefficients. Unfortunately, this procedure requires instruments that are correlated with within-household differences in height-for-age (weight-for-age) and thus places great demands on the data. Although the instruments used are not all significant, the Durbin-Wu-Hausman test clearly reject the null hypothesis that the OLS estimators are consistent and that the difference between the OLS and IV coefficients are random. The test is significant at the 1 percent level for the weight-for-age indicator confirming the treatment of the health indicators as endogenous.

This study found no evidence of the borrowing constraints hypothesis. Neither per capita income nor total expenses related to primary school enrollment affect child school performance. The results (not reported here) do not change even when including the crop-value variable or household assets instead of income.

Family size fails to reach the critical value of significance and does not seem to be determinant of grade attainment. However, the coefficient for age is positive and highly significant indicating that delays are longest for younger children and steadily decline for older cohorts.

Finally, this study found that parents' education, mainly the mother's, as measured by the number of grades completed, is always positive and highly significant:

The higher the parents' level of education, the greater their children's progress will be.

## V. CONCLUSION

This paper analyzed the effects of child health on school enrollment and grade attainment for children between the ages of 6 and 17 using the Matlab Health and Socio-Economic Survey conducted in Bangladesh in 1996. Some of the results challenge the conclusions found in the literature. First, it found that in the group sampled, child health as measured by a wide range of anthropometric indicators and a child's probability of being enrolled in school are at best weakly related. Poor nutritional status, when considered alone, affects positively and significantly school enrollment; however, this conclusion no longer holds once family and community characteristics are included. The omission of such variables is responsible for the incorrect inference that child health has a strong impact on school participation. This result is in opposition to that reported by Moock and Leslie (1986), Balderston et al. (1981), and Dumont (2000). One major difference between this study and these earlier works that can explain the difference in results is that the latter failure to control for the endogenous nature of child health which resulted in upward biases.

Second, the present results differ from the past literature with respect to the key health indicator. This study's estimates suggest that the impact of child weight-for-age, which is a combination of height-for-age and weight-for-height, is strong and appears as the best predictor of whether or not a child was enrolled in school. This is a surprising finding since all previous works put much more emphasis on child height-for-age.

This study also looked at the effects of family and community characteristics which turned out to be highly and significantly related to school enrollment, especially mother's education and school location. On the other hand, it did not find any support for gender gaps in school participation.

The grade attainment results are particularly interesting. This study found that nutritional status plays a great role in determining a child's school progress. Underweight children tend to be in lower grades than well-fed children of the same age. It is estimated that a one standard deviation improvement in weight-for-age would be expected to reduce the grades behind by about 0.25 years or about 13.5 percent of the actual years completed. Meanwhile this study found no support for any alternative explanation of school deviation based on household income or school enrollment fees. The school quality variable and school location fares no better than the borrowing constraint hypothesis. However, parents' education performs quiet well.

In summary, robust finding of this study is that child health is not significantly determinant to the school enrollment decision, but once enrolled nutritional deficiencies substantially retard school progress as it can affect a child's cognitive achievement. Therefore programs that aim at improving child health could have important implications for educational attainment and are likely to have important longer-run productivity effects. Future research on the subject based on longitudinal data will certainly shed more light on the health-schooling nexus.

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APPENDIX TABLE A

DEFINITION OF VARIABLES: MEANS AND STANDARD DEVIATION

| Variables | Mean | Standard Deviation |
|---|---|---|
| *S*: school enrollment (1 = Yes, 0 = No) | 0.94 | 0.22 |
| *G*: grade in school | 3.38 | 2.75 |
| ln*G*: natural log of *G* | 1.15 | 0.76 |
| *GH*: grades ahead given age | 0.08 | 1.71 |
| Sex (1 = male, 0 = female) | 0.53 | 0.49 |
| Age (years) | 12.42 | 3.92 |
| *Ht* / *AZ*: height-for-age *z*-score | –2.61 | 1.28 |
| *Wt* / *AZ*: weight-for-age *z*-score | –2.36 | 0.82 |
| BMI: body mass index | 15.78 | 31.66 |
| Outcome order: child's birth order | 4.02 | 2.64 |
| Father's schooling (1 = Yes, 0 = No) | 0.53 | 0.49 |
| Mother's schooling (1 = Yes, 0 = No) | 0.44 | 0.49 |
| Number of grades completed by the father | 3.37 | 3.90 |
| Number of grades completed by the mother | 2.07 | 2.89 |
| Height of the mother (cm) | 152.94 | 56.92 |
| Height of the father (cm) | 170.40 | 70.73 |
| Head is Muslim (1 = Yes, 2 = Hindus) | 1.09 | 0.28 |
| Head is working in food process (1 = Yes, 0 = No) | 0.49 | 0.49 |
| Family size: household size corrected by an equivalent scale | 2.45 | 0.35 |
| Agricultural land: proportion of land owned (anas[a]) | 15.6 | 2.10 |
| Crop value (taka) | 533.47 | 584.17 |
| Income per capita (taka, 1995) | 7,696.85 | 21,604.19 |
| Natural log of per capita income (1995) | 7.72 | 1.78 |
| Household assets (taka) | 182,030.5 | 1,027,473 |
| Rice consumption (1 = Yes, 0 = No) | 0.37 | 0.48 |
| School in village (1 = Yes, 0 = No) | 0.42 | 0.49 |
| Households in cluster with facility: | | |
| Modern latrine (1 = Yes, 0 = No) | 0.44 | 0.20 |
| Pit latrine | 0.73 | 0.26 |
| No latrine | 0.02 | 0.15 |
| Number of doctors (within 10 km) | 11.90 | 6.36 |
| Hours health providers are open a week | 48.33 | 3.39 |
| Distance to nearest health care provider (km) | 8.86 | 9.09 |
| Tap water | 0.004 | 0.06 |
| Tube well | 0.94 | 0.22 |
| Regular well | 0.001 | 0.03 |
| River | 0.03 | 0.18 |
| Total expenditure related to primary school (taka) | 655.90 | 1,021.27 |
| Expenses related to admission/register (taka) | 49.77 | 70.94 |
| Total educational expenses/income | 0.64 | 4.56 |
| Expenses related to books and other school supplies (taka) | 239.94 | 259.36 |
| School roofing type (1 = cement, 0 = wood/mud) | 0.70 | 0.45 |

[a] Equivalent to 342.25 sq. feet.

APPENDIX TABLE B

FIRST-STAGE REGRESSIONS

| Instrumental Variables | Height-for-Age *Z*-Score | | Weight-for-Age *Z*-Score | | The Body Mass Index | |
|---|---|---|---|---|---|---|
| Sex | 0.06 | (1.22) | –0.15 | (–5.05) | –0.32 | (–2.27) |
| Father's schooling | 0.01 | (2.24) | 0.011 | (2.55) | 0.03 | (1.82) |
| Mother's schooling | 0.003 | (0.656) | 0.004 | (0.90) | –0.01 | (–0.55) |
| Household assets ($10^{-8}$) | 2.28 | (0.307) | 1.68 | (1.28) | 0.0029 | (0.5) |
| Family size | –0.16 | (–2.07) | –0.08 | (–1.75) | 0.02 | (0.09) |
| Agricultural land | 0.35 | (2.38) | 0.05 | (0.67) | 0.03 | (0.82) |
| Distance to nearest health facility | –0.002 | (–0.483) | –0.01 | (–0.87) | 0.001 | (0.11) |
| Number of doctors | 0.007 | (1.87) | 0.03 | (1.66) | 0.019 | (1.68) |
| Hours open a week | 0.01 | (1.48) | 0.04 | (0.87) | 0.008 | (0.44) |
| Mother's height | 0.04 | (9.98) | 0.01 | (7.75) | –0.007 | (–0.60) |
| Father's height | 0.02 | (2.14) | 0.01 | (2.14) | –0.0002 | (–0.12) |
| Rice consumption | 0.26 | (4.58) | 0.2 | (5.88) | 0.25 | (1.65) |
| Household in cluster with: | | | | | | |
| Modern latrine | 0.48 | (3.57) | 0.27 | (3.50) | 0.05 | (0.17) |
| Pit latrine | 0.01 | (0.14) | 0.06 | (0.11) | –0.34 | (–1.20) |
| No latrine | –0.16 | (–0.75) | –0.04 | (–0.33) | –0.23 | (–0.38) |
| Tap water | 0.24 | (0.61) | –0.14 | (–0.65) | –0.69 | (–0.64) |
| Tube well | –0.13 | (–0.6) | –0.24 | (–1.81) | –1.03 | (–1.65) |
| Regular well | 0.27 | (0.23) | 0.53 | (0.75) | 0.08 | (0.03) |
| River | –0.17 | (–0.6) | –0.19 | (–1.18) | –1.19 | (–1.49) |

Notes: 1. *t*-values are in parentheses and are asymptotically normally distributed.
2. Variables that did not serve as identifying instruments are not included in this table.