Child Health and Schooling Achievement in Bangladesh

Structured Abstract:

Purpose: This paper examines the impact of child health (measured by nutritional status) on schooling performance of Bangladeshi children.

Design/methodology/approach: The data set used in this study comes from a survey titled "Micronutrient and Gender Study (MNGS) in Bangladesh". The survey was administered by the International Food Policy Research Institute (IFPRI). We control for the potential endogeneity of child health by an instrumental variables approach. Our results indicate that the impact of child health on school achievement will be overestimated if endogeneity of child health is ignored.

Findings: Our results reveal that child health has significant effects on school enrolment and grade attainment, although it does not affect current school attendance. The impact of child health is stronger for school enrolment compared to grade attainment.

Originality/value: This study improves our understanding on the relationship between child health and schooling in several ways. First, we control for the potential endogeneity of child health by an instrumental variables approach. Our chosen instrumental variables (i.e., heights of father and mother) are strong predictors of child health, and satisfy the validity test. Second, this study examines the effects of child health on wide ranges of schooling measures: enrolment, attendance and attainment.

Keywords: Child Health, School Attainment, Bangladesh

Article Classification: Research paper

1. Introduction

Economic development is a universal policy priority in all countries, particularly in developing countries. However, the crucial role that human capital such as education and health plays in economic development is not properly recognized in policy priorities in many developing countries, particularly in south Asian countries. For example, the government expenditure on health (Bangladesh 6 %, India 2%, Pakistan 1% and Sri Lanka 6%) and education (Bangladesh 14%, India 3%, Pakistan 2% and Sri Lanka 10%), especially on health, in this region is critically low[1]. Although, the investment in health and education in Bangladesh is not as bad as India and Pakistan, however, it lags behind in adult illiteracy rate (56%) and infant mortality and childhood malnutrition compared to other south Asian countries. Bangladesh's infant mortality rate (per 1000 live births) and under-5 mortality rate (per 1000 children) are, respectively, 46 and 69 (United Nations Development Program, 2008). The 2007 Bangladesh Demographic Health Survey (BDHS) reports that 43 per cent of Bangladeshi children under 5 years of age are short for their age or stunted, and 16 per cent are severely stunted. Another 17 per cent of the Bangladeshi children are wasted, and one per cent is severely wasted. Forty eight per cent of children are considered underweight (low weight for age), and 13 per cent are classified as severely underweight (ESCAP, 2005). Evidence suggests that malnourished children are more likely to have lower schooling. The low level of schooling in developing countries can be attributed to childhood malnutrition if there is a causal relationship between these two. This has implications for intergenerational transmission of poverty. Children who have poor health may be more likely to have lower schooling and lower earnings as adults and raise their children in poverty, which can seriously impute the

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[1] *Source*: UNICEF, http://www.unicef.org/infobycountry: accessed on 12 March 2012,

economic growth of a country. This line of insight suggests that the policies and programs that improve human capital development of children have important implications for breaking the cycle of intergenerational poverty, and thus contribute to economic development.

The role of poor health in childhood as an intervening factor in schooling has not been fully understood. This paper investigates how childhood health (measured by height-for-age) determines schooling of Bangladeshi children using a data set from Bangladesh. Our results reveal that child health has significant effects on school enrolment and grade attainment. The impact of child health is stronger for school enrolment compared to grade attainment.

This study improves our understanding on the relationship between child health and schooling in several ways. First, we use an instrumental variable approach, in which parental height variables that affect child health directly but do not affect schooling decision, are selected to identify child health. The point of departure of this study from the existing literature (for example, Grira 2004, Alderman et al., 2001) is the use of the over-identification test, which confirms the validity of our instruments. The first-stage regressions reveal that our set of instrumental variables very strongly correlated with child health, and validity test also confirm the appropriateness of these instruments to predict child health.[2] Second, this study examines the effects of child health on wide ranges of schooling measures: enrolment, attendance and attainment. We hypothesize that child health (measured by heights for age) affects not only enrolment probability but also school outcome. Our results reveal that child health has significant and expected effects on school enrolment, and grade attainment. This study, thus, adds considerably to our understanding on the impact of child health on schooling. Moreover, our study shows that childhood malnutrition has significant effects on schooling even after controlling for the endogeneity of child health, whilst some previous studies find lower effect (for example, Glewwe and Jacoby, 1995; Behrman and Lavy, 1998 and Grira, 2004) or no effect (Handa and Peterman 2007) of childhood malnutrition on schooling when endogeneity of child health is accounted for.

2. Literature Review

Behrman (1996) reviewed a large number of studies and reported a significant positive relationship between child health and schooling. For example, Gomes-Neto et al. (1997) noted that nutrition and health status strongly affected both grade attainment and student achievement of Brazilian children. They found that the students' short term nutrition had a strong role in cognitive learning although it did not have the same effect on their grade repetition. Similarly the works of Florencio (1988) on the Philippines and Pollitt et al. (1993) on Guatemala have found significant association between child health and child schooling. The studies of Chutikul (1986) in Thailand, Moock and Leslie (1986) in Nepal, and Jamison (1986) in China have also found a positive association between grade attainment and child height. Wisniewski (2010) found that better early nutritional status of children has a significant direct effect on test scores on Sri Lankan children. Her results were robust on variety of estimation strategies. Alderman et al. (2009) also revealed that childhood malnutrition seriously affects future academic achievement measured by years of school and delayed entry, which in turn reduce future earnings. A recent study by Aturupane, Glewwe and Wisniewski (2011) also confirmed that child health (among other variables) significantly affects learning outcomes of a child.

Most of the previous studies, such as Chutikul (1986), Jamison (1986), Moock and Leslie (1986), and Gomes-Neto et al. (1997), did not consider the fact that child health and schooling performance both reflects household decisions regarding investments into children's human capital, which is determined simultaneously in the household. In other words, most previous studies on the impact of child health on schooling did not control for the endogeneity of child health. Some exceptions are Glewwe and Jacoby (1995), Behrman and Lavy (1998), Glewwe et al. (2001), Alderman et al. (2001), Grira (2004), Handa and Peterman (2007) Wisniewski (2010) and Khanam, Nghiem and Rahman (2011). Particularly, Glewwe and Jacoby (1995), Behrman and Lavy (1998), and Grira (2004) controlled for unobserved heterogeneity by taking into account of household and community variables to identify child health. The estimates of child

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[2] The first stage F-statistics is 31.41, which is greater than the rule of thumb value of 10 (Staiger and Stock, 1997; Stock et al., 2002) showing that we do not have a weak instrument problem.

health found from these papers were considerably lower than those that did not control for the endogeneity of child health. These findings suggest that the impact of child health on schooling may be lower than commonly believed.[3] One possible issue is that household and community variables used in cross-sectional studies might be correlated with the unobserved variables affecting child schooling, which in turn could result in biased estimates. To overcome this problem, Alderman et al. (2001) controlled for unobserved heterogeneity using lagged price shocks to instrument earlier nutrition status of a child using longitudinal data from Pakistan.[4] They established a causal relationship between child health and schooling for Pakistani children. The authors found that the relationship between child's earlier health and subsequent schooling is actually much larger than those studies that did not account for behavioural choice. Using the same approach as Alderman et al. (2001), Handa and Peterman (2007), however, did not find any statistically significant relationship between child health and schooling in South Africa.

The controversial findings from different studies place a great demand on further exploration of the impact of child health on schooling. Although cross-sectional studies that used household and community variables to instrument child health provided similar trends in the impact of child health on child's schooling performance, longitudinal studies using lagged price shock to instrument child's earlier health provided quite different results across studies (see for example, Alderman et al., 2001, and Handa and Peterman, 2007). The divergence of results in different studies questions the validity of instruments to identify child health. A recent study by Khanam, Nghiem and Rahman (2011) examined the impacts of childhood malnutrition on schooling by using simultaneous bivariate probit model instead of instrumental variable approach. Khanam et al. (2011) found that malnourished Bangladeshi children are 26 percentage points less likely to enrol in school on time and 31 percentage points less likely to be in grade that is appropriate for age. Our study contributes to this literature, especially in the context of Bangladesh, which has very limited literature in this issue.

3 Data and Descriptive Statistics

Data Source

This study uses data from a survey titled "Micronutrient and Gender Study (MNGS) in Bangladesh". This survey, which was administered by the International Food Policy Research Institute (IFPRI), collected data from three survey sites: Saturia, Mymensingh and Jessore in 1996-1997. The MNGS sampled a total of 957 households from 47 villages and collected data on 5,541 individuals residing in the sample households. It provided economic, demographic, agricultural, and gender information. The survey also contained information about the schooling, anthropometry, morbidity, reproductive history and mortality, hospitalizations, chronic diseases and use of health care facilities in the household. The data were collected in four rounds. This study restricts the sample only to the children of the first round of the survey, because other rounds included only those adult household members who were away from home at the time of the first round of the survey. These household members only account for a very small proportion of the total sample, hence it is expected that they do not affect the analysis. The present analysis is based on data for children aged 5 - 17 years living in rural households in which the mother and father are both present.

Definition of Child Health

Child health (malnutrition) in this study is measured by height-for-age, which is an important indicator of malnutrition (Waterlow, 1972). The Z-score method, recommended by the World Health Organization (WHO), is used to measure a child's height-for-age. The z-score measures the degree to which a child's measurements deviate from what is expected for that child, based on a WHO/NCHS international reference population. In other words, the height-for-age is expressed as a number of standard deviations above or below the corresponding reference mean for a child of the same age and sex. We do not include in our study the height-for-weight variable because it is less than a perfect measure of child growth for children

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[3] In a case where it is assumed that child health is predetermined rather than determined by household choices in the presence of unobserved factors.

[4] Lagged price shocks are correlated with early childhood health, but uncorrelated with subsequent period price shocks that influence schooling decision in later period.

approaching the teen and adolescent age (Saigal et al., 2001). Moreover the prevalence of wasting (i.e., low height-for-weight) is relatively rare in Bangladesh (Grira, 2004).

Following Kassouf and Senauer (1996), health status of children in this study is categorized according to the following classification of malnutrition: *Normal* if the z-score is greater than -1; *Mild* if the z-score lies in the interval (-2, -1); *Moderate* if the z-score lies in the interval (-3, -2); and *Severe* if the z-score is less than -3. The proportion of children in our sample that are severely, moderately and mild malnourished are 15 per cent, 33 per cent and 32 per cent respectively , whilst only 19 per cent children are classified as normal compared to the reference population (see Table 1). Table 1 shows the schooling results (school attendance, enrolment and grade attainment) of children by their malnutrition status. Table 1 reveals that school attendance, enrolment in due time and being in right grade for age are very low among severely malnourished children

Table 1: Percentage of children by schooling and health status

Degree of malnutrition	Normal	Mild	Moderate	Severe	Total
School Attendance					
Currently attending school	16.250	26.350	27.180	11.160	80.940
Currently not attending	3.260	6.230	5.920	3.640	19.060
School Enrolment					
Enrolled in due time	11.620	13.590	10.020	1.750	36.980
Enrolled late	6.150	15.950	19.740	10.480	52.320
Never enrolled	1.750	3.040	3.340	2.580	10.710
Grade Attainment					
Having right grade for age	12.220	14.430	10.330	1.900	38.880
Falling behind in school	7.290	18.150	22.780	12.910	61.120
Total	19.510	32.570	33.110	14.810	100.000

A kernel density plot of height-for-age shows that majority (i.e., 95.98 per cent) of children in this sample has lower height-for-age compared to the international reference population. The central tendency (i.e, means, mode and median) of the height-for-age distribution of children in the sample is about -2 (i.e., two standard deviations below the average of the reference population) (see Panel (a) of Figure 1).

Figure 1: Kernel density of height-for-age, and average z-score by child's age

a) Kernel density plot of height-for-age   b) Average z-score by child's age
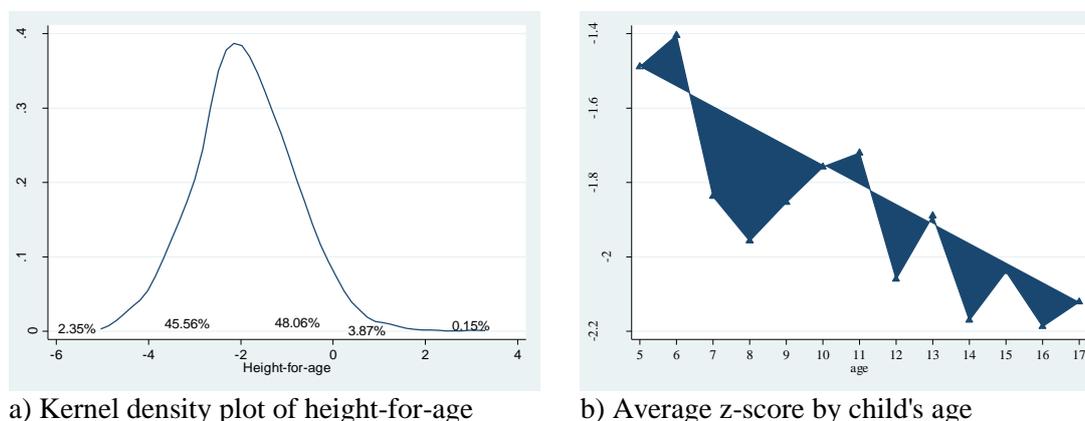
Panel (b) of Figure 1 shows average z-score for height-for-age by child's age. One interesting observation from this figure is that at the age of 6 or below, height-for-age z-score is close to international reference population (i.e., only 1.5 standard deviation below). However, at the age range from 7 to 17, the

height-for-age z-score declines sharply (with some variation). This suggests that the results of our study may differ from those examining only the young age cohorts (e.g., less than five years old).

The descriptive statistics of the variables used in this study, reported in Table 2, shows that children in our sample have mean height-for-age slightly less than two standard deviations below that of the reference population. Table 2 also shows that 79 per cent of the children in the sample are currently attending school and 62 per cent of them are in the right grade. It is shown that whilst 65 per cent of the community has a primary school, the availability of secondary school for girls and both sexes are only 5 and 12 per cent, respectively.

Table 2: Descriptive statistics

Variable Description	Median	Mean	Std.	Min	Max
Child health measured by height-for-age (z-score)	-1.940	-1.900	1.080	-4.820	3.080
School attendance (1=if the child is currently attending school)	1.000	0.790	0.410	0.000	1.000
Enrolment status (1=enrolled in time, 2= enrolled late and 3=never enrolled)	2.000	1.750	0.640	1.000	3.000
Grade attainment (1=if the child is not in right grade for his/her age)	1.000	0.620	0.490	0.000	1.000
Child's age (in years)	11.000	11.160	3.460	5.000	17.000
Gender of the child (female=1)	0.000	0.390	0.490	0.000	1.000
Total household member	6.000	6.510	2.770	2.000	19.000
Log of household expenditure	2.910	2.960	0.350	1.540	4.380
Father can read and write (1=yes)	0.000	0.440	0.500	0.000	1.000
Mother can read and write (1=yes)	0.000	0.230	0.420	0.000	1.000
Primary school (1= if there is a primary school in the community)	1.000	0.650	0.480	0.000	1.000
Secondary girls' school (1= if there is)	0.000	0.050	0.210	0.000	1.000
Secondary boys; and girls' school (1= if there is)	0.000	0.120	0.330	0.000	1.000
Father height (in centimeter)	162.300	162.100	5.400	144.200	179.100
Mother height (in centimeter)	149.900	149.800	5.230	133.400	167.100
Mymensingh district (1=yes)	0.000	0.320	0.470	0.000	1.000
Jessore district (1=yes)	0.000	0.350	0.480	0.000	1.000
Saturia district (1=yes)	0.000	0.330	0.470	0.000	1.000

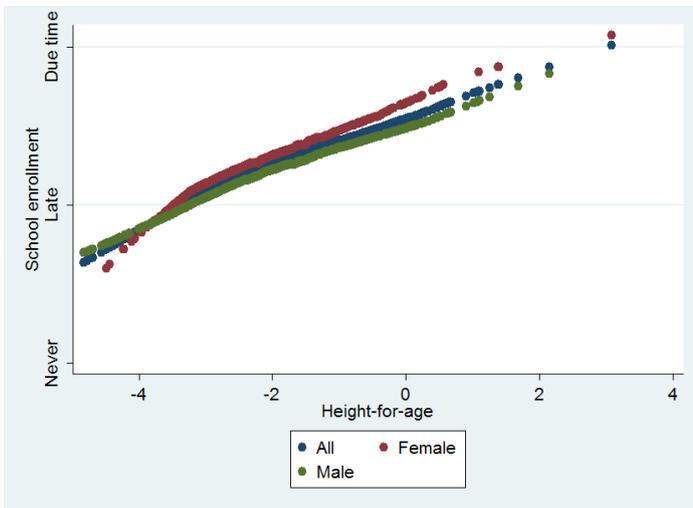**The Relationship between Child Health and Schooling**

Figure 2 shows the relationship between schooling status and child health (height-for-age) using locally weighted polynomial regressions (lowess). Particularly, the left panel of Figure 2 shows a monotonically increasing relationship between current school attendance and height-for-age. In addition, the relationship between health and school attendance appears to be stronger for girls. Particularly, it seems that above the threshold of z-score equal to -3, the rate of school attendance for girls is higher than that of boys whilst the story is reversed if the z-score is less than -3. The main message from this panel is that the school attendance rate of girls is more sensitive to changes in height-for-age than that of boys.

Figure 2: *Lowess* estimates of school attendance, enrolment and grade attainment
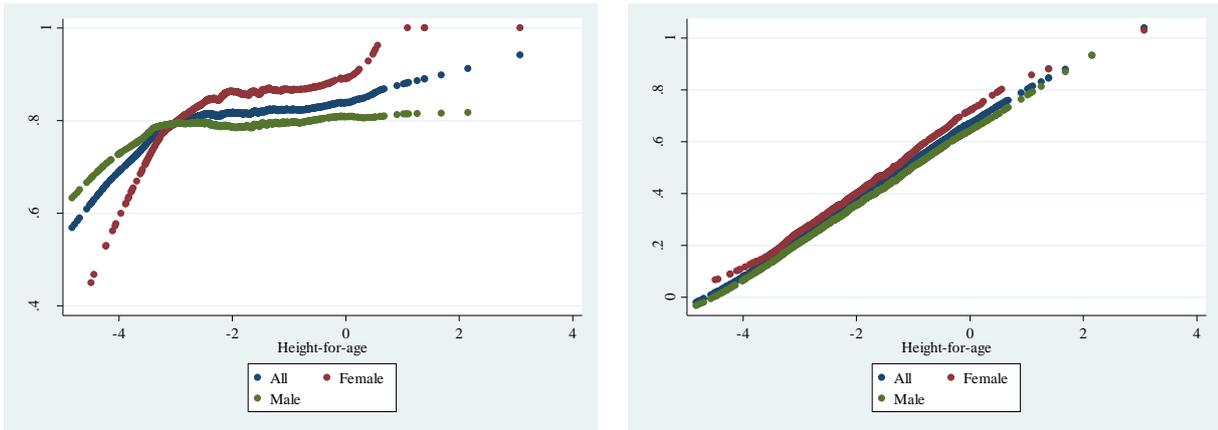
a) School Attendance   b) Grade Attainment

c) School Enrolment

The left panel of Figure 2 shows almost a perfect linear relationship between child health and grade attainment with very little difference between boys and girls. Particularly, for the same group of height-for-age, girls show slightly better school attainment than boys. All three lines in this graph almost represent 45^0 lines, showing near perfect linear relationship between the probability of right grade attainment and z-score of height-for-age. Regarding the enrolment status (i.e., due time, late and never enrol), there is also a clear trend that children are more likely to enrol in due time if they possess a good health (proxy by height-for-age). In addition, for the same height-for-age, girls are more likely to enrol than boys. However, for those whose z-score of height-for-age is -4 or below, girls are more likely to never enrol than boys. The possibilities of late enrolment, however, are quite similar for boys and girls.

4. Method[5]

Our basic model on the impact of child health on schooling is:

$$S_i = \alpha_0 + \alpha_1 H_i + \alpha_2 X_i + \varepsilon_i \tag{1}$$

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[5] This section is heavily dependent on Khanam et al. (2011).

where S_i is an indicator for child schooling; H_i is the health status of a child which is measured by height-for-age; and X_i is a set of exogenous variables that includes child age, gender, number of pre-school and school-aged children in the household, parental education, and the presence of primary and high school in the community.

We employ several measures of child's schooling. First we consider S_i as a dichotomous variable which is equal to 1 if a child was attending school during the survey. With this form of S_i, Equation (1) is estimated by a probit model. Although about 81 per cent of children in the sample were attending school during the survey (see Table 1) this does not consider all possibilities of enrolment. For example, 10.71 per cent of children were never enrolled, 52.32 per cent were enrolled late and about 37 per cent were enrolled by the due time Therefore, we also consider an ordered form of S_i; that is $S_i = 1, 2, 3$ if a child is enrolled by the age of 6 years, enrolled later than 6 years of age, and never enrolled respectively. In this circumstance, Equation (1) is estimated by an ordered probit model to see the effects of child's health on his/her school enrolment.

We hypothesize that child health not only affects his/her school enrolment or attendance, but also affects his/her grade attainment. Malnourished children might have lower progress in school because of missed school days, and lack of concentration in preparing home work. Therefore, we also measure child's grade attainment in school. A commonly used measure of grade attainment is schooling-for-age (SAGE), which measures schooling attainment relative to age (i.e. whether a child is in the right grade for his/her age). This measure also considers late enrolment. For example, children who are enrolled late will not be in the right grade for their age. This measure of school attainment is widely used in the literature (for example, Psacharopoulos and Patrinos, 1997; Ray and Lancaster, 2005; and Khanam and Ross, 2011) as a reliable measure of school outcome in the developing countries. Psacharopoulos and Patrinos (1997), and Ray and Lancaster (2005) defined SAGE as follows:

$$SAGE = \{Current\ grade / (Age - E)\} \times 100 \qquad (2)$$

where E represents the country-specific usual school entry age, which is 6 years in Bangladesh. The SAGE might take values of 100 or higher (i.e., the attainment of the highest possible grade attained to date) to 0 (i.e. never attended school).[6] A score of less than 100 indicates that the child is "falling behind" in their education. Based on Patrinos and Psacharopoulos (1997), and Ray and Lancaster (2005), we converted SAGE to a dichotomous variable, such as S_i that takes the value of 1 if a child has below normal progress (i.e., SAGE < 100), and 0 otherwise. The dummy form of SAGE is more useful than the original SAGE score as estimates found from the dummy SAGE can be intuitively interpreted as the probability of attaining the right grade or falling behind in schooling progress.

A household is likely to take decision regarding investment into child schooling and health simultaneously. Therefore, the child health variable in Equation (1) might be endogenous. The estimation of Equation (1) considering child health as an exogenous variable might provide inconsistent estimates and hence the results might be biased. One way to overcome this potential endogeneity problem is to select a set of covariates that affect child health without affecting child schooling as instrumental variables. We, therefore, estimate child health in the first stage using all exogenous variables as follows:

$$H_i = \beta_0 + \beta_1 Z_i + \varsigma_i \qquad (3)$$

where, Z_i is a set of exogenous variables that include X_i and a set of instruments for child health, which includes mother and father height. There are some other candidates for instrumental variables such as the availability and accessibility of doctors and other health facilities, and hygiene practices of the households. However, these factors might be correlated with the disturbance term of the schooling equation. Also, inclusion of these variables as instruments lead to the over-identification issue, and hence only parents' height are used to identify child health.

We estimate Equations (3) and (1) using the conditional recursive mixed process estimator using the *cmp* procedure in STATA developed by Roodman (2007), which is suitable for a large family of multi-

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[6] A score of more than 100 indicates that the child has attended more years of school possible for his age. It is possible because although official enrolment age in Bangladesh is 6 years, some parents enrol their children earlier.

equation systems where dependent variable of each equation may have different format (i.e., binary, categorical, and bounded or unbounded continuous). Since our model is a recursive process, consisting of two-stage structural equations, the analysis is essentially a full information maximum likelihood (FIML) estimator.

5. Results

We report our results in this section by estimating the model using a two-stage structural equation. As mentioned previously, it is possible that the child health is endogenous in the relationship with education, because a household might take a decision to invest in child health and schooling simultaneously. We mitigate this issue by using an instrumental variable approach, where the child's height-for-age is instrumented by mother and father height. The first-stage estimates (reported in the Appendix) show that mother and father heights significantly affect child health, measured by height-for-age. Most importantly, the instruments are jointly significant ($F = 31.41$), indicating that we do not have a weak instrument problem. The Amemiya-Lee-Newey test also did not reject the null hypothesis of no over-identification in all regressions.

5.1 Current School Attendance

Our results from school attendance equation show that child health (measured by height-for-age z score) does not significantly affect their school attendance (see Table 3) although it still has the expected positive sign. However, if the endogeneity issue is ignored, the coefficient of child health is significant at 10 per cent and the corresponding marginal effects show that a one unit increase in height-for-age increases the probability of attending school by 2.5 percentage points. This finding suggests that the impact of child health on schooling may be overestimated if the endogeneity issue is not taken into account. This insignificant coefficient on child health in school attendance equation is not surprising, because child health measured by height-for-age reflect long-term nutritional status of a child, whereas school attendance measures whether or not a child is currently attending school.

Table 3: The effects of child health on school attendance (binary probit)

Variables	Coeff.	Std. Err	Marginal Effect
Child health (height-for-age z score)	0.122	0.093	0.043
Child's age	**-0.026	0.013	-0.009
Gender of the child	*0.151	0.090	0.051
Total household member	0.010	0.016	0.004
Log of household expenditure	**0.291	0.130	0.100
Father can read and write	***0.333	0.090	0.110
Mother can read and write	*0.251	0.130	0.080
Primary school	0.080	0.090	0.030
Secondary girls' school	**0.868	0.440	0.220
Secondary boys' and girls' school	0.220	0.150	0.070
Mymensingh district	***0.514	0.130	0.150
Jessore district	-0.020	0.100	-0.010
Constant	0.050	0.470	

Notes: ***, **, & * indicates 1%, 5% and 10% level of significance respectively; N=1317; Overall significance: $\chi^2(25) = 270$; p-val=0.00; over-identification test $\chi^2 (1) = 4{:}664$, p-val=0.127.

Although our main focus is on the effect of child health on school attendance, there are some noteworthy results. Another important determinant of school attendance is the education of parents. The attendance rate is significantly higher for children having a father and/or mother who can read and write. This finding is consistent with our theoretical prediction. This result is also in line with Khanam (2008)'s study on Bangladesh. Our results also show that children from wealthier families (proxied by log of household expenditure) have a significantly (at 5 per cent) higher rate of school attendance. These results are similar with Siddqui and Iram (2007)'s findings from Pakistan. The availability of girls' secondary school in the community also increases the probability of enrolment by 22 percentage points compared to the

communities that do not have secondary school. The probability of school attendance in Mymensignh is higher by 15 percentage points (significant at one per cent) compared to the children from Saturia district.

5.2 School Enrolment

Another form of Equation 1 is estimated for the probability of enrolment, which is a categorical variable taking the value of: 1) if a child is enrolled in due time (by the age of 6), 2) if a child is enrolled late (not enrolled by the age of 6), and 3) if the child is never enrolled. Our results show that child health has a significant effect on the probability of enrolment. The marginal effects reveal that a one unit increase in child's height-for-age reduces the probability of never enrolment by 7.0 percentage points, whilst increases the probability of enrolment in due time by 6 percentage points (see Table 4). These results align with some previous studies such as Glewwe and Jacoby (1995), Behrman and Lavy (1998) Grira (2004) and Khanam et al. (2011) that account for endogeneity of child health.

Table 4: The effects of child health on school enrolment (ordered probit)

Variables	Coeff.	Std. Err	Marginal effects		
			Due enrolled	Late enrolled	Never enrolled
Child health (height-for-age z score)	***-0.235	0.080	0.060	0.010	-0.070
Child's age	*0.020	0.010	-0.010	0.000	0.010
Gender of the child	-0.080	0.070	0.020	0.000	-0.020
Total household member	-0.020	0.010	0.000	0.000	-0.010
Log of household expenditure	***-0.445	0.110	0.110	0.030	-0.130
Father can read and write	***-0.286	0.070	0.080	0.000	-0.080
Mother can read and write	***-0.407	0.090	0.120	-0.020	-0.100
Primary school	0.040	0.180	-0.010	0.000	0.010
Secondary girls' school	***-0.575	0.110	0.170	-0.040	-0.130
Secondary boys' and girls' school	***-0.358	0.090	0.100	-0.010	-0.090
Mymensingh district	***-0.388	0.090	0.110	-0.010	-0.100
Jessore district	***-0.447	0.070	0.130	-0.020	-0.110
μ_1	***-1.714	0.180			
μ_2	0.080	0.110			

Notes: ***, **, & * indicates 1%, 5% and 10% level of significance respectively; N=1317; Overall significance: $\chi^2(25) = 359$; p-val=0.00; Over-identification test $\chi^2(1) = 4:07$; p-val=0.157.

If we estimate the school enrolment equation by considering child health as an exogenous variable, the magnitude of this variable is higher than an endogenous case.[7] Again, children in wealthier families or having a mother and/or father who can read and write have a higher probability of being enrolled in due time. Compared with communities without secondary school, children in those with the availability of either girls' secondary school or mixed-sex secondary school have higher probability of enrolling in due time. In addition, children in both Mymensingh and Jessore have a higher probability of enrolling in due time than those in Saturia.

5.3 Grade Attainment

Our results shows that height-for-age (z score) has an expected and significant (at 10 per cent) effect on grade attainment (Table 5). The marginal effects show that a one unit increase in height-for-age will reduce

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[7] The coefficient of the height-for-age variable is -0.273 and significant at one per cent. The marginal effect show that a one unit increase in height-for-age increase the probability of due and late enrolment respectively by 6.5 and 1.5 percentage points whilst decreases the probability of never enrolment by 8.0 per cent.

the probability of falling behind in school by 4 percentage points. If the endogeneity of child health is ignored, then the impact of child health (the magnitude of coefficient is -0.354 and statistically significant at one per cent) on grade attainment is higher.

Table 5: The effects of child health on grade attainment (binary probit)

Variables	Coeff.	Std. Err	Marginal Effects
Child health (height-for-age z score)	*-0.164	0.090	-0.040
Child's age	***0.148	0.010	0.030
Gender of the child	-0.020	0.080	0.000
Total household member	-0.020	0.010	0.000
Log of household expenditure	***-0.694	0.130	-0.150
Father can read and write	***-0.233	0.087	-0.057
Mother can read and write	***-0.578	0.106	-0.164
Primary school	0.108	0.090	0.025
Secondary girls' school	***-0.549	0.197	-0.154
Secondary boys and girls' school	***-0.389	0.124	-0.102
Mymensingh district	***-0.418	0.110	-0.110
Jessore district	***-0.670	0.100	-0.200
Constant	***1.176	0.440	

Notes: ***, **, & * indicates 1%, 5% and 10% level of significance respectively; N=1317; Overall significance: $\chi^2(25) = 457$; p-val=0.00; Over identification test $\chi^2(1) = 0:066$; p-val = 0:797

The coefficient of age is found to be positive and significant indicating that an older child is more likely to fall behind in grade attainment. This finding is not surprising because opportunity costs of schooling increases as a child grows. One potential reason is that an older child can earn money from outside work or can help their parents in household/ farm works. Other significant determinants that have similar behaviour as in other schooling measures: children from educated parents (i.e., proxied by being able to read and write) or wealthier households have lower probability of falling behind in grade attainment. The availability of girls' secondary school has a stronger effect on grade attainment than mixed-sex secondary school, which also has a significantly lower rate of falling behind compared with that of communities without secondary school. Likewise, children from the Mymensingh and Jessore samples have a lower probability of falling behind compared to those from the Saturia district.

6. Conclusions and policy implications

In this paper we examine the impact of childhood malnutrition on educational achievement of Bangladeshi children. We control for the potential endogeneity of child health by an instrumental variables approach. Our chosen instrumental variables (i.e., heights of father and mother) are strong predictors of child health, and satisfy the validity test. Our results indicate that the impact of child health on school achievement will be overestimated if the endogeneity of child health is ignored. However, in contrast to other studies on Bangladesh (e.g. Grira 2004), our study shows a significant effect of child health on schooling attainment, in particular on school enrolment and grade attainment, of Bangladeshi children even after controlling the issue of endogeneity of child health. The impact of child health is stronger for school enrolment compared to grade attainment. The marginal effects reveal that a one unit increase in child health (height-for-age) reduces the probability of never enrolment by 7.0 percentage points, whilst increases the probability of enrolment in due time by 6 percentage points (see Table 4).). This result is consistent with most of the previous studies and theoretical prediction that malnourished children are more likely to start school late, or do not enrolled at all. This study also reveals the important role of parental income, education and availability of secondary school, in particular girls' secondary school in the community to increase schooling of Bangladeshi children.

Bangladesh has a long way to go to improve its education particularly in rural population. It is important for policy makers to understand the most effective way to improve schooling for children. This study reveals the importance of childhood nutrition, which has never got policy priority as an intervening factor in education. In fact, the role of childhood nutrition in economic development (through better schooling) has not properly recognized, as feeding children does not provide immediate, demonstrable, and measurable economic growth. Childhood malnutrition is a life cycle process, rather than short term crisis, which affects schooling, future health, productivity and earning over a life time. Our results suggest that efforts that improve children's malnutrition could pay off a nation in terms of economic development far beyond individual child and public health. As we have found a significant impact of height-for-age on schooling, which essentially suggests that a nutrition program that targets infants and very young child would be more appropriate. For example, Bangladesh government and development agencies can adopt programs such as the Thriposha program of Sri- Lanka that provides foodstuff to pregnant and lactating women, infants and older children who have growth deficits (identified by health professionals).   Another program (similar as the Samurdhi poverty reduction program of Sri-Lanka) could be income transfer to poor families, especially families with malnourished children. School health programs that check the health of school children and provide free mid-day meal could also be efficient way to increase educational outcome.

The findings of this study suggest some other policy initiatives to increase schooling of Bangladeshi children. First, increase in wider range of income generating activities in the community has the potential to increase parental income that will have a positive effect on child health and schooling. Second, as parental education is found to be an important determinant of schooling, adult education program and social campaigning program that will offset parental illiteracy and increase social awareness about the value of education could play a significant role to increase schooling. Third, availability of secondary school, particularly girls' secondary school, in the community increases school attendance and grade attainment. This finding suggests that presence of secondary school in the community will improve school attainment. Particularly, availability of girls secondary school would be more effective way to increase female education This is because, strong Muslim religious value discourage some parents to send their daughters to co-education school or school that is far from their residence.

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Appendix

Table A1. Strength of instrumental variables

Variables	Coeff.	Std. Err
Father's height	***0.027	0.010
Mother's height	***0.035	0.010
Constant	***-11.568	1.230

Notes: This is the regression of the endogenous variable (height-for-age) and the instrumental variables (parents' height); ***, **, & * indicates 1%, 5% and 10% level of significance respectively; N=1131; $F_{(2,1128)}=31.41$, p-value=0.00

Table A2. First stage regression estimates

Variables	Coeff.	Std. Err
Child's age	***-0.057	0.010
Gender of the child	-0.050	0.060
Total household member	-0.010	0.010
Log of household expenditure	***0.435	0.090
Father can read and write	-0.018	0.067
Mother can read and write	0.002	0.086
Secondary girls' school	*0.265	0.151
Secondary boys' and girls' school	**0.191	0.090
Mymensingh district	0.030	0.090
Jessore district	***0.389	0.070
Primary school	0.000	0.070
Father's height	***0.029	0.010
Mother's height	***0.028	0.010
Constant	***-11.514	1.220

Notes: ***, **, & * indicates 1%, 5% and 10% level of significance respectively; N=1317