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CHILDHOOD MALNUTRITION AND SCHOOLING IN THE TERAI REGION OF NEPAL

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Data on 350 primary school age children from subsistence farm households in the Terai (southern plains) region of Nepal are analyzed to assess the relationship between nutritional status and school participation. Only fifteen percent reported attending school; nutritional status, particularly as measured by percent of median height-for-age, was found to be a significant determinant of both enrollment in school and age-adjusted grade attainment. It is concluded that local interventions or national policies designed to improve child nutritional status could have important educational as well as health benefits.

1. Introduction

The negative effects of poverty on child education, child health, and child nutritional status, while generally acknowledged, are not yet fully understood. The direct impact of low income on each of these elements of child development is quite well documented, but only recently have researchers in the social and biological sciences begun to explore the indirect effects of poverty on child development by compiling evidence on how these various elements interact with one another.[1]

The importance of nutritional status to the overall well-being of a growing child is well recognized. In cases of extreme deprivation, childhood malnutrition is a direct or contributory cause of many child deaths in the developing world. Even among children who survive, malnutrition causes growth faltering and delayed sexual maturation. In addition, there is a cyclic interaction between malnutrition and infectious diseases; malnourished children are more susceptible to disease, and children who are ill eat less and are less able to absorb what they do eat. It has also been suggested that malnutrition reduces the activity levels of poor children in developing countries [Beaton (1983)].

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[1]See World Bank (1980, pp. 68–70) for a discussion of the 'seamless web' of interrelations between income, nutrition, fertility, education, and health in the development process.

Malnutrition has been shown to impair mental development, at least in the short term. In the most severe cases, it affects directly brain cellularity and, in other cases, lowers the child's motivation and energy levels and thereby reduces the quantity of effective learning time [Lloyd-Still (1976), Read (1982)]. Evidence of a positive relationship between nutritional status and school participation or between nutritional status and achievement in school supports the hypothesis of a longer term relationship between nutrition and the development of mental capacity. Such evidence has recently been cited in studies from Guatemala [Balderston et al. (1981)], China [Jamison (1986)], and the Philippines [Popkin and Lim-Ybanez (1982)].

This paper examines the relationship between nutritional status and schooling using a sample of 350 school-age children from subsistence farm families living in the Terai or Southern plains region of Nepal. The data for the analysis were obtained in December 1980 and January 1981 as a follow up to a study initiated three years earlier to investigate the relationship between schooling and various dimensions of rural development.

1.1. Background on malnutrition and schooling in Nepal

Nepal is a land-locked country located between China to the North and India to the South; it had a 1981 population of 15 million, of whom 94 percent were classified as rural. By most accepted measures, Nepal is one of the poorest and least developed countries in the world. In 1981, GNP per capita was just $150. According to the most recent available data, Nepal's adult literacy rate is 19 percent, only 9 percent of the rural population have access to safe water, and the average daily per capita energy availability is 1,977 kilocalories or just 86 percent of the average requirement [World Bank (1983)].

School enrollment has increased rapidly in Nepal since the country was opened to foreigners in 1951, but it still lags behind neighboring countries, particularly in terms of secondary school enrollment and female enrollment in primary school. Nepal's reported school enrollment ratios in 1980 were 0.91 at the primary level (1.26 for boys and 0.53 for girls) and 0.21 at the secondary level [World Bank (1983)]. School participation in Nepal declines rapidly by grade; the enrollment ratio for grade 1 was reported to be 1.15 in 1976, while the ratio for grade 7 was 0.09 [World Bank (1979)]. It is important to note that, since a reasonable fraction of enrolled students are likely to be over-age, these ratios may overstate the proportion of children in school, as is clearly the case in grade 1.

Nepal can point to some improvement in the health and nutritional status of its population in the past thirty years. However, mortality, morbidity, and malnutrition rates in Nepal remain among the highest in the world. In 1981, the child death rate was 22 per 1,000, and life expectancy at birth just 45 years [World Bank (1983)]. Child mortality is often used as an indicator of the severity of malnutrition in a developing country [Beaton and Bengoa (1976)]. The rate in Nepal (0.022) is considerably higher than those reported for neighboring countries such as Bangladesh (0.020), India (0.017), Pakistan (0.017) and Burma (0.012).

Direct evidence of the extent of malnutrition among preschool-age children in Nepal comes from the [Centres for Disease Control (1976)]. This survey obtained anthropometric data and hemoglobin measures for a random sample of 6,501 Nepalese children who were six to 72 months of age. Table 1 shows that 50 percent of the children were moderately to severely malnourished (below 75% of reference median weight-for-age), 52 percent were stunted (below 90% of reference median height-for-age), and 7 percent were wasted (below 80% of reference median weight-for-height). These rates of malnutrition are among the highest that have been reported anywhere.

Table 1

Rates of malnutrition among preschool age Nepalese children by age group, 1975.[a]

Age in months	Below 75% NCHS median weight-for-age	Below 90% NCHS median height-for-age	Below 80% NCHS median weight-for-height
6–11	49%	23%	8%
12–23	61%	48%	15%
24–35	48%	52%	9%
36–47	42%	59%	3%
48–59	49%	63%	2%
60–71	49%	55%	2%
Total	50%	52%	7%

[a]*Source*: Centers for Disease Control (1976).

1.2. World Bank research in the Terai

In 1977 a research project was undertaken by the Population and Human Resources Division of the World Bank, in collaboration with a Nepalese research and consulting organization, to study the determinants and consequences of formal education and cognitive ability among 795 subsistence farm households in the Terai region of Nepal. Nepal is a country divided into three ecological zones running in parallel strips from east to west. The northernmost zone, which straddles the border between Nepal and China (Tibet), consists of the Himalayan Range. The middle zone, which includes Kathmandu and the Kathmandu Valley, is known as the Hill Region. It ranges in altitude from 1,000 to 4,000 metres. The Terai to the south is a flat, fertile area straddling the border between the Hill Region of Nepal and the Indian states of Bihar and Uttar Pradesh. The inhabitants of the Terai on the two sides of the Indian–Nepalese border share many cultural and economic characteristics and are primarily agrarian. Although the Nepal Terai comprises less than a third of the country's land area and accounts for only about 40 percent of the population, it produces well over half the country's agricultural output, exporting surplus rice and other cash crops both internally within Nepal and internationally, primarily to India.

The initial data gathering phase of the World Bank's research project took place in three surveys carried out between November 1977 and May 1978. During this period, two sets of anthropometric measures of nutritional status were obtained for children six months to six years of age. School attendance but no anthropometric data were obtained for children six years to 16 years of age. Thus it was impossible to investigate the relationship between nutritional status and schooling, but a study of other determinants of school participation found male sex, high caste status, parental schooling, and 'modern' attitudes to be significant positive determinants of school participation among the six-to-16-year-old cohort [Jamison and Lockheed (1986)].

A final survey of the same sample of subsistence farm households was undertaken in late 1980 and early 1981. The purpose of the follow-up survey was to collect additional information on the approximately 600 children who had been the subjects of the earlier nutritional status research[2] and who were now three to nine years old. The present study, which investigates the impact of nutritional status on school participation, makes use of the data collected in the 1980–81 survey.

2. Methods

This section describes in greater detail the data collection methods and discusses the data analysis procedures used in this study of nutritional status and school participation.

2.1. Data collection

The data analyzed in this study were obtained from a longitudinal survey of rural households in two of Nepal's 75 administrative districts.[3] The districts, Bara and Rautahat, are located in the Central Region of the Nepal Terai. The household sample was a stratified random sample of all households in six panchayats of Bara (out of 109 panchayats in the district) and six panchayats of Rautahat (out of 132). In compiling this sample in 1977, a list of owners and tenants of all dwellings in each panchayat was obtained from the local rural health workers. Then, using a three-digit random

[2]See Leslie, Baidya and Nandwani (1981) for an analysis of the 1977 and 1978 nutrition data.

[3]The survey was conducted by New Era, a Nepalese research and consulting organization, and was designed jointly by staff of New Era and the Population and Human Resources Division of the World Bank's Development Economics Department. See Shrestha, Baidya and Shrestha (1981) for a full account of the sample areas and data collection instruments.

number table obtained from the Nepal Central Bureau of Statistics, households to be included in the sample were selected randomly within panchayats until 15 percent of households had been chosen in each panchayat. (Ten additional households per panchayat were selected for replacement of households lost through sample attrition.)

As stated above, the sampled households were surveyed in 1977–78 (three visits to each household between October and May) and resurveyed three years later (between December 1980 and early January 1981). The focus of the 1980–81 round of data collection was the cohort of younger children, those reported to have been six months to six years old in 1977. However, the task of matching individual children in surveys conducted three years apart proved difficult. Hence, we make no attempt in this study to use the individual-level longitudinal data nominally available in this data set. All of the data analyzed in this paper were obtained in the final round of data collection.

Moreover, in interviewing respondents, the field staff experienced considerable difficulty in obtaining precise age estimates, despite elaborate preparations beforehand in anticipation of this problem. As an indication of the extent of the problem, when we look at the data for age measured in months, we find that four out of every five children have ages that are multiples of 12 months. We believe that parents, in reporting the ages of their children, tended to round *upwards*. Hence, since the reference norms for height and weight are all age-specific, the malnutrition that we report for the children in this data set may be somewhat overstated [see Martorell, Leslie and Moock (1984)]. Even so, other studies corroborate our finding for this part of the Terai, that Nepalese children are among the most malnourished in the world [Centers for Disease Control (1976), Brink et al. (1976), Farquharson (1976)].

Height and weight were measured following standard techniques. Height was measured to the nearest millimeter with a locally constructed wooden measuring board, and weight was measured to within 0.1 kilogram using a portable beam balance scale. Nutritional status indicators were derived from these anthropometric measure using the National Center for Health Statistics' reference population [Hamill et al. (1979)]. In this analysis, the three indicators of nutritional status used are height-for-age, weight-for-age, and weight-for-height. A child's height-for-age is his or her height as a percentage of the median height of the reference population of the same age and sex. Weight-for-age and weight-for-height are defined similarly.[4]

[4]It has been suggested that the use of Z scores to measure nutritional status is preferable to the use of percents of median values because of differences in the size of the standard deviation between nutritional indicators and across ages groups. Both Z scores and percents of median were used in the early stages of the data analysis for this paper. Since similar results were obtained using both measures, and since percents of medians have been used most often in previous studies, it was decided to report only the results based on the latter set of measures. See Martorell, Leslie and Moock (1984) for a description of malnutrition levels in this population reported in terms of Z scores.

Whereas stunting (i.e., substandard height) indicates *chronic* malnutrition, wasting (substandard weight controlling for height) indicates *acute* malnutrition. Children who are less than 90 percent of the median height of the reference population of the same age and sex are generally classified as 'stunted'. Children who are less than 80 percent of the median weight of the reference population of the same height and sex are said to be 'wasted'. Weight-for-age is a summary indicator in that a low weight given the child's age and sex may indicate either stunting or wasting, or both. Gomez classifications of nutritional status are based on this measure; children who are less than 75 percent of the median weight-for-age are in the bottom two Gomez categories.[5]

Capillary blood was collected by finger prick and analyzed in the field. Blood was put directly on a slide, stirred with a reagent and the slide inserted into a reading chamber (method of American Optical Company). Values were not corrected for altitude since the Terai, unlike the rest of Nepal, is flat and close to sea level.

2.2. *Data analysis*

The initial sample of 637 children had to be pared down for this study of school participation. Excluded were children under the age of five, who were not yet eligible for school.[6] Excluded also was any child for whom we had a value smaller than 50 percent or greater than 150 percent of the NCHS norm for height-for-age or weight-for-height, since such extremes likely reflect errors in the measurement of body size, or age, or both. The further exclusion of all children residing in households for which we lacked information on such basic variables as land owned or family size or whose landholding was reported to be smaller than 0.1 ha. resulted in a usable sample of 350 children, as illustrated in fig. 1.

Table 2 indicates that 15 percent of the children in the sample were enrolled in school at the time of our survey. It may be noted that enrollment ratios in this area of Nepal are considerably smaller than those reported for the nation at large. In general, the ratio increases with age. Moreover, boys are more likely to be enrolled than girls at every age (except at age five, and here the proportions are not significantly different from one another).

Although we are interested in the range of determinants of school participation, the particular focus of this study is on the relationship between

[5]Gomez 0 (normal) is 90 percent or above of median weight-for-age, Gomez 1 (mildly malnourished) is 75 to 89 percent of median weight-for-age, Gomez 2 (moderately malnourished) is 60 to 74 percent of median weight-for-age, and Gomez 3 (severely malnourished) is less than 60 percent median weight-for-age [Gomez (1956)].

[6]The official school-entering age in Nepal is six years, but a few children begin school at age five. The majority of those who eventually attend school do not begin until they are seven years old or older.

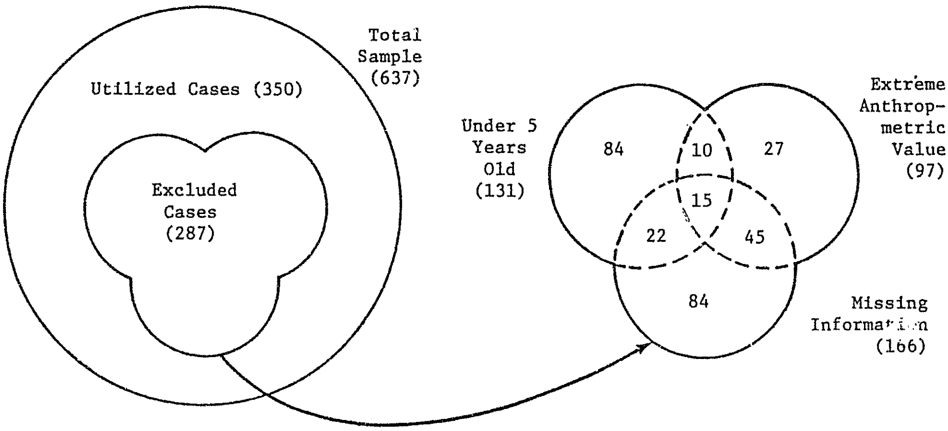

Fig. 1. Sample of children.

Table 2

School enrollment ratios by sex and age of child – Sample of 350 children, December 1980.[a]

Age in years	Boys		Girls		Both	
5	0.026	(39)	0.041	(49)	0.034	(88)
6	0.186	(43)	0.033	(30)	0.123	(73)
7	0.114	(35)	0.081	(37)	0.097	(72)
8	0.406	(32)	0.167	(18)	0.320	(50)
9	0.429	(28)	0.150	(20)	0.313	(48)
10	0.400	(5)	0.000	(9)	0.143	(14)
11	0.400	(5)	—	(0)	0.400	(5)
Total	0.225	(187)	0.047	(163)	0.154	(350)

[a]Totals in parentheses.

nutritional status and schooling. As table 3 indicates, the study sample of school-age children was quite malnourished judging by standard anthropometric indicators; two-thirds of the children were Gomez 2 and 3 (below 75% of the median weight-for-age), two-thirds were stunted (below 90% of the median height-for-age), and 3 percent were severely wasted (below 80% of the median weight-for-height).

Our study of school participation consists of two closely related sections. The first is a probit analysis of the dichotomous dependent variable, enrollment. The probability of a child's being enrolled in school was predicted based on a variety of theoretically relevant determinants of school participation behavior, including the child's age, sex, and nutritional status.

Table 3

Rates of malnutrition by age group – Sample of 350 children, December 1980.

Age in years	Below 75% NCHS median weight-for-age	Below 90% NCHS median height-for-age	Below 80% NCHS median weight-for-height
5	60%	76%	3%
6	59%	67%	3%
7	67%	65%	3%
8	66%	58%	4%
9	77%	63%	2%
10–11	84%	58%	5%
Total	66%	67%	3%

The probits were run for all children in the sample, and then separately for boys and for girls.

In the second of the two analyses, our focus shifts to grade attainment. Since a child's *grade* in school is conditional on the child's having been *enrolled* in school, this analysis is restricted to 51 children who were enrolled at the time of the survey.[7] Table 4 presents the joint frequency distribution of the 51 children by age (in years) and grade in school. Nearly half of the 51 were only in the first grade. Only one child had advanced beyond the third grade.

Our analysis of grade attainment was conducted in two ordinary-least-squares (OLS) stages. In the first, grade in school was regressed on age (in

Table 4

Grade in school by age for the 51 children attending school

Age in years	Grade in school					
	1	2	3	4	5	All
5	2	0	0	0	0	2
6	7	2	0	0	0	9
7	3	4	0	0	0	7
8	4	5	5	0	0	14
9	8	2	4	0	1	15
10	0	1	1	0	0	2
11	0	1	1	0	0	2
Total	24	15	11	0	1	51

[7]There were no children in the sample who had attended school in the past and dropped out by the time of the survey. Three children who were enrolled at the time of the survey are excluded from this analysis because their grade in school was not reported.

months).[8] This regression was used to predict a child's grade in school, and this prediction then subtracted from the child's observed grade level. The difference, labeled GRDAHD (grades ahead given age), has a mean of zero and a standard deviation of 0.846. In the second OLS stage, *GRDAHD* was regressed on the remaining determinants of school participation behaviour.

The variables used in the probit and OLS analyses are described in table 5. School participation behavior is modeled in this paper as a function of (1) *characteristics of the child* – namely, sex, age, and nutritional status, (2) *characteristics of the child's parents* – educational attainment and attitudes, (3) *characteristics of the household* – family size, farm size, caste membership, and income, and (4) *characteristics of the community* – administrative district (which is a measure of average educational attainment and other aggregate factors) and distance to the nearest primary school. The 17 independent variables in groups (1) through (4) can be reorganized into (a) those that primarily reflect differences in the *price of schooling* – e.g., distance to school and size of farm, (b) those that reflect differences in the real or perceived *benefits to be expected from an investment in schooling* – e.g., parental attitudes and caste, and finally (c) those that reflect the family's *income constraint*. Our principal measure of family income is the output value of the major crops (rice and wheat) produced on the farm in the year prior to the survey. We ignore income from other sources, which is judged to be minimal in this area of Nepal.[9]

3. Results

3.1. Probit analysis of school enrollment

The purpose of the analysis reported in this section is to determine how individual, parental, household, and community variables (X_{ij}) affect the probability of a child's being enrolled in school (P_j). The probability may be expressed as follows:

$$P_j = \text{prob}(INSCH_j = 1) = F(Y_j) \tag{1}$$

and

$$1 - P_j = \text{prob}(INSCH_j = 0) = 1 - F(Y_j), \tag{2}$$

[8]Both variables enter the regression in natural-log form. A linear and several non-linear specifications were tried. The log-log form was retained, as it proved to give the best fit.

[9]Although most households do produce other crops and keep some livestock, rice and wheat are the principal farm enterprises in this part of the Terai. The two together accounted for 1.0 ha. of land usage in 1980 on the 'typical' farm out of a total of 1.3 ha. available for cultivation. Most households (88 percent) reported no off-farm income, and for those few that did, the amount was relatively small (Rs. 213 on average).

Table 5

Variables used in probit and OLS analyses of school participation behavior — Minimum and maximum values, means and standard deviations.

Variable description		Min. val.	Max. val.	Probit analysis of school enrollment ($N = 350$) Mean	Probit Std. dev.	OLS analysis of grade attainment ($N = 51$) Mean	OLS Std. dev.
Dependent variables							
INSCH	enrolled in school (1 = yes, 0 = no)	0.0	1.0	0.154	0.362	1.000	0.000
GRADE	grade in school	1.0	5.0	—	—	1.804	0.917
LNGRADE	natural log of *GRADE*	0.0	1.609	—	—	0.472	0.484
GRDAHD	grades ahead given age	−0.730	3.306	—	—	0.000	0.846
Child characteristics							
FEM	female (1 = female, 0 = male)	0.0	1.0	0.466	0.500	0.196	0.401
AGE	age (months)	60.0	132.0	83.234	18.864	95.078	17.131
LNAGE	natural log of *AGE*	4.094	4.883	—	—	4.538	0.186
HA	height for age (% NCHS norm)	66.5	110.9	88.031	6.339	92.773	6.112
WH	weight for height (% NCHS norm)	60.9	140.3	92.798	8.575	93.773	9.144
WA	weight for age (% NCHS norm)	40.4	120.6	72.217	11.970	79.608	12.148
HG	hemoglobin (gm. per 100 ml.)	3.8	15.9	11.359	1.669	12.004	1.506
Parental characteristics							
FASCH	father went to school (1 = yes, 0 = no)	0.0	1.0	0.269	0.444	0.686	0.469
MOSCH	mother went to school (1 = yes, 0 = no)	0.0	1.0	0.063	0.243	0.216	0.415
OCCASP	high occup. aspir. for child of this sex (1 = yes, 0 = no)	0.0	1.0	0.889	0.315	1.0	0.000
Family characteristics							
FAMSIZ	family size	3.0	22.0	7.594	3.318	8.490	3.701
LAND	land owned (ha.)	0.1	29.4	1.670	2.744	3.501	4.393
CRPVL	value of crop output (100 Rs.)[a]	0.5	252.5	28.432	34.740	62.380	52.057
HICST	high caste (1 = high, 0 = all other)	0.0	1.0	0.046	0.209	0.137	0.348
LWCST	low caste (1 = low, 0 = all other)	0.0	1.0	0.303	0.460	0.118	0.325
Community characteristics							
VILSCH	school in village (1 = yes, 0 = no)	0.0	1.0	0.763	0.426	0.784	0.415
BARA	district (1 = Bara, 0 = Rautahat)	0.0	1.0	0.417	0.494	0.451	0.503

[a]The official exchange rate was approximately 12 Rs. to the U.S. dollar.

where $INSCH_j$ is the dichotomous indicator of enrollment ($=1$ if enrolled and $=0$ if not enrolled), Y_j is some linear combination of the observed independent variables ($=A+\sum_i B_i X_{ij}$), and $F(Y_j)$ is the cumulative density function relating Y_j and P_j. Since P_j cannot exceed 1 or fall below 0, this implies that the function $F(Y_j)$ must be non-linear, at least near the boundaries of 0 and 1. In this study, we make use of the probit model, which assumes that the function is cumulative normal. The parameters (A and B_i) of the latent variable Y_j are estimated using a maximum likelihood technique.

The probit results for the sample of 350 children are reported in table 6.[10] Eq. (1) and (2) include only the child's sex, age, and the nutritional status measures as independent variables. Older children are found to be significantly more likely than younger children, and girls signigicantly less likely than boys, to be enrolled in school. Of the nutritional status variables, a child's hemoglobin level is not found to be related to school enrollment.[11] On the other hand, both height-for-age (HA) and weight-for-height (WH) contribute positively and significantly to the probability of a child's being enrolled in school. As expected, the influence of the former, which measures chronic malnutrition, appears stronger than the influence of the latter, a measure of acute malnutrition. In eq. (2), weight-for-age (WA), which reflects the combination of chronic and acute conditions, is entered in lieu of the two separate indicators.

Table 6

Probit analysis of school enrollment ($N=350$).[a]

	(1)		(2)		(3)		(4)	
Constant	−14.15	(−6.331)	−7.494	(−6.594)	−16.26	(−6.115)	−16.10	(−5.931)
FEM	−0.692	(−3.338)	−0.659	(−3.237)	−0.954	(−3.783)	−0.955	(−3.686)
AGE	0.024	(4.603)	0.031	(5.600)	0.032	(4.940)	0.034	(5.061)
HA	0.098	(5.695)	—	—	0.105	(5.283)	0.101	(4.985)
WH	0.024	(2.111)	—	—	0.029	(2.149)	0.027	(1.907)
WA	—	—	0.049	(5.778)	—	—	—	—
HG	0.024	(0.419)	0.033	(0.582)	—	—	—	—
FASCH	—	—	—	—	1.519	(6.110)	1.329	(5.110)
LAND	—	—	—	—	0.047	(1.275)	−0.100	(1.654)
CRPVL	—	—	—	—	—	—	0.017	(3.005)
LWCST[b]	—	—	—	—	−0.529	(−1.845)	−0.577	(−1.853)
χ^2 (chi-square)	77.4		74.3		139.2		149.7	
d.f. (degrees of freedom)	5		4		7		8	

[a]*INSCH* is the dependent variable. Probit coefficients are given first, followed by asymptotic *t*-statistics in parentheses.

[b]Omitted from eq. (3) when inclusion resulted in non-convergence.

[10]A matrix of zero-order correlation coefficients for the variables in table 6 is provided in appendix A.

[11]When the indicator of the child's sex (*FEM*) is left out of the first equation, the probit coefficient for *HG* jumps to 0.59, but the test statistic for this coefficient (1.044) still falls short of the critical value (approximately 1.645 if we use the *t*-distribution).

The statistical relationships between nutritional status and enrollment and between child's sex and enrollment remain strong when additional variables are entered into the analysis as controls.[12] Four background variables are found to have signigicant direct effects on the probability of a child's being enrolled in school. These are father's schooling (*FASCH*), farm size (*LAND*), income from rice and wheat (*CRPVL*), and membership in one of the low-status castes (*LWCST*). Other independent variables described in table 5 were found in earlier runs not to be related significantly to enrollment probability, and these were dropped from the final probit equations.

Eqs. (3) and (4) are identical in form except that the latter includes and the former does not include the variable *CRPVL*. Of the other variables appearing in both equations, only the estimated effect of *LAND* is influenced markedly by this difference. The probit coefficient is positive in eq. (3) and becomes negative in eq. (4). In the first instance, *LAND* serves in part as a proxy for household income. In the second, however, *CRPVL* is introduced as an explicit measure of income, and *LAND* then would seem to function primarily as a measure of the value of the child's time spent working on the farm and, hence, as a measure of the cost of time spent studying.

To see how the predicted probability of a child's being enrolled in school changes with the exogenous variables, we entered two or more representative values of each variable of interest into the estimated probit equations, holding other variables constant at the sample mean values. The predicted probability of enrollment is the area under the standard normal curve between minus infinity and the computed value of the probit equation. The computed probabilities, based on eq. (4) of table 6, are presented in table 7.

3.2. OLS analysis of grade attainment

Once it has been determined that a child is enrolled in school, a second question to ask is how far that child has progressed in school. Given his or her age, the grade attainment of an enrolled child will depend on (1) the age at which the child first entered school, and (2) the average rate of promotion thereafter. In Nepal, there is considerable variation in the age at which the

[12]Having observed the large ceteris paribus relationship between gender and school enrollment, we decided to conduct a test of the homogeneity of the population of children across the male and female subpopulations, analogous to the OLS test of population homogeneity developed by Chow (1960). Two probit equations were estimated. In the first, presented as eq. (4) in table 6, the parameters were restricted to be the same for the two subsamples. In the second, not shown, two parameters were estimated for each one estimated in eq. (4) to permit the boys' and girls' estimates to vary. The significance of the additional estimates can be tested using a goodness-of-fit test for competing models [Pedhazur (1982, pp. 627–628)]. To test the null hypothesis of identical structures, twice the log of the likelihood ratio approximates a Chi-square distribution, with degrees of freedom equal to the number of additional parameters. The value of the test statistic in this case was 7.54. For a significance level of 0.05 and with 9 degrees of freedom, the critical value of the Chi-square is 16.92. Therefore, the null hypothesis cannot be rejected, and we do not report separate estimates for the male and female subsamples.

Table 7

Predicted conditional probability of a child's being enrolled in school.

Condition	Probability	Condition	Probability
Sex of child		*Father attended school*	
Boy	0.085	No	0.015
Girl	0.009	Yes	0.198
Age		*Land owned*	
60 months	0.004	0.5 ha.	0.045
84 months	0.037	1.5 ha.	0.036
120 months	0.284	5.0 ha.	0.016
Height-for-age		*Rice and wheat output*	
80% of NCHS norm	0.004	Rs. 1,000	0.017
90% of NCHS norm	0.053	Rs. 3,000	0.037
100% of NCHS norm	0.271	Rs. 6,000	0.100
		Rs. 12,000	0.398
Weight-for-height		*Caste*	
80% of NCHS norm	0.015		
90% of NCHS norm	0.029	low	0.014
100% of NCHS norm	0.052	middle or high	0.050

child first entered school, and the repeating of grades, though not officially sanctioned, is quite a common practice. As a result, it is not uncommon to find, in a single school grade, children whose ages differ by as much as five years (see table 4).

We view non-enrollment (i.e., not entering school at all) merely as an extreme value on the continuum indicating a child's age-adjusted grade attainment. Hence, the same explanatory variables used in the analysis of school enrollment are used again here in the analysis of grade in school. We should expect, for examnle, a child's progress to be related positively to nutritional status, particularly long-term status as measured by height-for-age, and to household income, and to be related negatively to farm size, ceteris paribus.

The analysis of school attainment was conducted in two OLS stages. In the first, the natural log of grade in school was regressed on the natural log of age,

$$\log(GRADE_j) = b_0 + b_1 \log(AGE_j) + u_j, \tag{3}$$

or

$$Z_j = \text{pred}[\log(GRADE_j)] = b_0 + b_1 \log(AGE_j), \tag{4}$$

where b_0 and b_1 are the regression estimates of the constant term and slope, u_j is a random error term, and Z_j the predicted value of the dependent variable. The child's predicted grade in school [antilog(Z_j)] was then subtracted from the child's observed grade in school,

$$GRDAHD_j = GRADE_j - \text{antilog}(Z_j). \tag{5}$$

The computed variable *GRDAHD* is a measure of how far ahead (or behind) a child is in school relative to others of the same age.[13] In the second stage of the analysis, this variable is regressed on the relevant explanators,

$$GRDAHD_j = b_0 + \sum_{i=1}^{k} b_i X_{ij} + u_j. \tag{6}$$

The OLS results are presented in table 8.[14] The estimates in eq. (1) are those that were used to create *GRDAHD*, the dependent variable in eqs. (2) through (4). The analysis of *GRDAHD* was conducted in a series of steps. In the first, all of the independent variables were entered at once [see eq. (2)]. In the second, those variables whose coefficients had not been significant at the 0.05 probability level in the first step were removed [see eq. (3)]. Then,

Table 8

OLS analysis of grade attainment ($N=51$).[a]

Dep. var.	*LNGRADE* (1)		*GRDAHD* (2)		*GRDAHD* (3)		*GRDAHD* (4)	
Constant	−4.280	(−2.766)	−5.454	(−1.976)	−4.913	(−3.313)	−5.233	(−3.609)
LNAGE	1.047	(3.073)	—	—	—	—	—	—
FEM	—	—	−0.098	(−0.347)	[−0.7]		[−0.8]	
HA	—	—	0.046	(2.255)	0.050	(3.114)	0.053	(3.389)
WH	—	—	−0.001	(−0.069)	[0.3]		[0.0]	
HG	—	—	0.069	(0.816)	[1.0]		[0.8]	
FASC	—	—	−0.094	(−0.333)	[−0.5]		[−0.6]	
MOSCH	—	—	0.052	(0.168)	[0.6]		[0.1]	
FAMSIZ	—	—	0.011	(−0.333)	[−0.6]		[0.3]	
LAND	—	—	−0.052	(−1.287)	[−2.0]		−0.065	(−1.967)
CRPVL	—	—	0.011	(2.582)	0.007	(3.859)	0.011	(4.087)
HICST	—	—	0.110	(0.319)	[0.1]		[0.1]	
LWCST	—	—	0.398	(1.115)	[1.3]		[1.1]	
VILSCH	—	—	0.060	(0.188)	[−0.6]		[−0.4]	
BARA	—	—	0.077	(0.323)	[0.6]		[0.1]	
R^2	0.162		0.450		0.362		0.411	
Adj. R^2	0.145		0.256		0.336		0.373	
F (d.f.)	9.446	(1,49)	2.326	(13,37)	13.629	(2,48)	8.443	(3,47)

[a]Regression coefficients are given first, followed by *t*-values in parentheses. Square brackets indicate that the variable is not included in the regression equation. The number within brackets would be the *t*-value were this variable to enter the regression in a subsequent step by itself.

[13]Although it has no effect on the results of the subsequent OLS analysis, the constant 0.171 was subtracted from each value of *GRDAHD* to make the mean of this variable equal to zero.

[14]A matrix of zero-order correlation coefficients for the variables in table 8 is provided in appendix B.

variables were allowed to re-enter one at a time according to *t*-values until the next variable to be included would not be significant at the 0.05 level. Only one variable, *LAND*, entered meeting this criterion [see eq. (4)].

As predicted, the regression coefficients for height-for-age (HA) and household income (*CRPVL*) are significantly positive. Farm size (*LAND*) is negatively related to grade attainment, as it was to school enrollment.

There are no other statistically significant findings in the OLS analysis. Four variables that had significant coefficients in the probit analysis of school enrollment fail to meet the standard criterion for significance in the OLS analysis of grade attainment. These are child's sex (*FEM*), weight-for height (*WH*), father's having attended school (*FASCH*), and membership in one of the low-status castes (*LWCST*).

With these four variables, only one of the regression coefficients has a *t*-value approaching the critical value for significance, and this is the coefficient for *LWCST*. Interestingly, the coefficient has a positive sign, whereas it was negative in the probit analysis of enrollment. It would seem that once a low-caste family has made the decision to send a child to school, its commitment to this investment is especially strong.

4. Summary and discussion

Our data on heights and weights of children from the Nepal Terai reveal childhood malnutrition that is as severe as has been observed anywhere in the world.[15] In this study, we have demonstrated some of the negative effects of this undernourishment on the school enrollment and grade attainment of young (five-to-11-year-old) children. A child's height-for-age was found to be the single best predictor of whether or not the child was enrolled in school. In a study of rural Guatemalan children, Balderston et al. (1981) also found height to be related significantly to enrollment, other things held constant. When we turned to the analysis of grade attainment, once again height was found to be an important determinant. Of those children who were enrolled in school, taller children tended to be in higher grades than shorter children of the same age. Jamison (1986) has reported the same finding for Beijing and the Gansu and Jiangsu provinces of China.

The importance of height as a determinant of school enrollment and school performance depends on the general level of nutrition in the population. In any population, height should reflect some combination of genetic and environmental (nutritional) factors. Whereas for a well-fed population, the genetic factor predominates, in an impoverished environment, height

[15] The characteristics and determinants of childhood malnutrition in this population are discussed in much greater detail in a companion paper to his one [Martorell, Leslie and Moock (1984)], and in another paper analyzing the 1977–78 data [Leslie, Baidya and Nandwani (1981)].

(though still genetically determined in part) is a good indicator of an individual's long-term nutritional status. The importance of height in predicting children's school participation in the Nepal Terai is a further indication of how poorly nourished the child population is on average.

We looked also at the effects of weight-for-height and blood hemoglobin on school enrollment and grade attainment. Low weight-for-height or low hemoglobin would indicate a situation of acute malnutrition, that is, of current as distinct from long-term nutritional deprivation. Hence, we might predict that these would have an impact on enrollment, since enrollment is a measure of current status, but not on grade attainment, which is a measure of the cumulative effect of past behavior. We found that weight-for-height has a positive impact on enrollment, and as predicted, we found no additional effect of weight-for-height on grade attainment. Although girls had lower hemoglobin levels on average (11.02 grams per 100 milliliters as compared with 11.65, the average for boys), and girls were less likely than boys to be enrolled in school (7 percent of the girls were enrolled, as compared with 22 percent of the boys), hemoglobin was not found to have any statistically significant effect on enrollment once sex was taken into account. Neither was hemoglobin related to grade attainment. In a study of Filipino children, Popkin and Lim-Ybanez (1982) found a significant positive association between weight-for-height and a measure of the child's ability to concentrate in school, and also that children with higher hemoglobin levels were less likely to be absent from school.

Chernichovsky (1985) and Paqueo (1981) have developed household production models that predict a negative impact on school participation of variables that reflect the cost of a child's time spent in school. Paqueo demonstrated with data from the Bicol region of the Philippines that electrification, which would tend to reduce the value of a child's time in household activities such as firewood collection and water carrying, was related positively to the probability of enrollment, especially in the case of boys. With data from rural Botswana, Chernichovsky showed negative effects on enrollment, attendance, and attainment, of farm size, the presence of a baby in the household, and the number of small livestock, all of these apparently related positively to the cost of time spent studying.[16] Consistent with the predictions of Chernichovsky and Paqueo, we found a negative effect of farm size on enrollment, once a measure of household income was included as a control variable in the analysis.

We found that children in Nepal were more likely to go to school if their fathers had done so. A positive effect of parental schooling on child school participation in the Terai was reported earlier by Jamison and Lockheed

[16]On the other hand, Chernichovsky found a positive effect on attendance of the number of cattle owned.

(1986). Paqueo (1981) in the Philippines found a relation between father's education and whether or not the child was enrolled, as did Birdsall (1985) between father's education and child's grade attainment. Birdsall, whose study is based on Brazilian census data, found that mother's education too was related to grade attainment, and Balderston et al. (1981), that the children of literate mothers in Guatemala were more likely to be enrolled than were the children of illiterate mothers, all else equal.

Like Jamison and Lockheed (1986), we found that girls in the Terai were less likely to be enrolled than boys, other things the same. Balderston et al. (1981) found the same in Guatemala. On the other hand, Chernichovsky (1985) found just the opposite in rural Botswana.

As the above discussion indicates, the finding of a positive association between anthropometric indicators of nutritional status and both school enrollment and grade attainment among children in the Terai region of Nepal adds to the growing evidence suggesting that efforts to improve child nutritional status may have educational benefits as well as survival and health benefits. If the economic benefits of improving nutritional status can be legitimately calculated to include the higher productivity of a more educated adult population [cf. Selowsky and Taylor (1973)], as well as the treatment savings from a better nourished, less disease-prone child population, it may turn out that an investment in child nutrition is one of the best investments a developing country can make.

Appendix A

Table A.1

Pearson correlation matrix – variables used in probit analysis of school enrollment ($N = 350$).

	INSCH	*FEM*	*AGE*	*HA*	*WH*	*WA*	*HG*	*FASCH*	*MOSCH*	*OCCASP*	*FAMSIZ*	*LAND*	*CRPVL*	*HICST*	*LWCST*	*VILSCH*
FEM	−0.209															
AGE	0.258	−0.084														
HA	0.318	−0.058	0.087													
WH	0.313	−0.001	−0.189	−0.094												
WA	0.254	−0.028	−0.222	0.785	0.499											
HG	0.136	−0.187	0.055	0.153	0.001	0.118										
FASCH	0.402	−0.023	−0.019	0.076	−0.021	0.065	0.053									
MOSCH	0.281	−0.053	−0.037	0.130	0.027	0.138	0.060	0.427								
OCCASP	0.151	−0.361	0.036	−0.039	−0.009	−0.040	0.028	0.112	0.092							
FAMSIZ	0.110	−0.064	0.039	0.098	−0.015	0.069	0.155	0.082	0.181	−0.095						
LAND	0.278	−0.018	0.042	0.164	0.005	0.136	0.020	0.342	0.227	0.042	0.294					
CRPVL	0.416	−0.039	0.041	0.198	0.025	0.178	0.098	0.450	0.378	0.048	0.416	0.810				
HICST	0.172	−0.040	−0.011	0.035	0.079	0.084	0.056	0.238	0.225	0.078	−0.010	−0.014	0.015			
LWCST	−0.161	0.008	0.010	−0.067	−0.048	−0.094	−0.059	−0.147	−0.120	−0.024	−0.169	−0.195	−0.243	−0.144		
VILSCH	0.034	0.009	0.091	−0.004	−0.028	−0.034	−0.081	−0.041	−0.022	−0.069	0.112	0.100	0.030	0.058	−0.100	
BARA	0.040	0.012	−0.033	0.130	0.068	0.161	−0.026	0.037	−0.004	−0.087	−0.047	−0.018	0.085	0.120	−0.091	0.118

Appendix B

Table B.1
Pearson correlation matrix – Variables used in OLS analysis of grade attainment ($N = 51$).

	GRADE	*LNGRADE*	*GRDAHD*	*FEM*	*AGE*	*LNAGE*	*HA*	*WH*	*WA*	*HG*	*FASCH*	*MOSCH*	*FAMSIZ*	*LAND*	*CRPVL*	*HICST*	*LWCST*	*VILSCH*
LNGRADE	0.976																	
GRDAHD	0.942	0.915																
FEM	−0.111	−0.118	−0.066															
AGE	0.391	0.394	0.060	−0.148														
LNAGE	0.399	0.402	0.071	−0.146	0.994													
HA	0.339	0.327	0.405	−0.010	−0.104	−0.106												
WH	−0.122	−0.152	−0.086	−0.030	−0.127	−0.132	−0.290											
WA	0.191	0.157	0.322	−0.011	−0.319	−0.321	0.782	0.345										
HG	0.257	0.236	0.210	−0.193	0.189	0.214	0.209	−0.088	0.132									
FASCH	0.040	0.035	0.043	0.228	0.001	0.007	−0.175	−0.097	−0.229	0.047								
MOSCH	0.218	0.178	0.247	0.101	−0.028	−0.010	0.107	−0.024	0.088	0.190	0.355							
FAMSIZ	0.371	0.304	0.298	0.069	0.288	0.304	0.095	−0.121	−0.022	0.055	0.021	0.229						
LAND	0.241	0.234	0.248	0.012	0.037	0.051	0.142	−0.141	0.037	−0.047	0.220	0.096	0.284					
CRPVL	0.454	0.399	0.483	0.041	0.025	0.037	0.100	−0.036	0.049	0.037	0.347	0.319	0.460	0.759				
HICST	−0.039	−0.050	−0.036	0.234	−0.019	−0.001	0.130	−0.042	0.108	0.026	0.147	0.206	−0.085	−0.147	−0.205			
LWCST	0.079	0.132	0.089	−0.180	−0.009	−0.009	−0.090	0.099	−0.037	−0.140	−0.147	−0.044	−0.115	−0.109	−0.058	−0.146		
VILSCH	−0.008	−0.047	−0.032	0.139	0.061	0.041	0.056	−0.158	−0.041	−0.405	−0.149	−0.189	0.200	0.112	0.037	0.071	−0.252	
BARA	0.152	0.099	0.202	0.049	−0.102	−0.094	0.207	0.513	0.304	−0.016	0.018	−0.092	0.008	−0.027	0.147	0.097	−0.086	0.092

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