Maternal Education and Child Nutritional Status:

Do Family and Community Matter? The case of Ethiopia

Tesfayi Gebreselassie[1]

Population Research Institute
The Pennsylvania State University

[1] E-mail: txg164@psu.edu

Introduction

There is a general consensus today that a complex set of factors causes malnutrition. Inadequate and/or inappropriate dietary intake and infectious diseases are the immediate/direct causes, which in turn are related to a number of socio-economic, demographic, child-care, and environmental factors. A child's body responds to malnutrition through the deceleration of growth, which over the long term results in low height-for-age (stunting); and low weight-for-height (body wasting), which is a response to short term inadequate dietary intake.

Several studies report that children born to educated mothers have a lower mortality risk (Bicego and Boerma, 1993; Cochrane, et al., 1982; Wolfe and Behrman, 1982; Caldwell, 1979). Educated women are likely to be more assertive and to play a greater role in intra-family decision-making favoring their children's needs. It may be argued that mother's education would affect their children's nutritional status by similar mechanisms, and various studies have shown some degree of association between mother's education and the nutritional status of children (Chen, 1986; Caldwell, 1986; Lavy et al., 1996; Sahn and Alderman, 1997). However, studies that investigate pathways of influence argue that the causal linkages between these two factors are far from clear (Desai and Alva, 1998; Hobcraft, 1993). A deeper understanding calls for an investigation for how maternal education affects child nutritional status.

Child malnutrition is among the most serious problems facing Ethiopia. Results of the 1992 National Rural Nutrition Survey indicated that about 64 per cent of all children in rural Ethiopia aged 6-59 months were chronically malnourished (CSA, 1993). This level of stunting (low height-for-age) is among the highest in the world. The report also shows that 47 per cent of the children surveyed were underweight (low weight-for-age).

The World Bank report on Ethiopia (1998) indicates that the prevalence of stunting in 1995 was 65.2 per cent, with 46.2 per cent underweight and 10.5 per cent wasting for children under age 5. In rural areas, the proportion of stunted children under the age of five increased from 64 per cent in 1983 to 68 per cent in 1995. The report also suggests that mother's education has some effect on the level of wasting and stunting of children, but its independent effects may not be dramatic after controlling for other influences, such as income, mother's own health, and other variables. Moreover, the analysis found no clear pattern in the relationship between malnutrition and per capita household expenditure.

Background

In most regions of the developing world, most studies document a decline in malnutrition rates over the last two decades, but at markedly different paces. However, in most countries of sub-Saharan Africa malnutrition rates began increasing during the early 1990s (UNICEF, 1998; de Onis et al., 2000).

The evidence on the link between maternal education and nutritional status of children is mixed. Even after controlling for income, a number of studies in sub-Saharan Africa have reported the presence of a weak link between maternal education and child nutrition status (Alderman, 1990; Sahn, 1994; Thomas, Lavy and Strauss, 1996; Penders et al., 2000). In Cote d'Ivoire, Strauss (1990) found that unobserved heterogeneity related to the household but not the mother is an important determinant of child height (an indicator of long-term nutritional status of the child). He also reports the absence of any significant interaction effect between maternal education and community health services. In analysis of the determinants of child nutrition in Mozambique, Sahn and Alderman (1997) report that mother's education is a significant determinant of nutritional status of younger children below two years of age. In contrast, increases in household income affect only the nutritional status of children two years of age and older. Garret and Ruel (1999) investigate the determinants of nutritional status for children 0-23 months old and children 24-60 months old using data from Mozambique. They reported that maternal education has the greatest positive influence on child growth for the 0-23 month old children, but is not significant for the 24-60 month old children. In comparison to the younger children (0-23 months old), the physical environment, such as contamination, hygiene and food safety are factors that determine child growth for the 24-60 month old children. Lavy et al. (1996), using data from Ghana, report that maternal education has the largest effect on the height for babies, and the effect declines with child's age. On the other hand, maternal education has no effect on child weight for height. In addition, the results show that expenditure has no effect on the height of babies and infants, but it has a positive and significant influence on the height of children 3 years or older.

Lambert and Sahn (2002), using the 1991 and 1996 Demographic and Health Surveys (DHS) for Tanzania, found large and significant effect of post-primary schooling among mothers and fathers on height of children 3-36 months old. Madise et al. (1999), using cross-sectional data from six sub-Saharan African countries[2], report that the level of mother's education was significant in four of the six countries. Generally, children whose mothers' had secondary or higher education were better nourished, with the exception of Tanzania. Primary education was the category associated with improved weight-for-age in Tanzania. In addition, they found that individual characteristics of the child such as age, gender, and reported illness preceding the survey were significant determinants of child nutrition across the six countries in the study. Family level characteristics such as maternal anthropometry, parental occupation and access to sanitation facilities were statistically significant determinants of child nutrition status, while source of drinking water was not. The number of children under the age of five was negatively associated with nutritional status of the child. In Uganda, Ahn and Shariff (1995) found maternal schooling has a strong effect on child health only after the estimates are corrected for selectivity bias. In addition, the authors report that living in an urban area and female education are complements, whereas owning a radio and female education are substitutes in the production of child health. In rural Rwanda, the positive effect of female education on child growth (measured by height-for-age) appears to be limited to primary schooling (Grosse, 1996). Grosse (1996) argues that strong positive result for primary schooling is achieved if it is accompanied by functional literacy. Deolalikar (1996) using data from the Kenya[3] found that maternal education, in particular having secondary and above level of education, is a significant determinant of child height. Alderman (1990), using the 1987-88 Ghana Living Standards Measurement Survey, reported that parental

[2] Data were taken from Demographic and Health Surveys (DHS) for Ghana, Malawi, Nigeria, Tanzania, Zambia and Zimbabwe.
[3] Data were taken from the Second Welfare Monitoring Survey ((WMS-2) conducted in 1994.

education was not a significant determinant of child height. However, he argues that the result may reflect the low quality of education for women in their childbearing years.

Bicego and Boerma (1991) examined the relationship between maternal education and child survival using DHS data from 17 countries[4]. The results indicate that maternal education is not significantly related to stunting of children (low height-for-age) for Mali and Togo. Sahn (1994) finds no positive significant impact of mother's education on the nutritional status of the child in Cote d'Ivoire in 1987 after controlling for household income. Eltigani (1994) investigates the determinants of nutritional status of children using data from rural central Sudan. He found that sex of the child, age of the mother, access to clean water, access to preventive health care, the prevalence of diarrhea, and child mortality were significant determinants of child nutritional status in rural central Sudan. However, the impact of mother's education on nutritional status of children was not significant. Penders et al. (2000), using data from the Demographic and Health Survey (DHS) I and II for Mali, report that there is no significant relationship between mother's education and height-for-age (stunting).

Evidence from other countries also suggests that the association between mother's education and child health and/or nutritional status of children is far from conclusive. Desai and Alva (1998), using data from the first round DHS data for 22 countries, examine the effect of maternal education on three markers of child health, namely, infant mortality, child height-for-age and immunization status. Their findings indicate that the effect of maternal education on child nutritional status is weakened after controlling for household socioeconomic variables (such as husband's education, and access to piped water) and area of residence. The effect remains statistically significant in only a few countries after incorporating the above variables. They argue that education acts as a proxy for the socioeconomic status of the family and geographic area of residence of the family. Most notably, if the proportion of educated mothers is high within the community, uneducated mothers may increase visits to health facilities at the community level for their children, as well as for themselves, through the spillover effect from educated mothers.

---

[4] The analysis included the following countries from sub-Saharan Africa: Burundi, Ghana, Mali, Senegal, Togo and Zimbabwe.

Using data from Brazil, Thomas, Strauss and Henriques (1991) found a significant interaction effect between maternal education and community health services. The result shows that education and community health services are substitutes in Brazil. On the other hand, Behrman and Wolfe (1987), using data from Nicaragua report that maternal education was not a statistically significant determinant of child height after controlling for unobserved family background and genetic endowment. Barera (1990) reports the presence of a positive association between maternal education and child health. However, the findings indicate that the pathways through which maternal education affects child health and/or nutrition are by affecting the productivity of health inputs (efficiency effect) and by lowering the cost of information (allocative effect).

There is mixed evidence regarding the association between mother's employment status and child nutritional status. Leslie (1989) examines the relationship between women's work and the nutritional status of children under five. The findings indicate that maternal employment should not be expected to have a negative effect on child nutrition. For women in Ghana, Haddad (1993) reports that the independent effect of working outside home is negative and statistically significant for food budget share and calorie availability. Using data from Guinea (West Africa), Glick and Sahn (1998) found a negative relationship between women's work outside home and the nutritional status of children. The authors contend that the income effect is not strong enough to offset the diminished quality of child care, as a result adversely affecting the health status of very young children in the household. The UN (1985) reports that the negative relationship between maternal employment and child survival was maintained even after controlling for possible confounding factors, such as maternal education, urban-rural residence, marital status and parental occupation. However, the report warns that the findings should be viewed cautiously as the line of causation is far from clear. Encouraging labor force participation of women without addressing the issue of low earnings of women in the labor market is not likely to result in improvement in child health.

Community Effects

Most studies on nutritional status of children have focused mainly on child-specific and household-level determinants under the assumption that factors in the child's immediate environment are likely to have the greatest impact on growth. For instance, Behrman (1995) argues that, "it can fairly be said that the household probably plays the major proximate role in determining the preschool child's health and nutrition." However, evidence shows the significant role of community characteristics[5] on child health and nutrition. Using data from Colombia, Rosenzweig and Schultz (1982) analyze the impact of community-level (at the municipality level) factors and climate on child survival. The result shows that mother's education and public health facilities substitute for one other, especially in urban areas, to improve child health. In Brazil, Thomas et al. (1992) state that "… the effects of community characteristics are systematically correlated with maternal education and household resources" (p. 329).

Using data from Ghana, Lavy et al. (1996) suggest that improvement in water and sanitation infrastructure in rural areas will likely lead to substantial gains in child health. Penders et al. (2000) report that the presence of a community infrastructure is associated with higher height-for-age (HAZ) in Mali. Moreover, the findings indicate that the presence of secondary schools within a 2 km radius of the central village has the strongest positive effect on HAZ. Madise et al. (1999) report a significant association between child malnutrition and unobserved heterogeneity between families and between communities. Based on the relative magnitude of the intra-class correlations, they argue that residence in a particular community may be a less important determinant of child malnutrition than membership in a particular family. The paper by Desai and Alva (1998) underscores the importance of explicitly incorporating community-level variables in order to develop effective health policies in developing countries.

---

[5] Community characteristics may include **population density**, community infrastructure, i.e., availability of sewerage, electricity connections, number of clinics … (Thomas and Strauss, 1992), or accessibility to health care and educational facilities, such as **distance to health facility, distance to primary, distance to secondary school,** and others (Al-Kabir, 1984). Grangnolati (2000) uses **distance to the nearest market,** altitude, number of doctors within 20 kms radius, number of health facitilties in community, number of paved road, etc… as community variables in his analysis.

In summary, studies regarding the relationship between mother's education and child nutritional status in sub-Saharan Africa have reported mixed results. Some have reported the lack of a significant relationship between mother's education and child nutritional status (Penders et al., 2000 for Mali; Strauss, 1990 for Cote d'Ivoire; Madise et al., 1999, for two out of six sub-Saharan African countries; Eltigani, 1994, for Rural Central Sudan; Garret and Ruel, 1999 for Mozambique - for 24-60 month old children). A few report weakly significant relationship (Sahn, 1994; Thomas, Lavy and Strauss, 1996 both for Cote d'Ivoire). Some findings report strong and significant effect of mother's education on child nutrition status (Lambert and Sahn, 2000 for Tanzania; Sahn and Alderman, 1997 for Mozambique- 0-23 month old children; Lavy et al., 1996 for Ghana; Ahn and Shariff, 1995 for Uganda). Moreover, since some of the studies do not control for income it might be difficult to separate the income effect from education.

The goal of this paper is to examine the influence of maternal education on child nutrition after controlling for socioeconomic, demographic and community level variables; and investigate the effect of community level variables on child nutritional status and how it affects the influence of maternal education.

Data and Methods

The data used in this paper come from the Household Income, Consumption and Expenditure Survey and the Welfare Monitoring Survey carried out in 1995/96 by the Central Statistical Authority with financial support from the World Bank. These surveys were conducted to assess the impact of the social dimensions of adjustment currently being undertaken in the country as part of the Economic Reform Program. The objectives of the Household Income, Consumption and Expenditure Survey (HICES) and the Welfare Monitoring Survey (WMS) were to obtain household consumption and expenditure patterns, to acquire data on levels of consumption and expenditure to use for poverty mapping and analysis, to obtain data on consumption from own production, payments in kind and exchange (barter), and to make a base for nutrition analysis.

The WMS focused on six basic needs indicators: health, education, anthropometry, access to selected services/facilities, amenities, and assets. The HICES collected data on basic demographic characteristics of households, consumption of food, drinks and tobacco; expenditure on consumption and non-consumption items[6]; and household income and receipts.

The sample was drawn in two stages. The first stage involved the selection of the Primary Sampling Units (PSUs), the enumeration areas (EAs). At the second stage households were systematically selected from EAs. All households participated in the two rounds of the surveys. The first round was conducted between June 1995 and August 1995, while the second round was conducted between December 1995 and January 1996. The first round includes the wet season and the second round the dry season of Ethiopia.

This paper uses data from two urban centers and rural areas of the northern regions of Ethiopia, and the capital city, Addis Ababa. A total of 3616 households were included in the survey, of which 2110 households were from rural areas, and the remaining 1506 households were from urban areas[7]. The data used for this paper is a sub-sample of the nationally representative sample survey.

The paper examines determinants of child nutritional status and child health-seeking behavior of households. Results of the multivariate analyses are reported using ordinary least squares and two stage least squares (2SLS) estimates for the reduced form. To examine the presence of unobserved heterogeneity due to clustering multilevel analysis is used, and results are reported.

---

[6] Domestic expenditure is defined as total expenditure incurred by the household or any member and includes expenditure on consumption as well as non-consumption items. Items included are: food; beverage; cigarettes and tobacco; clothing and foot wear; housing, water, electricity, gas and other fuels; furnishings, household equipment and operations; health; education; transportation; entertainment; cultural and religious services; personal care and effects.

[7] The Central Statistics Authority of the Government of Ethiopia was willing to give me permission to use of the data for this part of the country only.

Descriptive Statistics

The mean, standard deviation, and the minimum and maximum values of selected variables for the analysis are presented in Table 1. The working sample contains 1992 children aged 3-59 months from 1567 households (families) in 269 villages. The average age of the children in the sample is around 30 months. Around 24 per cent of the children in the sample were reported sick during the last two months preceding the survey. The survey also found parents paid a consultation visit to a health professional for 44 per cent of the children reported ill. On the other hand, 27 per cent were reported sick during the two weeks preceding the survey. About 45 per cent of the children in the sample received combined immunization of Measles, Diphtheria, Pertussis, and Tetanus (DPT) and Bacillus Calmette-Guerin (BCG), which is anti-tuberculosis vaccine. In 1996 WHO/UNICEF estimated immunization coverage for BCG, DPT, and Measels in Ethiopia was 57 per cent, 55 per cent and 54 per cent, respectively (WHO/UNICEF, 2001). Basic health coverage is very low in Ethiopia. Among other things, the health service system is characterized mainly by poor distribution (only 46 per cent of the population lives within a 10 kms radius of a health facility), lack of skilled health staff, and lack of supplies and necessary equipments.

Education level is defined here as the highest level of schooling attended by any adult member of the household. Parental education was categorized into three groups: no education, primary complete or less than primary and post-primary level of education. The education level of the mother (or senior female in the household) is very low. Table 1 shows that almost three-quarters of the mothers have no education, 11 per cent the mothers have primary education, and 12 per cent of mothers have post-primary education. The average age of mothers' in the sample is about 30 years, and 16 per cent of the households are female-headed. On the other hand, 61 per cent of the adult male household head have no education, 25 per cent have some primary of education, and the remaining 14 per cent have post-primary education.

Table 1 shows that around 19 per cent of the women in the sample worked outside of home. Mother's employment status was categorized into working outside home and not working outside the home. This classification does not distinguish mothers working for cash, or as family workers. Mothers working outside the home comprised those women who are working for cash or in kind, and those working as family workers during the survey reference period.

Table **1** shows that the annual average log consumption expenditure for each household was 8.34 birr (annual expenditure of 4188.10 birr or approximately $50.00 US per month.) The average number of members of a household in the sample was 5.86. The sample consists of 71 per cent households from rural areas. Only 24 per cent of the households own a radio at the time of the survey.

Infrastructure, such as schools, clinics and roads has an important role in the overall welfare of a community. Research has shown that the availability of infrastructure in a community affects child nutritional status. In this regard distance is an indicator of the propensity to use that facility within a given community. Table 1 shows that the average distance to the nearest health center is about 8 kilometers. The average distance to the nearest primary school is around 3.5 kilometers, while the average distance to the nearest water facility (well, piped water or open water) is 3.4 kilometers. On the other hand, the average distance to the nearest all-weather road is about 15.8 kilometers. Road and road density are the major bottlenecks to the development of Ethiopia.

Table 1. Variable names and definition and Descriptive statistics

Variable	Definition	n	Mean	Standard Deviation	Minimum	Maximum
	Child specific variables					
CGENDER	Gender of child - female child	1992	0.51	0.50	0.00	1.00
CAGEM	Child age (in months)	1992	29.75	15.65	3.00	59.00
CAGEM2	Child age squares (in months)	1992	1129.89	982.27	9.00	3481.00
CHILDILL	Child sick during last 2 weeks preceding the survey	1992	0.27	0.44	0.00	1.00
OWNCHILD	Own Child?	1992	0.90	0.30	0.00	1.00
HAZ	Z-score Height-for-age	1992	-2.73	1.69	-5.98	4.73
WAZ	Z-score Weight-for-age	1992	-1.84	1.23	-5.43	4.09
WHZ	Z-score weight-for-height	1992	-0.16	1.40	-3.99	5.94
HLTHSTAT	Health status during the last 2 months preceding the survey – proportion reported ill	1992	0.24	0.43	0.00	1.00
CONSULT	Consulted anyone while ill?	1992	0.44	0.50	0.00	1.00
IMMUNIZ	Proportion immunized for Measels, BCG and DPT	1992	0.45	0.50	0.00	1.00
	Parental characteristics					
M1Q17	Mother's age	1567	30.53	8.45	14.00	72.00
MNOEDUC	Mother → No Education (RC)	1567	0.75	0.43	0.00	1.00
MPRIMARY	Mother → Primary (1-6)	1567	0.11	0.31	0.00	1.00
MPOSTPRM	Mother → Post-primary	1567	0.12	0.33	0.00	1.00
WORKOUT	Work outside home	1567	0.19	0.40	0.00	1.00

Table 1 (Cont'd): Variable names and definition and Descriptive statistics

Variable	Definition	n	Mean	Standard Deviation	Minimum	Maximum
FHHEAD	Female head	1567	0.16	0.36	0.00	1.00
HNOEDUC	Male HH head → No educ. (RC)	1567	0.61	0.49	0.00	1.00
HPRIMARY	Male HH Head → Primary (1-6)	1567	0.25	0.43	0.00	1.00
HPOSTPRM	Male HH Head → Post-primary (7+)	1567	0.14	0.35	0.00	1.00
	Household level characteristics					
HHSIZE	Household size	1576	5.86	2.15	2.00	16.00
LNEXP	Log of annual expenditure	1567	8.34	0.57	6.39	10.61
RADIO	Radio	1567	0.24	0.43	0	1.00
RURAL	Residence in rural areas	1567	0.71	0.45	0.00	1.00
	Community level variables					
DHEALTH	Avg. distance to nearest health clinic	269	8.09	8.26	0.00	87.00
DPRIMARY	Avg. distance to nearest primary school	269	3.55	4.83	0.00	32.08
DTRANSPO	Avg. distance to nearest all-weather road	269	15.76	19.42	0.00	88.00
DWATER	Avg. distance to nearest source of drinking water	269	3.42	7.93	0.00	50.00
POPDENSITY	Population per square kilometer in wereda (in 1994)	269	2831.57	9184.42	7.07	63619.87

RC = Reference category in multivariate analysis.

HH = Household

Multivariate Analysis of Standardized Child Height-for-Age

The Base Model

Table 2 presents the standardized height-for-age regression results for the base model and models that include income. All the regressions in Table 2 include child characteristics (age, gender and health status), parental characteristics (education, headship and working status) and household characteristics (location of residence). The results from ordinary least squares (OLS) are presented in columns 1 and 2. The results from the two stage least squares are reported in column 3. Although the OLS estimates are likely to be biased due to the endogeneity of household expenditure and child illness, [8]it is useful to begin with them. In most cases the estimates change only slightly even when other estimation methods are used.

Child Characteristics:

In Table 2 (columns 1 and 2), as one would expect given the data in figure 4.3 (p. 56), the age of the child is significant, and shows a curvilinear relationship with height. The age coefficient indicates that standardized height declines until about the child is about 30 months old and then increases thereafter. These results persist using two stages least squares estimation (column 3) as well.

The relationship between child illness and child height is negative and significant. When child illness is exogenous, it lowers child height by about 0.230 standard deviations. In column 3 (child illness is endogenous) the estimate from two stage least squares (2SLS) indicates that the relationship between reported illness and child height still persists. Moreover, the coefficient changes appreciably (almost doubles), and the standard error is about 2.5 times as large as that of the OLS estimate.

---

[8] The Wu-Hausman test indicates both household expenditure (proxy for income) and child illness are endogenous. The F-values for log of household expenditure and child illness are 17.53 and 9.37, respectively. Both are statistically significant at $p\text{-value} < 0.01$.

Gender of the child is not significantly related to height although girls appear to have a slight advantage over boys (the sign of the coefficient is positive). In sub-Saharan Africa, previous research has shown either the lack of a systematic gender bias or a slight advantage for girls in nutritional outcomes.

Parental Characteristics:

The results in Table **2** also show a strong and positive relation of education of the mother and child height. The impact is more prominent for children whose mother has post-primary education. In addition, the education level of the male head of the household is positively related to child height with statistically significant differences obtained for children who live in a household where the male head has post-primary education. Columns 2 and 3 add household expenditure (proxy for income) to the model. In column 2, household expenditure is treated as exogenous; whereas in column 3 it is treated as an endogenous variable. In both cases, the significance of parental education is not affected. The decline in the coefficients is also very small. Taken together, parental education has a significant and positive effect on child nutritional status. The joint F-test indicates that parental education is strongly related to child height. The implication is that education of the male household head is equally relevant as the mother's education in determining child nutritional outcomes. Columns (2) and (3) of Table 2 demonstrate that mother's education represents more than simply an income effect. In particular, the estimates for post-primary education are robust when we control for income.

Table **2** also provides an estimate of the difference between working and non-working mothers. Working outside the home affects child height negatively, but the estimate is not strongly significant. It is possible that working outside the home is associated with factors that are not measured explicitly in this survey, but influence child nutritional status.

Household Characteristics:

Table **2** shows that (log) annual household expenditure (a proxy for household income) has a strong positive effect on the nutritional status of the child. Assuming household expenditure is exogenous, the result indicates that for every additional unit in the log of household expenditure there is a 0.311 gain in standardized height for the child. The 2SLS estimate in column 3 also confirms the importance of household expenditure in improving child nutritional status. The magnitude of the estimate does not change appreciably, but the standard error is 2.4 times as large as that of the OLS estimate.

Location of residence of the household, that is urban vs. rural, is important and a significant determinant of child nutritional status. Controlling for other factors, the nutritional status of children living in rural areas is worse off compared to that of children living in urban areas. In particular, a child living in rural areas is around 0.6 standardized height lower than her counterpart in urban areas.

Finally, the overidentification test suggests that the instrumental variables are uncorrelated with the residuals (p-value = 0.880). Thus, the test indicates the model has no identification problem. In addition, the test for the validity of instruments (F-statistics on the excluded instruments in the first stage regressions) shows that the instrumental variables have strong explanatory power. It turns out that the F-test for excluded instruments for household expenditure is 77.5, whereas it is 75.1 for child illness. These values are strongly significant.

Table 2. Child height-for-age regressions – Base model

	OLS		2SLS[1]
	Model 1	Model 2	
Intercept	-1.795** (0.194)	-4.310** (0.581)	-4.311** (1.358)
Child characteristics			
Female child	0.091 (0.073)	0.092 (0.072)	0.088 (0.072)
Age of child in months	-0.050** (0.010)	-0.053** (0.010)	-0.054** (0.010)
Age of child squared (x 100)	0.075** (0.016)	0.079** (0.016)	0.080** (0.016)
Child ill during the preceding two weeks of the survey? [1]	-0.226** (0.083)	-0.230* (0.082)	-0.417* (0.205)
Parental Characteristics			
Mom completed primary or less[b]	0.255+ (0.143)	0.238+ (0.142)	0.228 (0.143)
Mom has post-primary education[b]	0.488** (0.172)	0.374* (0.173)	0.350* (0.183)
Mom working outside home [c]	-0.160 (0.113)	-0.197+ (0.113)	-0.198+ (0.114)
Female headed household	-0.188 (0.118)	-0.066 (0.120)	-0.059 (0.134)
Male household head completed primary or less[b]	0.155+ (0.092)	0.137 (0.091)	0.128 (0.092)
Male household head has post-primary education[b]	0.419** (0.157)	0.385* (0.156)	0.383* (0.157)

Table 2 (cont'd.): Child height-for-age regressions – Base model

	OLS		2SLS[1]
	Model 1	Model 2	
Household characteristics			
Log of annual household expenditure [1]	----	0.311** (0.068)	0.321* (0.166)
Living in rural areas	-0.597** (0.123)	-0.631** (0.122)	-0.636** (0.124)
R^2	0.08	0.11	0.11
Model F-statistic	19.84**	20.12**	18.33**
F-test for joint significance			
- Parental education	7.63**	5.41**	4.35**
F-test for excluded instruments			
- Household income - Child illness	--	--	77.53** 75.11**
Overidentification test	--	--	0.671 $\chi^2(3)$ p-value = 0.88

Level of significance: ** p < 0.01, * p < .05, + p < .10

Standard errors are in parentheses

[b] Reference category is no education [c] Reference category is a mother who is homemaker

---- Not included in the analysis -- Not applicable

[1] Endogenous variables 2SLS = Two-Stage Least Squares.

Instruments used are index of wealth, literacy (dummy), household size, and incidence of child illness in the community.

Number of children used in this analysis = 1952

The Role of Community Characteristics on Child Nutritional Outcomes

The provision of public services and amenities is particularly important in improving human well-being and the standard of living. The availability of physical infrastructure (roads, electricity, communication) and social infrastructure (schools, health clinics, and water systems) -- is closely linked to outcomes in social development. When facilities are not available people have to travel long distances -- often with difficulty because of inadequate transportation services- to go to school, to see a health worker, or to sell their produce. Inadequate road infrastructure in marginal areas constrains access to social services, markets and development opportunities, thus affecting income and health. Hence, measures of physical distance serve as a proxy for market access, access to public services, and biases in public investment priorities. In this section I examine the effect of distance to water facility, school facility, clinics, transportation facility, and population density on child nutritional status.

Table 3 provides the results from ordinary least squares (in column 1) and two-stage least squares estimations (columns 2 & 3) where the dependent variable is standardized height-for-age. The set of predictors consists of characteristics of the child (age, gender and health status), parental characteristics (educational attainment, work status), household characteristics (location of residence and expenditure) and community level variables (physical distance to services and population density). The ordinary least squares specification (Model 1) includes all the predictor variables assuming household expenditure and child illness are exogenous. The specifications in column 2 and 3 attempt to correct for endogeneity in household expenditure and child illness. In model 2, child characteristics and community level characteristics (distance to services and population density) are fitted using two-stages least squares. Finally, in model 3 child characteristics, parental characteristics and community level characteristics (distance to services and population density) are fitted using two-stage least squares.

The estimates from model 1 (OLS specification) and model 3 (comparable 2SLS specification) indicate that age of the child and child illness are significant predictors of height-for-age. Illness during the two months preceding the survey reduces standardized height by 0.25 standard deviations in the OLS estimate and by 0.39 standard deviations in the 2SLS). Mother's education has a significant impact on child height only if the mother has post-primary education, and this holds true for the male head of the household as well. All together parental education is significant predictor of child height. Another noteworthy finding is that income is positive and significant predictor of long term nutrition status of the child. Having more income improves the nutritional status of the child. Of the community level variables, average distance to the nearest primary school, average distance to the nearest transport facility and population density are significant determinants of child height-for-age.

In model 2, controlling for child characteristics and community variables only, age of the child, child illness, log of household expenditure and location of residence (living in rural areas), average distance to the nearest primary school, average distance to the nearest transport facility, and population density are significant determinants of child height-for-age.

The impact of population density on child height is negative and significant. Children living in areas with high population density are more susceptible to malnutrition. Increasing population density has often gone together with the intensification of agriculture and adoption of new technology (Boserup, 1965). The agricultural system in Ethiopia has changed very little, but population has grown at a fast rate over the last thirty years. Ethiopian farmers (85 per cent of the population lives in rural areas) are highly dependent on rain-fed agriculture. Moreover, the depletion and fragmentation of arable land have made farming less sustainable. Due to this and other natural causes, Ethiopia has either to import food or depend on food aid to cover the annual shortfall. On the other hand, greater population density leads to relatively higher incidence and prevalence of communicable disease. This may make improvement in nutritional status more difficult.

Distance to primary school affects child nutritional outcomes negatively. The estimate is significant, and for every kilometer distance further away from the household, height-for-age declines by about 0.02 units. This implies that the role of schools goes beyond the institution of learning. Apart from education, the presence of a primary school opens up the way for the establishment of other facilities, such as health clinics and telecommunication. The World Bank (1998) reports that only 38 per cent of the villages in Ethiopia have primary schools. On average each primary school serves three to four villages. Adjacent villages in Ethiopia are too far apart from each other, and each village covers an average of 45 square kilometer of land.

One other infrastructure variable that is weakly significant is distance to the nearest transportation facility. The results show that children residing in households far away from the nearest transportation facility are more likely to be stunted. The lack of physical infrastructure (roads, rail) tends to be associated with a lack of credit provision, information, and social services. Thus, measures of physical distance serve as a proxy for market access, access to public services, and biases in public investment priorities.

Finally, the test for the validity of instruments (F-statistics on the excluded instruments in the first stage regressions) shows that the instrumental variables have strong explanatory power. The overidentification test suggests that the instrumental variables are uncorrelated with the residuals.

Table 3. Child height-for-age regressions - the Extended model

	OLS	2SLS	
	Model 1	Model 2	Model 3
Intercept	-4.141** (0.585)	-4.301** (1.275)	-4.334** (1.347)
Child characteristics			
Female	0.095 (0.072)	0.094 (0.073)	0.086 (0.073)
Age of child in months	-0.054** (0.010)	-0.061** (0.010)	-0.058** (0.010)
Age of child squared (x 100)	0.080** (0.016)	0.091** (0.016)	0.086** (0.016)
Child ill during the preceding two weeks of the survey?[1]	-0.249** (0.082)	-0.412** (0.204)	-0.392+ (0.205)
Parental characteristics			
Mom completed primary school or less[b]	0.212 (0.142)	----	0.198 (0.143)
Mom has post-primary education[b]	0.332+ (0.173)	----	0.303+ (0.182)
Mom working outside home[c]	-0.153 (0.113)	----	-0.162 (0.114)
Female headed household	-0.089 (0.120)	----	-0.065 (0.133)
Male household head completed primary school or less[b]	0.102 (0.093)	----	0.095 (0.094)
Male household head has post-primary education[b]	0.318* (0.156)	----	0.309* (0.158)
Household characteristics			
Log of annual household Expenditure[1]	0.315** (0.068)	0.388** (0.152)	0.352* (0.164)
Living in rural areas	-0.676** (0.145)	-0.922** (0.112)	-0.686** (0.146)

Table 3. (cont'd): Child height-for-age regressions - the Extended model

	OLS	2SLS	
	Model 1	Model 2	Model 3
Community characteristics			
Average distance to the nearest health center	0.004 (0.006)	0.006 (0.006)	0.006 (0.006)
Average distance to the nearest water source	-0.001 (0.005)	-0.001 (0.005)	-0.001 (0.005)
Average distance to the nearest primary school	-0.022* (0.009)	-0.022* (0.010)	-0.020* (0.010)
Average distance to the nearest transportation facility	-0.004+ (0.002)	-0.005* (0.002)	-0.004+ (0.002)
Wereda population density (x100)	-0.0014** (0.0004)	0.0017** (0.0004)	-0.0015** (0.0004)
Adjusted R^2	0.11	0.11	0.12
Model F	15.26**	18.61**	13.91**
F-test for joint significance			
- Parental education	3.77**	--	2.96*
- Community	3.85**	5.34**	3.99**
F-test for excluded instruments			
- Household income	--	85.26**	78.67**
- Child illness	--	75.56**	74.73**
Overidentification test	--	1.248 (p=0.741)	1.359 (p=0.714)

Level of significance: ** $p < 0.01$, * $p < .05$, + $p < .10$

Standard errors are in parentheses

[b] Reference category is no education [c] Reference category is a mother who is homemaker

---- Not included in the analysis -- Not applicable

[1] Endogenous variables 2SLS = Two-Stage Least Squares.

Instruments used are index of wealth, literacy (dummy), household size, and incidence of child illness in the community.

Number of children used in this analysis = 1917

Multilevel Analysis of Child Nutritional Status

In the past, community level factors were not usually measured in individual level survey data. Community context was often omitted in analyses of child malnutrition. However, now there are datasets and statistical techniques that allow us to measure community level variables as well as individual variables. Data from many Living Standard Measurement Surveys (LSMS) tend to have a hierarchical structure due to the sampling procedure used to collect the data. Households are clustered within a community (usually a village is used as the primary sampling unit), and families are clustered within households. For example, children of the same mother (or living in the same household) may have similar health outcomes (e.g., morbidity) because of shared feeding practices and sanitation and water facilities.

In this section I investigate the distribution of child nutritional status (stunting) across communities and the magnitude of intra-family correlation of height-for-age outcomes, before and after controlling for observed covariates using multilevel modeling. I examine the extent to which child nutritional status is homogenous within households and within communities. I discuss how the impact of education on child nutritional status is influenced once community level factors are taken into account. I also compare the results with those obtained from OLS and 2SLS specifications.

The 1992 children come from 1567 households. These households come from 269 kebeles/peasant associations. Each kebele (group) has 11 to 30 observations (households), and there are 1-4 children per household, of which about 26 per cent of the households have more than one child in the age range 3-59 months.

Table 4 presents estimates for four models. Model 1 is a null model fitting the mean height-for-age. This is the simplest model for it includes no fixed terms at any level except the overall intercept. The specification in model 2 includes child and parental characteristics fixed effects. This model does not control for income. In model 3, I control for child and parental characteristics, and income. The model helps to understand how income affects the estimates for parental education. The model assumes that income is exogenous. Finally, model 4 provides estimates for child, parental and community level factors. The models were fitted using PROC MIXED in SAS. This procedure uses Restricted Maximum Likelihood (REML) estimation method.

In model 2, the age and health status of the child are significant factors associated with standardized height-for-age. Mother's education, especially post-primary level of education, is a positive and significant determinant of child height. Education of the adult male household head is also positive and significant. The results are consistent with the findings in sections 5.2.1 and 5.2.2. In this model one result that appears to be different from the OLS and 2SLS specifications in sections 5.2.1 and 5.2.2 is the coefficient for female headship. The variable is a negative and significant determinant of child nutritional outcomes. Accordingly, children from female-headed households have lower nutritional status. Model 2 does not control for income, which means variables representing parental characteristics may not be independent of an income effect.

In model 3 we control for income (household expenditure is the proxy). Income has a strong positive relation with the standardized child height. After controlling for income, the effect of parental education on standardized height-for-age diminishes. In particular, mother's education is affected by the inclusion of income in the model. Similarly, female headship is no longer a significant determinant of child height.

The multilevel model allows for the decomposition of the variance into three variances, which shows the variability around the grand mean at the child, family and community levels. In Table 4 the variance component for each model shows how the residuals are distributed across communities, families and individual children. Large and significant variances of the community (u_i) and family (v_{ij}) random terms indicate the presence of heterogeneity in child nutritional status across groups, and greater correlation among observations belonging to the same group. In all the models (model 1 to model 4), hypothesis tests regarding the variance components of each hierarchy (child, family and community) indicate that the estimates are significantly different from 0. The estimates suggest that children in communities and families do differ in their average height-for-age z-score. Moreover there is more variation among children in communities within families.

The intra-class correlation measures how much of the observations within communities and within families are replications of each other. A zero correlation indicates that the observations are independent, in which case the classical regression model is appropriate. The total variance from model 1 (the specification with no covariates) is 2.885, of which the intra-community correlation accounts for 19 per cent of the variation in child height-for-age, while the intra-family correlation accounts for 38 per cent of the variation in the standardized child height. This result tells us that children within families are more similar in standardized height than children selected at random.

Comparison of the variance components between model 1 (the null model) and model 4 (the full model) which includes child, family, household and community covariates, indicates that about 41 per cent[9] of the overall variation in the standardized child height is accounted for by the covariates in the model.

In model 2, after controlling for child and parental characteristics, and location of residence the intra-family correlation accounts for 34 per cent, while the intra-community correlation accounts for 13 per cent of the variation. The correlations are still substantial. The intra-community and intra-family correlations do not change substantially in models 3 and 4 as well.

Estimates derived from multilevel models reveal much clustering of child height-for-age outcomes within families and communities. The models account for most of the variation in child growth patterns but explain only about a third of the overall intra-family variation. Table 4 suggests that membership in a particular family and a particular community is a major determinant of child nutritional outcomes.

[9] (0.560 – 0.331)/0.560

Table **4.** Multilevel analysis of child height-for-age

	Model 1	Model 2	Model 3	Model 4
Intercept	-2.733**	-1.753**	-5.051**	-4.256**
	(0.060)	(0.199)	(0.636)	(0.651)
Child characteristics				
Female child	----	0.086	0.087	0.080
		(0.070)	(0.069)	(0.070)
Age of child in months	----	-0.053**	-0.055**	-0.059**
		(0.009)	(0.009)	(0.010)
Age of child squared (x100)	----	0.082**	0.085**	0.091**
		(0.015)	(0.015)	(0.015)
Child ill during the preceding two weeks of the survey?	----	-0.282**	-0.281**	-0.293**
		(0.084)	(0.083)	(0.084)
Parental characteristics				
Mom completed primary or less[b]	----	0.234	0.222	0.209
		(0.148)	(0.147)	(0.147)
Mom has post-primary education[b]	----	0.394*	0.290^{+}	0.270
		(0.175)	(0.176)	(0.176)
Mom working outside home[c]	----	-0.065	-0.101	-0.084
		(0.117)	(0.117)	(0.117)
Female headed household	----	-0.234*	-0.111	-0.110
		(0.119)	(0.122)	(0.122)
Household head completed primary or less[b]	----	0.234	0.099	0.087
		(0.148)	(0.097)	(0.098)
Household head has post-primary education[b]	----	0.394*	0.342*	0.294+
		(0.175)	(0.162)	(0.164)
Household characteristics				
Log of annual household expenditure	----	----	0.327**	0.335**
			(0.075)	(0.076)
Living in rural areas	----	-0.616**	-0.641**	-0.702**
		(0.149)	(0.148)	(0.186)

Table 4. (cont'd): Multilevel analysis of child height-for-age

	Model 1	Model 2	Model 3	Model 4
Community characteristics				
Average distance to the nearest health center	----	----	----	0.006
				(0.009)
Average distance to the nearest water source	----	----	----	0.004
				(0.007)
Average distance to the nearest primary school	----	----	----	-0.021
				(0.014)
Average distance to the nearest all-weather road	----	----	----	-0.004
				(0.003)
Village (Wereda) population density (x100)	----	----	----	-0.001*
				(0.0005)
Variance components				
Intra-Community	0.560**	0.347**	0.339**	0.331**
	(0.086)	(0.065)	(0.064)	(0.064)
Intra-Family	0.535**	0.543**	0.526**	0.527**
	(0.111)	(0.108)	(0.107)	(0.108)
Residual	1.790**	1.710**	1.708**	1.700**
	(0.111)	(0.108)	(0.107)	(0.108)
Intra-class correlations (%)				
Intra-Community	19.41	13.35	13.19	12.93
Intra-Family	37.95	34.23	33.62	33.54

Level of significance: ** $p < 0.01$, * $p < .05$, + $p < .10$

Standard errors are in parentheses

[b] Reference category is no education [c] Reference category is a mother who is homemaker

---- Not included in the analysis -- Not applicable

Number of children used in this analysis = 1917

Key Findings

The main results of this study indicate that child age, child illness, parental education, household income, distance to primary school and population density are strong predictors of child nutritional status in Ethiopia. Nonetheless, the strong positive effect of mother's education on child height appears to be limited to post-primary level of education. Some studies have reported similar result for sub-Saharan Africa. For instance, Svedberg (1990) argues that a floor level of education is required to see positive effects on nutrition, and this may explain why in countries with low levels of education schooling has a limited impact on nutrition. The results from this study suggest that although the independent effect of maternal employment (working outside the home) is not statistically significant determinant, it is negatively related to child nutritional status. An exception worth mentioning is that in the base model maternal employment is weakly significant (at 10% level of significance).

This study uses household income (household consumption expenditure is used as proxy), both as observed variable and in instrumented form to purge measurement error and transitory fluctuations from the variable. The results from this study reveal significant association of child nutritional status and health to household income. Except for the illness outcome variable, income is a strong and significant determinant of child height-for-age. None of the models predict the presence of a gender difference with respect to child nutritional status. Most studies in sub-Saharan Africa have reported similar results.

Results in the base model (Table 2) show that working outside the home affects child height negatively, however the estimate is not strongly significant. Once community level factors are included (Table 3) working outside the home was not significant predictor of child nutritional status. Income (the proxy is household expenditure) is strong and significant determinant of child nutritional status.

Among community variables, the presence of primary school and population density are significant predictors of child height-for-age. Other studies found similar results, for instance, Al-Kabir (1984) found that the distance to a primary school emerged as one of the strongest determinant of child mortality among community-level correlates.

The results from multilevel analysis indicate that presence of unobserved heterogeneity across families and across communities with respect to child nutritional outcome. The intra-community correlation is high (ranges from 19.1 per cent in the null model to 13.4 per cent in the full model), showing that membership in a particular family and a particular community is a major determinant of child nutritional outcomes.

Overall the results in terms of the expected sign of the variables in the models from both the classical models (OLS and 2SLS) and the multilevel analysis are similar. Factors such as child age, gender and illness, mother's and adult male household head's education (in particular post-primary education), income, location of residence (living in rural area) and population density are important in explaining child nutritional status.