The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0306-8293.htm

Child health and schooling achievement in Bangladesh

Rasheda Khanam
School of Accounting, Economics and Finance,
University of Southern Queensland,
Toowoomba, Australia

Received 26 July 2012
Revised 2 November 2012
Accepted 21 November 2012

Abstract

Purpose – This paper aims to examine 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). The author controls for the potential endogeneity of child health by an instrumental variables approach. The results indicate that the impact of child health on school achievement will be overestimated if endogeneity of child health is ignored.

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

Originality/value – This study improves the understanding on the relationship between child health and schooling in several ways. First, the author controls for the potential endogeneity of child health by an instrumental variables approach. The 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, Bangladesh, School attainment

Paper type 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 per cent) and education (Bangladesh 14, India 3, Pakistan 2 and Sri Lanka 10 per cent), 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 per cent) and infant mortality and childhood malnutrition compared to other south Asian countries. Bangladesh's infant mortality rate (per 1,000 live births) and under-5 mortality rate (per 1,000 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 five 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 1 per cent is severely wasted. 48 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

International Journal of Social Economics
Vol. 41 No. 1, 2014
pp. 60-74

0306-8293
DOI 10.1108/IJSE-11-2012-0132

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 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 (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 (Glewwe and Jacoby, 1995; Behrman and Lavy, 1998; 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 *et al.* (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 *et al.* (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 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) and 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 (Alderman *et al.*, 2001; 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 *et al.* (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 five to 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 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, 33 and 32 per cent, respectively, whilst only 19 per cent children are classified as normal compared to the reference population (Table I). Table I shows the schooling results (school attendance, enrolment and grade attainment) of children by

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

Table I.
Percentage of children by schooling and health status

their malnutrition status. Table I reveals that school attendance, enrolment in due time and being in right grade for age are very low among severely malnourished children.

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) (Panel (a) of Figure 1).

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 II, shows that children in our sample have mean height-for-age slightly less than two standard deviations below that of the reference population. Table II 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.

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.

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.

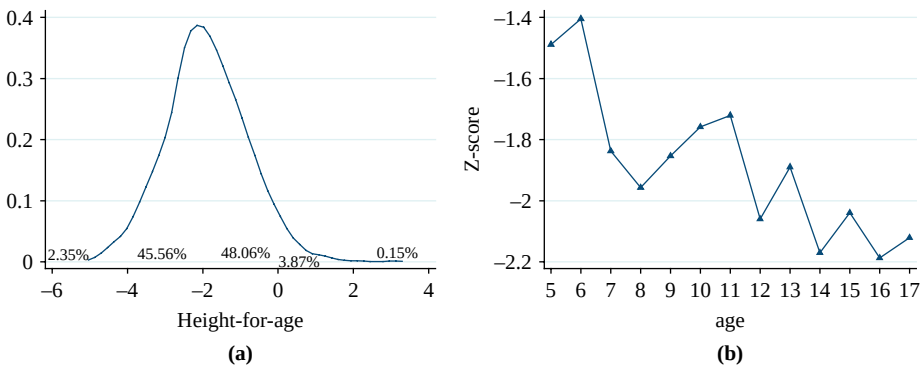
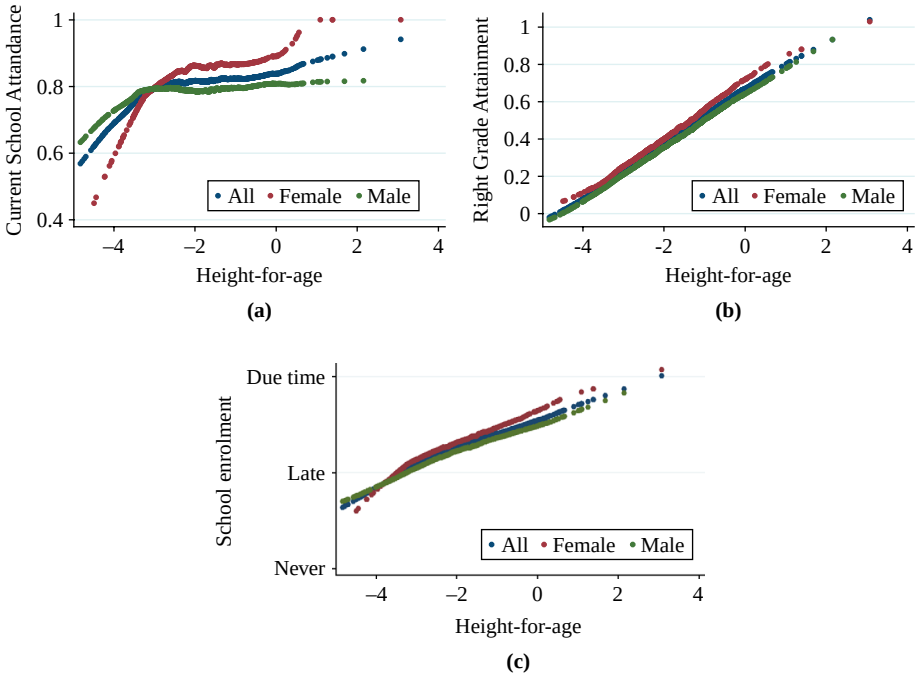


Figure 1.
Kernel density of height-for-age, and average z-score by child's age

Notes: (a) Kernel density plot of height-for-age; (b) average z-score by child's age

Variable description	Median	Mean	SD	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

Table II.
Descriptive statistics



Notes: (a) School attendance; (b) grade attainment; (c) school enrolment

Figure 2.
Lowess estimates of school attendance, enrolment and grade attainment

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° 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:

$$S_i = \alpha_0 + \alpha_1 H_i + \alpha_2 X_i + \varepsilon_i \quad (1)$$

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 (Table I) 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 six years, enrolled later than six 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 (Psacharopoulos and Patrinos, 1997; Ray and Lancaster, 2005; 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:

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

where E represents the country-specific usual school entry age, which is six 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 Psacharopoulos and Patrinos (1997) and Ray and Lancaster (2005), we converted

SAGE to a dichotomous variable, such as *Si* 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:

$$H_i = \beta_0 + \beta_1 Z_i + \varsigma_i \tag{3}$$

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-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 (Table III) 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

Variables	Coeff.	SE	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	

Table III.
The effects of child health on school attendance (binary probit)

Notes: Significant at: *10, **5 and ***1 per cent levels; $n = 1{,}317$; overall significance: $\chi^2(25) = 270$; p-value = 0.00; over-identification test $\chi^2(1) = 4{:}664$, p-value = 0.127

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.

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's (2008) 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's (2007) 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 1 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:

- if a child is enrolled in due time (by the age of 6);
- if a child is enrolled late (not enrolled by the age of 6); and
- 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 (Table IV). 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.

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 V). The marginal effects show that a one unit increase in height-for-age will reduce 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 1 per cent) on grade attainment is higher.

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

Variables	Coeff.	SE	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: Significant at: *10, **5 and *1 per cent levels; $n = 1{,}317$; overall significance: $\chi^2(25) = 359$; p-value = 0.00; over-identification test $\chi^2(1) = 4{:}07$; p-value = 0.157

Table IV.
The effects of child health on school enrolment (ordered probit)

Variables	Coeff.	SE	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	

Table V.
The effects of child health on grade attainment (binary probit)

Notes: Significant at: *10, **5 and ***1 per cent levels; $n = 1{,}317$; overall significance: $\chi^2(25) = 457$; p-value = 0.00; over-identification test $\chi^2(1) = 0{:}066$; p-value = 0.797

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 (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 (Table IV). 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.

Notes

1. Source: UNICEF, www.unicef.org/infobycountry (accessed 12 March 2012).
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.
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.
5. This section is heavily dependent on Khanam *et al.* (2011).
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 six years, some parents enrol their children earlier.
7. The coefficient of the height-for-age variable is -0.273 and significant at 1 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.

References

Alderman, H., Hoogeveen, H. and Rossi, M. (2009), "Preschool nutrition and subsequent schooling attainment: longitudinal evidence from Tanzania", *Economic Development and Cultural Change*, Vol. 57 No. 2, pp. 239-260.

Alderman, H., Behrman, J.R., Lavy, V. and Menon, R. (2001), "Child health and school enrollment: a longitudinal analysis", *The Journal of Human Resources*, Vol. 36, pp. 185-205.

Aturupane, H., Glewwe, P. and Wisniewski, S. (2011), "The impact of school quality, socioeconomic factors, and child health on students' academic performance: evidence from Sri Lankan primary schools", *Education Economics*, Vol. 21 No. 1, pp. 2-37.

Behrman, J.R. (1996), "The impact of health and nutrition on education", *The World Bank Research Observer*, Vol. 11, pp. 23-37.

Behrman, J.R. and Lavy, V. (1998), "Child health and schooling achievement: association, causality and household allocations", Technical Report 97-023, Penn Institute for Economic Research, Philadelphia, PA.

Chutikul, S. (1986), "Malnourished children: an economic approach to the causes and consequences in rural Thailand", Technical Report 102, East-West Center, Honolulu, HI.

ESCAP (2005), "Bangladesh demographic health survey (BDHS)", Technical Report, United Nations Economic and Social Commission for Asia and the Pacific, Bangkok.

Florencio, C. (1988), "Nutrition, health and other determinants of academic achievement and school-related behaviour in grades one to six pupils", Technical Report, University of the Philippines, Baguio City.

Glewwe, P. and Jacoby, H.G. (1995), "An economic analysis of delayed primary school enrollment in a low income country: the role of early childhood nutrition", *The Review of Economics and Statistics*, Vol. 77 No. 1, pp. 156-169.

Glewwe, P., Jacoby, H.G. and King, E.M. (2001), "Early childhood nutrition and academic achievement: a longitudinal analysis", *Journal of Public Economics*, Vol. 81 No. 3, pp. 345-368.

Gomes-Neto, J.B., Hanushek, E.A., Leite, R.H. and Frota-Bezzera, R.C. (1997), "Health and schooling: evidence and policy implications for developing countries", *Economics of Education Review*, Vol. 16 No. 3, pp. 271-282.

Grira, H. (2004), "The determinants of grade attainment in low-income countries: evidence from rural Bangladesh", *The Developing Economies*, Vol. 42 No. 4, pp. 494-509.

Handa, S. and Peterman, A. (2007), "Child health and school enrollment", *Journal of Human Resources*, Vol. 42 No. 4, pp. 863-880.

Jamison, D.T. (1986), "Child malnutrition and school performance in China", *Journal of Development Economics*, Vol. 20 No. 2, pp. 299-309.

Kassouf, A.L. and Senauer, B. (1996), "Direct and indirect effects of parental education on malnutrition among children in Brazil: a full income approach", *Economic Development and Cultural Change*, Vol. 44, pp. 817-838.

Khanam, R. (2008), "Child labour and school attendance: evidence from Bangladesh", *International Journal of Social Economics*, Vol. 35 No. 1.

Khanam, R. and Ross, R. (2011), "Is child work a deterrent to school attendance and school attainment? Evidence from Bangladesh", *International Journal of Social Economics*, Vol. 38 No. 8.

Khanam, R., Nghiem, H.S. and Rahman, M.R. (2011), "The impact of childhood malnutrition on schooling: evidence from Bangladesh", *Journal of Biosocial Science*, Vol. 43, pp. 437-451.

Moock, P.R. and Leslie, J. (1986), "Childhood malnutrition and schooling in the Terai region of Nepal", *Journal of Development Economics*, Vol. 20 No. 1, pp. 33-52.

Pollitt, E., Gorman, K.S., Engle, P.L., Martorell, R., Rivera, J., Wachs, T.D. and Scrimshaw, N.S. (1993), "Early supplementary feeding and cognition: effects over two decades", *Monographs of the Society for Research in Child Development*, Vol. 58 No. 7, pp. 1-118.

Psacharopoulos, G. and Patrinos, H.A. (1997), "Family size, schooling and child labor in Peru – an empirical analysis", *Journal of Population Economics*, Vol. 10, pp. 387-405.

Ray, R. and Lancaster, G. (2005), "The impact of children's work on school: multi-country evidence", *International Labour Review*, Vol. 14, pp. 189-210.

Roodman, D. (2007), "CMP: Stata module to implement conditional (recursive) mixed process estimator", Technical Report, Statistical Software Components S456882, Boston College Department of Economics.

Saigal, S., Stoskopf, B.L., Dagger, D.L.S. and Burrows, E. (2001), "Physical growth and current health status of infants who were of extremely low birth weight and controls at adolescence", *Pediatrics*, Vol. 108, pp. 407-415.

Siddiqui, A. and Iram, U. (2007), "Socioeconomic determinants of school progression in Pakistan", *Applied Econometrics and International Development*, Vol. 7 No. 2.

Staiger, D. and Stock, J.H. (1997), "Instrumental variables regression with weak instruments", *Econometrica*, Vol. 65 No. 3, pp. 557-586.

Stock, J.H., Wright, J.H. and Yogo, M. (2002), "A survey of weak instruments and weak identification in generalized method of moments", *Journal of Business & Economic Statistics*, Vol. 20 No. 4, pp. 518-529.

United Nations Development Program (2008), "Human development report 2007/2008", Technical Report, United Nations Development Programs, New York, NY.

Waterlow, J. (1972), "Classification and definition of protein-calorie malnutrition", *British Medical Journal*, Vol. 3, pp. 566-569.

Wisniewski, L.W.S. (2010), "Child nutrition, health problems, and school achievement in Sri Lanka", *World Development*, Vol. 38 No. 3, pp. 315-332.

Appendix

Variables	Coeff.	SE
Father's height	0.027***	0.010
Mother's height	0.035***	0.010
Constant	−11.568***	1.230

Notes: Significant at: *10, **5 and ***1 levels; this is the regression of the endogenous variable (height-for-age) and the instrumental variables (parents' height); $n = 1{,}131$; $F(2{,}1128) = 31.41$; p-value = 0.00

Table AI.
Strength of instrumental variables

Variables	Coeff.	SE
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: Significant at: *10, **5 and *1 per cent levels; $n = 1{,}317$

Table AII.
First-stage regression estimates

About the author
Dr Rasheda Khanam comes to the University of Southern Queensland (USQ) from the University of Queensland (UQ) where she was a Postdoctoral Research Fellow in Health Economics at the Australian Centre for Economic Research on Health (ACERH). She gained a PhD in economics from the University of Sydney. Prior to coming to Australia for her PhD research, she was an Assistant Professor of economics at the University of Chittagong, Bangladesh. In addition to her teaching commitments at the USQ, the UQ, the University of Sydney and the University of Chittagong over a period of 14 years, Dr Khanam has been actively involved with research in the areas of health economics, development economics and labour economics. She has published in prestigious economics journals including the *Journal of Health Economics*, *Journal of Biosocial Science* and the *Journal of Economic Issues*. Her research in the field of child health is well recognised nationally by having invitations for media comments and seminar presentations at different universities. Dr Khanam is also an Adjunct Research Fellow at ACERH, the University of Queensland and an Editorial Board member of *Asian Journal of Empirical Research*. Recently, she (with others from USQ) has been successful in two bids to secure more than $1 million funds for two Post Doctoral Research Fellows and three PhD students from Digital Futures – Collaborative Research Network (CRN). In one of these bids, she is one of the lead investigators. She is currently supervising two PhD, one DBA and one Masters students in economics field. Rasheda Khanam can be contacted at: rasheda.khanam@usq.edu.au