ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

DETERMINANTS OF THE NUTRITION AND HEALTH STATUS OF CHILDREN IN RURAL ETHIOPIA: A LONGITUDINAL ANALYSIS

By

Daniel Ayalew

A Thesis Submitted to the School of Graduate Studies of the Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Economics (Human Resource Economics)

July 2006

Addis Ababa University
School of Graduate Studies

Determinants of the Nutrition and Health Status of Children in Rural Ethiopia: A Longitudinal Analysis

By

Daniel Ayalew Mekonnen

Approved by the Board of Examiners:

Tassew Woldehanna ____________________
Advisor ____________________ Signature

Wassie Berhanu ____________________
Examiner (Internal) ____________________ Signature

Dr. Shail Singh ____________________
Examiner (External) ____________________ Signature

ACKNOWLEDGEMENTS

The assistance of many individuals and institutions in a number of ways has made this study possible and some of them deserve at least their names mentioned here. First of all, I would like to take this opportunity to thank Dr. Tassew Woldehanna for having me as his advisee and providing me with his invaluable comments and suggestions, the data and supplementary materials.

I also owe a great debt of gratitude to Dr. Abdulhamid Bedri for his unreserved help ever since I met him as his student and at all times of my study.

I would like to thank the African Economic Research Consortium for financing this thesis and the International Food Policy Research Institute for providing me with the cleaner version of the data.

My great thanks also goes to my family Melake-tsehay Haile mekonnen, Asresu, Sophi, Ato Mamo, Tiru, Ato Ephrem, Getch, Sammy, Ephrem, Kubi, and Simegne for all kind of support and love you have given me. You just made it all simple for me to achieving my goal and I wonder if I could ever repay you back. Once again, please accept my little thanks.

Last but not least, my special thanks goes to my darling, Rahel Deribe, for the love, encouragement and every support you have extended me. In fact you are the reason for me joining the graduate study and you take the credit for this achievement.

Table of contents

List of Tables **Page**

Abstract

This study tried to see the determinants of nutritional status of children using longitudinal data from fifteen villages of rural Ethiopia. An attempt was also made to see if there are any significant interactions between mother's education and community characteristics. By employing random effects procedure, both height-for-age and weight-for-height z-scores were regressed on various private and public determinants. The results show that age of the child, parental height and primary education, existence of permanent partner to the household head, household size and composition, and safe water source of the household are an important determinants of child nutritional outcomes. However, most of the interaction terms between mother's education and community variables (such as access to healthcare and the communities' safe source of water) failed to be significant implying partly the unimportance of these community variables and partly the low level of maternal education in the sampled households. But for the significant term in the WHZ regression (i.e the interaction between access to health care and mother's attainment of at least a year of primary education but not higher), one may argue that having at least a year of primary education is a substitute to access to health care.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

It is argued in the literature that health and nutrition are important as ends in themselves and often are emphasized as critical components of basic needs in developing countries. Due to this fact, economists have directed increasing attention towards exploring the determinant of and the impact of health and nutrition in the development process. The surveys by Behrman and Deolalikar (1988) and more recently by Strauss and Thomas (1995) provide the excellent works done by economists.

According to Behrman and Deolalikar (1988), both health and nutrition may be channels through which productivity and distributional goals of developing societies may be pursued effectively if, as is often hypothesized, the productivity of low income persons in work and human capital formation is positively affected by health and nutrition. Thus, a sensible developmental policy of any country must obviously aim at providing for a level of calorie intake that will permit the full productivity and work output from its labor force, and a level of growth and development for its children that represents the fullest expression of their genetic potential (Steckel, 2001).

Health (nutritional) status of children is used as an indicator of parental and societal investment in child quality and can be captured by various measurements. But most of them are problematic for two reasons: first, it is multidimensional; second, measurement error in health is likely to be related to income and labour market outcomes (Strauss and

Thomas, 1998). As a result, anthropometric measurements (age standardized weights and heights) are used as general indicators of short run and long run health/nutrition outcomes in most of the empirical literature (See for e.g. Behrman and Deolalikar, 1988; Senauer and Garcia, 1991; Strauss and Thomas, 1995; Glewwe, 1999; Schultz, 2002; Chaudhuri, 2003).

The nutritional and health status of children have been given greater concern recently-for poor health in childhood has so many implications. For example, Jensen and Richter (2001) argue that temporary shortfalls in health or nutrition can have lasting and irreversible effects when they occur during childhood a period of significant development. They say that health investments may be one channel through which poverty and disadvantage are transmitted across generations, as children of poor parents receive worse health investments, which in turn may reduce future earning capacity.

Similarly, Case et al. (2002) argue that in addition to the direct welfare and financial costs of illness, poor childhood health results in lower levels of human capital accumulation. Because, less healthy children spend more days in bed and miss more school. The finding is that having unhealthy condition reduces years of education, but that it does so less for children with higher incomes. In addition, they argue that the greater adverse effect of having a medical condition for a poorer child grows larger as the child becomes older implying poorer children arrive at the doorstep of adulthood with lower health status and with less education.

What can be seen from the above argument is that the positive association between health and income in adulthood has antecedents in childhood. This confirms the working of the intergenerational transmission of socio economic status through the impact of parents' income on children's health. Because, according to Case et al, wealthier parents may be better able to purchase medical care, nutritious foods, and safer environments for their children and, in these and many other ways, income may have a causal effect on children's health.

On the other hand, using the 1994 urban household data on Ethiopia, Abdulhamid (1996) could not establish a significant relationship between poverty (income) and nutritional status. Contrary to expectations, most of the hypothesized determinants of poverty fail to be significant contributors to the nutritional status of households covered in the study.

Although there is no consensus on the relationship between poverty (income) and nutritional status of children, malnutrition is a malicious problem of developing countries. Studies show that millions of lives are ruined by malnutrition every year. It destroys physical and mental capacity of children by inhibiting normal body growth starting with the formation of life and continuing over the entire life span of an individual. High vulnerability to diseases, lower cognitive ability and lack of physical and mental fitness due to improper growth of organs including brain are some consequences of malnutrition (WMS, 2004).

In general, these and other results from the literature show the importance of adequate health and nutrition to children and therefore understanding the determinants behind those outcomes entails for a further research.

1.2 Statement of the Problem

It is now widely acknowledged that higher investments in human capital (such as health and nutrition) of children may not only improve their current welfare but also enhance their opportunities for escaping from poverty as adults. Because, improved nutrition (health) improves the mental and physical capabilities of children and thereby their future earning capacity. In a wider context this may mean contributing to the potential of the economic growth and poverty reduction efforts of a given country like Ethiopia.

On the other hand, improved nutrition and health to children have long been recognized as fundamental human rights and are clearly indicated in key international conventions (see a selected collection of Major Human rights Instruments, 1998). For example, in one of the conventions that Ethiopia has ratified (Convention on the Rights of the Child, 1992), we find the following: "States parties recognize the right of the child to the enjoyment of the highest attainable standard of health..."... and shall take appropriate measures "to combat disease and malnutrition...through the provision of adequate nutritious foods and clean drinking water..." and, "health care"[1].

[1] The extract is taken from the book "Convention on the rights of a child", Article 24:1,2. Children, Youth and Family Welfare organization, January 1992, Addis Ababa

Moreover, as is stated in the National Nutrition Strategy document, the right to the determinants of adequate nutrition is also upheld in the constitution of Ethiopia, entrusting the government to take appropriate measures to ensure that these rights are adequately protected, especially among the most vulnerable. It is said that, therefore, in fulfilling its obligations, the government has recently formulated the national nutrition strategy (FDRE, 2005).

In spite of all these, however, the nutritional and health status of children in Ethiopia are registered as one of among the worst in the world. For example, almost one in every ten babies born in Ethiopia (97 per 1000) does not survive to celebrate its first birthday, and one in every six children dies before its fifth birthday. As a result it is said it will be challenging to reach the child survival Millennium Development Goals (reducing child mortality by ⅔) with the current pace of mortality reduction (WB and MoH, 2005).

High malnutrition rates in Ethiopia pose a significant obstacle to achieving better child health outcomes. Prevalence of malnutrition measured by wasting (low weight-for-height), stunting (low height-for-age), and underweight (low weight-for-age) differs by age, gender and place of residence. Based on the 2004 Welfare Monitoring Survey (WMS), out of the total children aged 3 to 59 months, the prevalence of wasting, stunting and underweight at country level are reported as 8.3 percent, 46.9 percent and 37.1 percent respectively. In terms of gender, the survey reports that male children are more vulnerable to malnutrition than female children with respect to the three indices considered.

Regional and urban/rural differences in child malnutrition are prominent in Ethiopia. The WMS (2004) report shows that rural children are reported as more prone to all kind of malnutrition. Regionally, prevalence of underweight varies from as low as 12.7 percent for Addis Ababa to as high as 45.4 percent for Amhara region. The highest and the lowest stunting rates registered are in Amhara region (58.3 percent) and Addis Ababa (22.7 percent). Similarly, Afar region and Addis Ababa register the highest and the lowest wasting rates (16.2 percent and 5 percent respectively) in the country.

The figures given show the extent to how much of the country's potential work force is faced with growth retardation. This has a very serious implication. Goplan (2001), for example, argues that a country or community in which large segments of the population suffer from growth retardation is one in which the quality and caliber of human resources is eroded and of substandard quality resulting in a poverty trap. Goplan (2001) writes:

> *A community in which a considerable part of the population is stunted is usually a community with high infant and child mortality, high levels of morbidity in children, and a high rate of drop-outs from schools. This is also a community in which children have lost valuable time for learning skills, mothers have lost considerable part of their daily wages, and health services are so overburdened with curative work that preventive and promotive health programmes are relegated to the background.*

On the other hand, even though the problem of child malnutrition in the country has been sufficiently documented, the reasons behind it are still poorly understood (Christiaensen and Alderman, 2001). There is also inconsistency across studies regarding the determinant factors behind child health/nutrition (Alemu et al., 2005a). For example, despite the fact that the literature commonly described the mother as the most important health worker and how well a mother performs this task may depend on her schooling (see Barrera, 1990), we find mixed results over the impact of maternal education on child health in the Ethiopian context. Moreover, most of the existing studies in Ethiopia do not show how maternal education interacts with other factors and policies in explaining child health.

To conclude, the causes of poor health-and-nutrition outcomes in childhood are said to be complex, multidimensional and interrelated leaving efforts to solve the problems with no or little success. For example, interventions targeted at a specific child can often either be appropriated by others or offset by corresponding reductions elsewhere (Appleton and Mackinnon, 1993). Therefore, to design a sensible policy intervention and look for its envisaged outcome, there is a need for careful examination of the determining factors behind the nutritional and health status of children.

1.3 Objectives of the Study

The main objective of this study is to investigate the determinants of the nutritional status of children (1 - 10 years of age) in rural Ethiopia.

Specifically, the objectives of the study are:

a) To identify private and public determinants of child nutrition outcomes;

b) To see the extent to which there are any significant interactions between household socio-economic characteristics (in particular mother's education) and community level variables, and whether interactions suggest gross substitution or complementarities;

c) To see the extent to which the influence of the determinants of child health/nutrition vary by age and gender of the child;

1.4 Significance of the Study

Most of the studies in the area of child health and nutrition in Ethiopia so far used cross-sectional data and among them there is a lack of agreement about the relative importance of factors too. However, in addition to this disagreement of results, the problems of child health/nutrition may change with age/time and, therefore, panel data estimation would be appropriate to better identify the determinant factors and give better result which couldn't have been found otherwise.

Existing studies also do not show how maternal education interacts with other factors (including access to safe water and toilet and healthcare facilities) in explaining child health. Hence, this paper is believed to fill this gap. Moreover, since the study covers 15 villages which are good representatives of non-pastoralist farming systems scattered over different agro-ecological set up of the country, it would suggest better policy implications for the country at large as the majority of the country's population belong to this kind of system.

On top of these, as this study is conducted just after the government has formulated a national nutrition strategy to improve the nutritional/health status of children in the country, it is believed that the result from this study will have paramount importance in guiding appropriate policy interventions.

1.5 Limitation of the Study

As this research is based on the secondary data and utilizes physical/body measurements and age of children to asses nutritional/health outcomes, a couple of problems might affect the analysis. For example, it is expected that the age data could have been misreported by parents for various reasons and this might be the reason for the biologically "implausible" z-scores values given.

Similarly, in addition to problems associated with data editing and entry, wrong data on height and weight could have been registered by the enumerator out of problems with measuring equipment. Also, children may not have been available for measurement in some of the survey rounds. Thus, these and other associated problems resulted in missing data which has led to dropping of these children from the analysis. This in turn resulted in a reduction in sample size and the possibility of introducing a selectivity bias into the estimates.

On the other hand, this research is entirely dependent upon quantitative data. As a result, it was difficult to give more sensible explanations for some less-intuitive results that came up, and this limited the analysis which could have been possible had there been qualitative information supplementing the research.

Therefore, these and other similar problems could have affected the quality of the data and hence the statistical results, which in turn might have led to wrong conclusions.

1.6 Organization of the Study

This study is presented in five chapters. The first chapter gives a general background of the study, statement of the problem, objective, its significance and limitation of the study. Chapter 2 deals with the review of the literature on health and nutrition in Ethiopia and the rest of the world, whereas chapter 3 specifies the analytical framework and the methodology of the study. Chapter 4 reports results from the descriptive and regression analysis and provides discussions. Finally, the last chapter presents summary and conclusions, and policy recommendations based on the findings of the study.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Concepts and Definitions

The words "nutrition" and "health" are used interchangeably here (as is used in the literature[2]) for both outcomes are too related that it is difficult to disentangle one from the other, and thus both may signify the same thing when children are considered.

Though the word "malnutrition" is associated with both undernutrition and overnutrition (Smith and Haddad, 2000), in this paper it is meant to refer to undernutrition.

The word "Anthropometric" is generally meant to represent the measure of people's growth indicators such as weights and heights (related to their age and sex). It is used for growth assessment and is a single measurement that best defines the health/nutritional status of a child (Blossner, et. al., 2005). According to this measure, the nutritional/health status of children is determined by comparing growth indicators with the distribution of the same indicators for "healthy" reference group, and identifying "extreme" or "abnormal" departures from this distribution. The international reference standard that is most commonly used (and recommended by the WHO) is that of the data on the weights and heights of a statistically valid population (US National Center for Health Statistics (NCHS)) of healthy infants and children in the US.

[2] See for e.g. Behrman and Deolalikar (1988), Strauss and Thomas (1998), Glewwe, (1999); Schultz (2002); Chaudhuri, (2003).

There are three ways of expressing these comparisons: Z-score (standard deviation (SD) score), percent of median, and percentile. But the interest here is on the SD score (Z-score) and it is defined as the difference between the value for an individual and the median value of the reference population for the same age, height, or weight divided by the standard deviation of the reference population[3]. Based on this comparison method, the three most commonly used anthropometric indicators for infants and children are[4]:

Weight-for-height (W/H): measures body weight relative to height and is normally used as an indicator of current nutritional status. Extreme cases of low W/H (Z-score below -2 SD) are commonly termed as "wasting".

Height-for-age (H/A): reflects cumulative linear growth. Extreme case of low H/A (Z-score below -2 SD) is referred to as "stunting."

Weight-for-age (W/A): reflects body mass relative to age. The severe case of low W/A (Z-Score below -2SD) is commonly referred as "underweight"

Depending on the value of the Z-scores of the above indicators, the degree of malnutrition could be categorized as; low (normal), medium (mild), high (moderate) and, very high (severe).

2.2 Theoretical Literature

2.2.1 Conceptual Framework

As stated in Behrman and Deolalikar (1988), a theoretical framework for the determinants of health and nutrition is essential in order to analyze these variables in an organized manner and to be able to interpret empirical studies. Therefore, the conceptual

[3,4]See Qualitative Techniques for Health Equity Analysis-Technical Note #2 (www.google.com), and Blossner and de Onis (2005).

framework guiding the empirical analysis for this study is based on the United Nations Children's Fund's framework for the causes of child malnutrition (UNICEF 1990, 1998) and the subsequent extended model of care as presented in Engel, Menon, and Haddad (1999), and cited in Smith and Haddad (2000) (see the figure in Smith and Haddad, 2000). It presents a useful generalized understanding of how child's nutritional status and/or health are the outcomes of a multisectoral development problem that can be most effectively analyzed in terms of immediate (the most proximate level), underlying, and basic (the deepest level) causes.

It is shown in the framework that a child's nutritional status is the result of the interactions between the child's dietary intake and the child's health status, at the immediate level. Smith and Haddad (2000) argue that a child with inadequate dietary intake is more susceptible to disease and, disease in turn depresses appetite, inhibits the absorption of nutrients in food, and competes for a child's energy. Thus, dietary intake must be adequate in quantity and in quality, and nutrients must be consumed in appropriate combinations for the human body to be able to absorb them.

On the other hand, the immediate determinants themselves are stated to be influenced by three underlying determinants manifesting themselves at the household level. Thus, according to Behrman and Deolalikar (1988), since the proximate determinants of a child's health and nutrition usually are decisions made by the household in which the child lives-given assets, prices, and community endowments, a natural starting point is the determination of child's health and nutrition at the household level. The underlying determinants stated in the framework are food security, adequate care for mothers and children, and a proper health environment and services.

In the conceptual framework, the degree to which the three underlying determinants are expressed, positively or negatively, is a question of available resources. Food security, for instance, is achieved when the household have the resources available for food production, food purchase or if the household gains in-kind transfer of food from outside sources. Similarly, care, which is quoted in Smith and Haddad (2000) as the provision in households and communities of "time, attention, and support to meet the physical, mental, and social needs of the growing child and other household members", is determined by the caregiver's control of economic resources, autonomy in decision making, and physical and mental status. All of these resources for care are influenced by the caregiver's status relative to other household members. A final resource for care is the caregiver's knowledge and beliefs.

The third underlying determinants of child nutritional status, health environment and services, rests on the availability of safe water, sanitation, health care, and environmental safety, including shelter.

It is indicated that a key factor affecting all underlying determinants is poverty. Smith and Haddad (2000) made it clear that the effects of poverty on child malnutrition are pervasive. It is argued that poor households and individuals are unable to achieve food security, have inadequate resources for care, and are not able to make use of (or contribute to the creation of) resources for health on a sustainable basis.

Finally, the framework shows that the underlying determinants of child nutrition (and poverty) are, in turn, influenced by basic determinants, which include the potential resources available to a country or community, limited by the natural environment, access to technology, and the quality of human resources. Political, economic, cultural, and social factors affect the utilization of these potential resources and how they are translated into resources for food security, care, and health environments and services (Smith and Haddad, 2000).

2.3 Empirical Literature

2.3.1 Regional Levels and Trends of Malnutrition in Developing Countries: Evidence from Cross-Country Data, 1970-95

Malnutrition is a malicious problem of developing countries and yet it is preventable if dealt with on time. The alarming situation in the prevalence of child malnutrition in developing countries indisputably raises the need for monitoring the extent and distribution of malnutrition so as to help the most affected by setting priorities, for instance, of food-targeting policies to the severely malnourished groups. In their effort to do this, Smith and Haddad (2000) summarized the regional levels and trends of child malnutrition prevalences of 63 developing countries for the period of 1970s-1990s. They categorized these countries into five regions. Based on their order of underweight prevalence for the given period, the regions are presented as follows: South Asia (61 percent), Sub-Saharan Africa (31 percent), East Asia (23 percent), Latin America and the Caribbean (12 percent) and, Near East and North Africa (11 percent).

The authors reported that except for Sub-Saharan Africa, there was some reduction in the level of malnutrition during the given period. South Asia and East Asia were the two regions whose malnutrition rate declined the most (i.e. from 69.1percent in 1970s to 55.7 percent in 1990s for South Asia; and from 45 percent in 1970s to 19.4 percent in 1990s for East Asia). On contrary, the levels of malnutrition for Sub-Saharan Africa have increased from 27.2 percent in 1970s to 33.7 percent in 1990s (Smith and Haddad, 2000).

Evidence from Ethiopia

The prevalence of malnutrition in Ethiopia has been and still is very high for so many years. As part of welfare monitoring survey, the central statistical authority of Ethiopia is permanently providing data on nutritional status of children every two years since 1996. According to WMS (2004) report, about 10.4 million children (constituting 5.1 million female and 5.3 male) between the ages of 3-59 months are considered for anthropometric measurements. The following table (see next page) provides the prevalence of Wasting, Stunting, and Underweight by gender and survey year for the country.

Table 1: profile of child malnutrition by gender, place of residence and survey year

	Underweight			*Wasting*			*Stunting*		
	Boys	**Girls**	**Both**	**Boys**	**Girls**	**Both**	**Boys**	**Girls**	**Both**
Country level									
1996	47.8	42.9	45.4	7.8	6.9	7.3	67.6	63.8	65.7
1998	46.5	43.2	44.9	10.7	8.4	9.6	55.9	53.5	54.7
2000	45.9	44.1	45.0	10.2	8.9	9.6	58.1	55.3	56.7
2004	37.6	36.7	37.1	8.6	7.9	8.3	48.3	45.5	46.9
Rural									
1996	49.3	44.0	46.7	8.0	7.2	7.6	68.4	64.8	66.6
1998	47.9	44.7	46.3	10.8	8.6	9.7	57.4	55.0	56.2
2000	47.6	45.6	46.7	10.4	9.2	9.8	59.4	56.3	57.9
2004	39.1	38.3	38.7	8.8	8.1	8.4	49.9	47.1	48.5
Urban									
1996	35.1	33.6	34.4	6.4	4.1	5.3	61.0	55.5	58.4
1998	32.8	28.7	30.7	9.8	7.2	8.5	42.1	38.9	40.5
2000	26.7	27.4	27.0	7.0	5.8	6.4	44.2	44.7	44.4
2004	21.5	20.0	20.8	6.9	6.0	6.5	31.1	27.9	29.6

Source: Welfare Monitoring Survey, Analytical Report, June 2004

As can be seen from Table 1, the results of successive surveys have indicated that over time there is a tremendous decrease in the rate of malnutrition measured by percentages of stunting and underweight through out the country. At country level, stunting exhibits a sharp decline over the given period; from 65.7 percent in 1996 to 46.9 percent in 2004 while the level of underweight over the period (1996 to 2000) is shown to be relatively stable. Yet, there is a sharp decline in the level of underweight from year 2000 to 2004 which is also evidenced by the prevalence rate of both stunting and wasting. Nevertheless, the prevalence of wasting has slightly risen from 1996 (7.3 percent) to 1998 and 2000 (9.6 percent) for both male and female children, though this figure has come down to 8.3 percent in year 2004.

Although table 1 indicates child malnutrition to be declining over time in both urban and rural areas, the prevalence of malnutrition is higher in rural areas implying that rural children are more prone to all kinds of malnutrition. Similarly, in terms of gender, boys are indicated to be more vulnerable to malnutrition than girls with respect to the three indices over the given period (WMS, 2004).

2.3.2 Determinants of Child Health/nutrition

Various studies in different/same countries may find different results over the importance of the determinant factors behind children's nutrition outcomes. Estimates may differ depending on various factors including the nature of the data and estimating methodology. As is shown in the theoretical framework, the determinants of child health/nutrition can be grouped into three categories namely child characteristics, household characteristics and community characteristics.

Child characteristics may include dummies for age, gender, birth interval, birth order of the child etc. Parent and household characteristics may include parental schooling, age, health and nutritional status; household size and composition, household economic welfare, social capital etc. Access to services including sanitation facilities, clean water and healthcare facilities at community as well as at household level is important for their direct and spill over effects on child health/nutrition. Therefore, the following two sections review the empirical literature on Ethiopia and the rest of the world based on these three categories.

2.3.2.1 Rest of the World

Child characteristics

Most studies report that child characteristics such as age, sex and birth order are important determinants. Some of them found that child height for age and weight-for-height vary substantially with age whereby malnutrition rises with age in the first two years of life but then levels off (see Strauss, 1990; Glewwe, 1999; Dercon and Hoddinott, 2003). A relatively different result is reported by Alderman (1990) and Kovested et al. (2002) where they found height-for-age, the cumulative measure of health or malnutrition declines until the child is above age four.

The above studies did not find strong evidence of gender discriminations against females. In fact if any thing Sahn and Stifel (2002), Barrera (1990), Senaur and Garcia (1991) found girls achieving better outcomes than boys, controlling for other covariates in the model.

Using data which came from four separate household surveys carried out in three rural provinces of the Philippines in 1983-84 over 800 households, Senauer and Garcia (1991) utilized Weighted Least Square and Fixed Effects models to see the determinants of nutritional and health status of children. In this study, higher birth order children were found to be suffering in terms of the long run health status (height-for-age). The authors argued that this could be presumably due to the increased burden on family resources.

Parental and household characteristics

Parental and household characteristics such as parental age, education level, health knowledge, height, household size, household resources etc are all important in child health outcomes. However, the most controversial result comes from parental education. Most of the studies reported maternal education to have a positive and statistically significant coefficient (see Barrera, 1990; Thomas et al. (1990)a,; Thomas et al. (1990)b; Barrera, 1991; Thomas, 1994; Senauer and Garcia, 1991; Chaudhuri, 2003; Escobal, 2005). For example, using data from five regions of Brazil, Thomas et al. (1990)a found that in urban north east, relative to having an illiterate mother, a child with a literate mother will be about 1.6% taller, 2.5% taller if she has completed elementary school and 4.2% taller if she has completed secondary school.

However, some studies like Strauss (1990) reported that the effects of both mother's and father's education were non linear, and the impact was found negligible until the fourth year; and also maternal education was found to have a greater effect than father's. Also Attanasio et al. (2005) found that head of the household's education do not seem to influence child height, especially if one controls for the endogeneity of household consumption

On the other hand, Alderman (1990) studied the nutritional status of preschool children and its determinants in Ghana for the period 1987-1988. This study used cluster fixed effects estimation methods to find height-for-age and weight-for-height outcomes. This study shows the education of the father to have a negative influence while the positive influence of the mother was not significant suggesting the low quality of education for women.

Although maternal education is found to be important in many of child health and nutrition studies, its significance diminishes or disappears when health knowledge is introduced as an explanatory variable (see Kovested et al., 2002; and Glewwe, 1999). For example, Glewwe (1999) tried to assess the role played by mother's education on children's health and nutrition using data on 1495 children age 5 or younger from 2171 households from all areas of Morocco. Utilizing OLS and community fixed effects models, the author found that when health knowledge was specified as endogenous, mother's schooling become completely insignificant and even slightly negative. Glewwe argues that it seems health knowledge is the main pathway by which mother's education leads to healthier children.

In terms of intra-household allocations, Sahn and Stifel (2002) and Thomas (1994) found mother's education to matter more for the height-for-age of girls than of boys while the opposite is true for father's education in which we find a greater positive effect on the height of boys than of girls. Moreover, in terms of age structure, Barrera (1990) and Thomas et al. (1990)a found that the effect of mother's education tends to be larger for children younger than 24 months of age.

Other studies tried to see the role of maternal schooling and its interaction with public health programs in child health production (see Barrera, 1990; Barrera, 1991; Thomas et al. 1990b; Chaudhuri, 2003; Escobal et al., 2005). Barrera (1990), for example, found the coefficient of the interaction between maternal schooling and the community cleanliness (proxied by absence of visible excreta in the community) to be negative suggesting that maternal education is a substitute for community cleanliness. Barrera argues that this is because better educated mothers have more information and skills which put them in a better position to protect their children against an unhealthy environment.

Similarly, from the same study, consistent with expectations, the interaction between mother's schooling and availability of safe water and mothers schooling and access to health care suggest substitution effects i.e. children of less educated mothers benefit more from the availability of a safe water source and access to health care.

In addition, interaction between mother's education and toilet connections is found to be positive and statistically significant suggesting complementarity between the two. This means that children of more educated mothers derive greater health benefits from the availability of toilets and that this public health program functions primarily as a subsidy to health inputs.

As mother's height is assumed to possess genetic and human capital investments, Strauss (1990) found that it had an important impact on child height but its effect on weight-for-height was insignificant. By the same token Barrera (1990), Alderman (1990) Thomas et al. (1990)a, and Attanasio et al. (2005) underscored the importance of both parents height though the influence of the mother's is reported to be higher and robust in various forms of regressions.

Household resources such as income are believed to be one of the important factors in the production of child health and nutrition. Nevertheless, there is lack of consistency across studies over the significance of these variables. For example, using data from the 1986 Brazilian Demographic and Health Survey, Thomas et al. (1990)b found total income to have a positive and significant effect on child height in both urban and rural sectors and the effect is much larger in magnitude in the rural sector.

On the contrary, using data from ENDEF large scale household survey of four regions of Brazil, Thomas et al. (1990)b attempted to estimate the impact of household characteristics on child height and survival. Applying the quasi-maximum likelihood estimation techniques for the binomial model and instrumenting income by logarithm of household expenditure and including unearned income, its square and a set of month dummies, income appears to have no effect on child height in all four of the regions. However, including non-mother earnings (its square and an interaction with unearned income) to the instrument set, the estimated income effects rise and become significantly positive in every region.

Consistently, as food availability is being one of household resources, both Alderman (1990) and Maxwell et al. (2000) did not found it to be a significant determinant; rather care and health were found to be important inputs. Moreover, Maxwell et al. (2000) didn't find higher incomes leading to significantly improved care practices and behaviors. Rather they found female education as a substitute for income.

Household size is also important in the analysis of child nutritional status for it has direct implications on household resources. Senauer and Garcia (1991) for example found it to have a significant positive impact on height of children. The authors argue that this could be because household full income is a function of wage rates and the number of economically active family members, and thus this variable may be reflecting a full income effect.

On the other hand, as household size gets larger there is a big chance of having economically inactive members in the household and this leads to an adverse impact on the available resources and thereby on child nutrition outcomes. For example, according to Alderman (1990) in Ghana, those children in households with a full sibling less than 2 years of age were found to be significantly shorter than cohorts without such a sibling implying the influence of prenatal conditions or competition for resources.

Community characteristics

Access to services including sanitation facilities, clean water and healthcare facilities at community as well as at household level is important for their direct and spill over effects on child health/nutrition.

Using Young Lives data obtained from a stratified nationwide sample of Peruvian 1,980 children aged between 6 and 18 months, Escobal et al. (2005) tried to explore the interaction of public assets, private assets and community characteristics and its effect on early childhood height-for-age. The finding is that service availability (electricity, piped water and sewerage) at the household level significantly affects height-for-age where mothers are less educated but not for more educated mothers. The same is true for access to a paved or engineered road. In contrast, public and health service supply in the community is found to have an impact on height-for-age only among children living in households with more educated mothers.

Similarly, the study shows that children living in areas that have sewerage facilities but do not have these facilities in their households are, on average, worse off than other children, even compared to those living in communities without sewerage facilities. Nonetheless, children living in communities without this facility also show lower height-for-age than those living in households with sewerage systems.

However, the impact of health services availability is no longer evident once other factors are taken in to account. The impact of public services (in this case sewerage facility) is larger in those households where less educated mothers live. In other words, education may be working as a substitute in more educated households (Escobal et al., 2005). We can also see a similar finding in Thomas et al., (1990)b where education and health services are found to be substitutes. On the contrary, these findings are the direct opposite of Barrera's (1990), as discussed in the previous section.

Barrera (1990) found that the availability of a safe source of water is a positive and statistically significant determinant of health for the 0-2 year olds of Philippines' children. However, in this study the coefficients for the travel time to the least-cost child outpatient facility do not exhibit the expected negative sign (except for the 7-10 year olds) and are not statistically significant (except for the 0-2 year olds).

Attanasio et al. (2005) tried to understand the determinants of child health in Colombia particularly focusing on the influence of household consumption and public infrastructure. The paper estimated four sets of regressions using OLS and 2SLS with and without municipality fixed effects and instrumental variables. The finding is that having a hospital improves children height and this is robust for OLS and IV specifications. However, consistent with Escobal et al. (2005) the coverage of the piped water network positively influences child health if the parents have some education.

2.3.2.2 The case of Ethiopia

Child specific characteristics

Age

Studies show that while the main causes of malnutrition appear to change with age of children, in most cases older children are found to be associated with increased malnutrition. For example, a country status report on health and poverty by WB and MOH (2005) show that older children were found having a higher likelihood of being underweight and stunted relative to children who are less than a year old. To sum, the probability of a child being underweight or stunted increases significantly as the child gets older (see Woldemariam & Timotiwos, 2002; Alemu et al.,2005a; Silva, 2005).

On the contrary, however, Christiaensen and Alderman's (2001) study found that a child's standardized height deteriorates up to the age of three, and slightly improves afterwards. Also, using Young Lives sample of eight-year-old children Alemu et al. (2005)b found that older children have higher weight-for-height with the rate of increase decreasing as children grow older.

Gender

At the country level, all the four welfare monitoring surveys from 1996-2004 have revealed that boys are indicated to be more vulnerable to malnutrition than girls with respect to the three indices (wasting, stunting, and underweight). Similar results are also reported from some case studies and official surveys (Sentayehu, 1994; Christiaensen and Alderman, 2001; Bilisuma 2004; Alemu et al. 2005a; Alemu et al. 2005b). Various reasons behind this gender differential are given in the literature. Alemu et al. (2005)a, for example, argue that this could be due to genetic differences between male and female children and, due to girls' greater access to food through their gender-ascribed role in contributing to food preparation.

However, using the 2000 Ethiopia Demographic and Health Survey data, Silva (2005) did not find the coefficient on the child's gender to be significant in any of the regressions, suggesting there is no gender bias affecting the nutritional status of children in Ethiopia. Similarly, unlike the OLS result, Bilisuma (2004) could not find sex of a child to have a significant impact on the probability of being stunted.

Finally, considering age and gender together, a relatively different result was reported by Abay Asfaw (?). Using the data collected from four regions of rural Ethiopia, he studies how poverty affects the health status and the health care demand behavior of households. The finding is that instead of gender and age, relation to the head of the household is an important factor that affects the health status, demand for medical care, and provider choice of households. Immediate family members are more likely to report illness, to get treatment, and more likely to visit modern health care providers especially private clinics than other family members.

Birth order and birth interval of the child

In combination with other factors, high birth order and low birth intervals are reported to have their share in poor childhood health/nutrition outcomes. According to the draft report on the health sector MDGs needs assessment, FDRE (2004), and Woldemariam & Timotiows (2002), high birth order and close spacing imply uninterrupted pregnancy and breast feeding and, this depletes women biologically and drains their nutritional resources. These lead to low birth weight which is a key factor in both infant and under five mortalities, death being more prevalent among smaller children. Close spacing may also have a health effect on the previous child, who may be prematurely weaned if the mother becomes pregnant again too early.

Using Young Lives children between the age of 6 and 18 months, Alemu et al. (2005)a, however, did not find birth order to be significantly associated with any of the three indicators considered (wasting, stunting, and underweight) for the whole sample.

However, the results stratified by location show that it is associated with wasting and underweight for urban children, while the likelihood of being wasted decreases with higher birth order in rural areas.

On the other hand, unlike expectations, based on the National Rural Nutrition Survey of 1992 on Sidamo, Sentayehu (1994) found positive sign of birth order on height-for-age and weight-for-age equation. The sign is unexpected because high birth order is expected to adversely affect the quantity and quality of resources that could be allocated to the children in the household.

Parent and household specific characteristics

This set of variables may include parental schooling, age, health and nutritional status; household size and composition, household economic welfare, social capital etc.

Parental characteristics

Parental education in general is expected to improve the health/nutrition status of children for a number of reasons. For example, it is argued that higher level of education is associated with higher job opportunity and thereby higher income availability to the household, more efficient management of limited household resources, greater utilization of available health care services, better health promoting behaviors, lower fertility and more child-centered caring practices. Nevertheless, findings show that the impact and direction of parental schooling on the determination of health/nutritional status of children in Ethiopia is inconclusive.

Using household data from three consecutive welfare monitoring surveys of Ethiopia over the period 1996-1998, Christiaensen and Alderman (2001) found that both female and male adult (parental) education have a large positive and statistically significant effect on the child's nutritional status, and the effect of female education is about twice as large as that of male education. This study also shows that maternal nutritional knowledge, proxied by the community's diagnostic capability of growth faltering, as key determinants of chronic child malnutrition in Ethiopia.

Other studies also report similar results from female's education (SCUK, 2002; Woldemariam & Timotiows, 2002; Alemu et al., 2005b; Silva, 2005). For example, using *woreda* level data on children under age of 24 months, SC-UK (2002) confirmed that children whose mothers attended school were less likely to be malnourished than the children of uneducated mothers.

Nevertheless, there are some studies which could not find a significant relationship between female's education and child nutritional status, though having the expected positive sign (e.g. Sentayehu, 1994). Various reasons could be attached to this result. According to SCUK (2002), for instance, this could be because, although educating mothers (and other care givers) better will undoubtedly lead to an improvement in the way some young children are cared for, many mothers will never be able to act on their new knowledge because they are simply poor. This means that poverty could cause bottlenecks, not allowing other public policies to influence child health (Attansio et al., 2005).

By the same token, using the 2000 Ethiopia Demographic and Health Survey data, Silva (2005) examined the impact of access to basic environmental services, such as water and sanitation on children's nutritional status, while controlling for the effects of important determinants of nutritional status identified in the literature. She could not find the father's level of education to be significant in any of the equations. As a result, she argues the possibility that the indirect effect of his education is already picked up by other variables, such as household wealth.

On the contrary, few studies reported that there is a negative relationship between the education level of parents and child nutritional status (Abdulhamid, 1996; Alemu et al., 2005a). The two studies found a positive association between female education and child malnutrition for urban and rural areas, respectively. Abdulhamid argues that plausible explanation could be that mothers with more education have better chance of getting employment and thus have less time in the home to supervise the nutrition of their children. Nevertheless, after controlling for the variable determining the employment status of the mother, he did not find the result to change and the variable did not have as significant relationship with the dependent variable.

A "difficult" result to explain was also reported from Alemu et al.(2005)b, whereby the presence of better-educated males in the household was found to have a negative and significant association with children's nutritional status (as measured by weight-for-height), for urban households. The authors hypothesized that children of more educated male members of the household are eating "less traditional" food infavor of processed food items which may have a negative effect on weight-for-height. On the contrary, from same sample area but considering children between the age of 6 and 18 months, Alemu et al.(2005)a found that households with better educated male members had a lower incidence of stunting.

Similarly, based on the 1999/00 WMS data on urban Ethiopia, Bilisuma (2004) estimated the determinants of child stunting using OLS and Probit models. Unlike the OLS estimates, the probit result shows that primary and university level of education of head of the household do have a significant positive impact on the probability of children being stunted. On the other hand, Bilsuma found that having a secondary level of education decreases the chance of a child being stunted and it was significant.

Parental (in particular mother's) age, health and nutritional status etc also are found to be important in the child health/nutrition outcomes. FDRE (2004) reports that the nutritional status of women is a major problem in the country that contributes to the high level of child malnutrition through intergenerational relationships, as discussed earlier. As a result, to reduce maternal and child morbidity and mortality, the ministry of health is said to have developed a guideline for what essential nutrition actions should be taken, one of the focus of this guideline being improving women's nutrition (FDRE, 2004).

Empirically, Alemu et al.(2005)a found from the qualitative analysis that maternal health, both pre- and post-partum, is considered to be very important in decreasing the likelihood of child malnutrition. Bilisuma (2004) also found age and health status of the mother to be significant determinants of height-for-age of children, but with a negative sign. Similarly, Alemu et al. (2005)b found children of older mothers to be more wasted in rural areas.

Household size and composition

Just like the other variables discussed above, there is no consistency of the literature on the impact of household size and composition on children's nutritional status. For example, Christiaensen and Alderman (2001) found household size affecting children's standardized height positively, while Sentayehu (1994) found otherwise. The argument infavor of the former result is that this benefit could arise from scale economies in time for child care as well as expenditure and also alternatively from accumulated experience at raising children.

In terms of the age-sex composition of household members, unexpected result was found by Alemu et al. (2005)b i.e. while there is a negative association between WHZ and the number of female adults in both rural and urban areas, the number of girls in the household was found to have a significant negative association with WHZ only in rural areas. On the other hand, while Silva (2005) and Alemu et al. (2005)a reported that the number of children under 5 years of age was found to be associated with increased likelihood of a child being stunted in both rural and urban areas, Sintayehu (1994) found the opposite for stunting. Alemu et al. (2005)a also observed similar result for underweight in both urban and rural areas and wasting in rural areas.

Household economic welfare

This category may include the situation of household wealth/income, shocks, mother's employment status, household health and education etc., among others.

Most of the studies in Ethiopia including Christiaensen and Alderman (2001), SCUK (2002), Woldemariam & Timotewos (2002), Bilisuma (2004),Alemu et al. (2005)b, Abay Asfaw (?), and Silva (2005) found household wealth/income as an important determinant of child nutritional/health status. Because, according to SCUK (2002), for example, better off households have better access to food and higher cash incomes than poor households, allowing them a better quality diet, better access to medical care and more money to spend on essential non-food items such as schooling, clothing and hygiene products. The studies mentioned above proxy wealth/income in either one or the other of the following variables: housing quality, cattle and land ownership/rental, households' access to food, cash income/expenditure etc.

On the contrary, however, Abdulhamid (1996) couldn't able to establish a significant relationship between poverty (income) and nutritional status of children in urban Ethiopia.

On the other hand, children from those households that experience shocks in terms of food availability and crop failure (drought) are found to be affected (Dercon and Hoddinott, 2003; Qusumbing, 2003; Yamano et al., 2003; Alemu et al., 2005a). The impacts of these shocks, however, differ in magnitude and direction and across different age and gender groups.

Dercon and Hoddinott (2003), for example, reviewed the evidence on the impact of large shocks, such as drought in 1994/95, on child and adult health, with particular emphasis on Zimbabwe and Ethiopia. While there appears to be no differential impact based on gender, younger preschoolers are found to be more adversely affected than older preschoolers.

Similarly, Yamano et al. (2003) found that the results on growth of children aged 6 to 24 months old are quite vulnerable to shocks than those of 25 to 60 months old, consistent with findings by Dercon and Hoddinott (2003). According to Yamano et al., inclusion of an interaction term between the ratio of damaged plot area and the gender of the child indicates that on average intra-household dynamics tend to favor girls in protecting children under two from income shocks. Furthermore, based on the empirical results Yamano et al. underscore that the average value of food aid received in a community has indeed a large positive effect on early child growth and it can indeed be used as an effective mechanism for protecting children from droughts and other income shocks.

Qusumbing (2003) examined the effects of food aid (free distribution-FD and Food-for-work-FFW) on child nutritional status using a panel data set from four rounds (between 1989 and 1997) of the Ethiopian Rural Household Surveys. The study classified children in to two age groups (0-5 years and 5-9 years) and in to high asset and low asset households. Regressions were run for these categories using dynamic panel data model.

The results show that FFW has a positive direct impact on the weight-for-height of younger children in low asset households, while FD has a similar positive impact on children of both age groups in high-asset households. In terms of gender, FFW receipts appear to be invested improving boys' nutritional status relative to girls in both low- and high-asset households, while girls' nutritional status improves with FD in high-asset households. This result is interpreted as if the increase in the households' unearned income from FD are invested in girls, while changes in the wage rate (earned income) and in women's outside options from FFW translate into better outcomes for boys.

An opposite to the above results is indicated in Alemu et al. (2005)a. It is reported that crop failure decreases the likelihood that the child will be stunted and that decreased food availability makes underweight and wasting of the child less likely in urban areas. While explaining, the authors pointed the possibility that households are cushioned against such shocks by different kinds of support, especially food aid and food-for-work programmes, that were not captured in the quantitative data but were discussed in the qualitative interviews.

Employment status of women (care giver) is found to be insignificant in some studies (see Alemu et al., 2005a; Bilisuma, 2004; Woldemariam & Timotewos, 2002). It is argued that this could be because the time allocated to earning income may be at the expense of time spent in feeding and caring for children, and thus the net effect of these two opposing effects makes employment status of the caregiver an insignificant variable.

Considering household headship, we find mixed results from the literature. Christiaensen and Alderman (2001), for instance, found that children's standardized height scores are not affected by the gender of the household head. On the other hand, Silva (2005) and Alemu et al. (2005)a reported that children of female-headed households are more wasted or underweight than those of male-headed ones. Alemu et al argue that this may be a reflection of factors such as limited availability of resources, income and household labour supply as well as the more limited time available for childcare.

Contrary to Alemu et al. (2005)a, however, Bilisuma noted that the chance of being stunted increases with children residing in male headed households compared to children in female headed households, though the variable sex of the household head was reported to be insignificant.

Social capital

Not many studies incorporated this form of capital as explanatory variables in their analysis. But Alemu et al. (2005)a and Alemu et al. (2005)b attempted to see the impact of this form of capital on child nutritional status, and contradictory results were found from the two studies. For example, Alemu et al. (2005)a found that absolute social capital, specifically membership in religious groups, increases the likelihood of stunting and underweight, while membership in funeral groups and women's groups were found to decrease the likelihood of a child being underweight and wasted in urban areas.

The negative influence of social capital on a child's nutritional status is because strongly religious parents put their faith in divine intervention rather than actively seeking to improve their caring practices and to access appropriate preventative and curative healthcare (Alemu et al., 2005).

On the other hand, the exact opposite result for the above finding is reported by Alemu et al (2005)b i.e. membership of religious groups had a significant positive association with weight-for-height of children, while membership of funeral groups had a significant negative association. The authors hypothesized that because members of religious groups such as *mahber* is partially determined by wealth status, the lower WHZ in this sub-group could be because of the greater level of resources available to group members. Conversely, they added that, in the case of funeral groups where non-attendance is penalized, the poor may be more likely to attend than the better-off for whom the penalties are not so significant. Moreover, because attendance at funerals is relatively time-consuming, it may have negative spill-over impact on the time available to parents to take care of their children (Alemu et al., 2005b).

Community specific characteristics/access to services

Water and sanitation

Silva (2005) examined the impact of access to basic environmental services, such as water and sanitation on children's nutritional status using probit analysis. While the coefficient for household's own access to water and sanitation in both the underweight and stunting equation are found to be negative, as expected, these coefficients are small and not significant. However, Silva noted that the results for the model including community environmental sample indicate the coefficients on the proportion of households with access to these services are highly significant in the underweight equations suggesting a spillover effect of other household's access to these services.

Nevertheless, Silva (2005) underscores that the external impact of access to water and sanitation facilities diminishes as the proportion of households in the community with access to water and sanitation increases. (The same is true for stunting). For example, when only one third of the population has access to water and sanitation services, the spillover effect is a decrease in the probability of being underweight of 37 and 44 percent, respectively. As the level of access to these services approaches fifty percent of households, the spillover impact is only about twice as large as the full sample results, and, etc. The finding in general is that as the level of access increases, the coefficient on these variables gets smaller and less significant.

Christiaensen and Alderman (2001) found possession of a tap and a flush toilet to have a positive effect on child height. However, access to other sources of drinking water which are generally deemed safe such as public taps and protected wells were not found to positively affect children's height. Similar results for underweight are also found by Woldemariam and Timotiwos, 2002; Alemu et al, 2005a.

Considering usage of a tap and a flush toilet, opposite results to Christiaensen and Alderman (2001) are reported in Alemu et al. (2005)a and Alemu et al (2005)b for the case of wasting in urban and rural areas, respectively. The reason suggested for the former is that it could be because of the unhealthy conditions of communal latrines in slum areas, while the rural case is assumed that people may still prefer to use the open field rather than unfamiliar pit latrines.

Access to healthcare

Many studies use the distance between the household's home and the nearest health facility to proxy for access to health care (see Christiaensen and Alderman, 2001; Alemu et al, 2005a, Alemu et al, 2005b). In addition to these studies, however, Collier et al., 2002 and Abay Asfaw (?) argue that usage of health services is sensitive not just to the distance to the nearest facility but also the quality (such as availability of material inputs and drugs, the number and qualification of staff, user fees, etc) of care provided.

As a result, studies report the impact of access to healthcare (proxied by the distance variable) on child health/nutrition to be either insignificant or give result in the counter-intuitive direction. For example, while Christiaensen and Alderman (2001) found no effect of the proximity of a health clinic on children's height, Alemu et al. (2005)a found that communities with better access to public health facilities were having a higher incidence of child wasting, stunting and underweight. Based on the qualitative research, Alemu et al. (2005)a noted that service quality, availability of drugs and affordability of health services have a greater impact on a child's nutritional status than distance to health services.

On the other hand, Alemu et al. (2005)b found distance to a public health clinic to have the expected negative and significant association with weight-for-height in rural areas, but the result is the opposite for urban areas, which is not expected.

Some studies use the number of prenatal care visits of a mother, as proxy for access to health services and they found it to be significant for children of lower age group i.e between 0 and 12 months old. For example, Woldemariam & Timotiwos (2002) found that the odds of stunting among children whose mothers have had no or (1-4) prenatal care visits were 1.5 times more compared with children whose mothers had five or more prenatal care visits. The authors argue that this is because as the contact of mothers with health services increases, their health seeking behavior improves and therefore they are likely to take appropriate actions to improve the health status of their children, which is also important component of child nutrition.

Using antenatal visits and child vaccinations against measles as proxies for health-seeking behavior, Alemu et al. (2005)a found children less likely to be wasted and underweight suggesting the importance of the use of health facilities/services in reducing the incidence of underweight and wasting. However, from the qualitative research the authors found that there is still both inadequate understanding of and/or trust in modern scientific healthcare in tackling malnutrition, which is in turn reflected in an unwillingness to replace reliance on spiritual healers with faith in modern medicine.

CHAPTER 3

METHODOLOGY OF THE STUDY

3.1 Source of Data

The data source of the research came from a longitudinal data set of Ethiopian Rural Household Surveys (ERHS) conducted by the Department of Economics of Addis Ababa University in collaboration with the Center for the Study of African Economies, University of Oxford and the International Food Policy Research Institute. The data were collected in six separate survey rounds from year 1994 to 2004.

The first four rounds of ERHS surveyed about 1477 households within 15 villages /communities across Ethiopia. The sampling frame to select the villages was strictly stratified in the main agro-ecological zones and sub-zones, and one to three villages per strata was selected. Communities were selected to account for the diversity in the farming systems in the country and hence farming systems were considered as a stratification basis[5]. Additional three villages were included in the fifth (1999) and sixth (2004) rounds, increasing the number of villages to 18 and, households to 1681[6]. Nevertheless, since anthropometric data was not collected in the fifth round and for it was not of good quality relatively for the sixth round, both are excluded in this study.

[5] Stephan Dercon and John Hoddinott (2004), The Ethiopian Rural Household Surveys: Introduction (memo). Data set CD-ROM

[6] Sisay Regasa (2004), The Effect of Income Variability on The Allocation of Child Time: Empirical Evidence from Rural Ethiopia, MSc Thesis, Addis Ababa.

Why Panel (Longitudinal) Data? Their Benefits and Limitations

Panel data set is one that follows a given sample of individuals over time and thus provides multiple observations on each individual in the sample. It has a number of advantages and limitations over simple cross section or time series data sets, and they are summarized below, as discussed in Baltagi (2001).

Advantages

- Allows one to control for individual heterogeneity. Panel data suggest that individuals, firms, states or countries are heterogeneous. This heterogeneity is not controlled for in time series or cross section studies and these studies run the risk of obtaining biased results.
- Gives more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency.
- Panel data are better able to study the dynamics of adjustment.
- Panel data are better able to identify and measure effects that are simply not detectable in pure cross section or time series data
- Panel data allows us to construct and test more complicated behavioral models than purely cross section or time series data
- Panel data are usually gathered on micro units like individuals, firms and households. Many variables can be more accurately measured at the micro level and biases resulting from aggregation over firms or individuals are eliminated.

Limitations

- Design and data collection problems e.g. problems of coverage (incomplete account of the population of interest), nonresponse (due to lack of cooperation of the respondent or because of interviewer error), recall (respondent not remembering correctly), frequency of interviewing, interview spacing, reference period, etc

- Distortions of measurement errors. Measurement errors may arise because of faulty responses due to unclear questions, memory errors, deliberate distortions of responses (e.g. prestige bias), inappropriate informants, misrecording of responses and interviewer effects
- Selectivity problems e.g. self selectivity, nonresponse and attrition. These may arise due to any one of the following: refusal to participate, nobody at home, untraced sample unit, or that respondents may die, or move, or find that the cost of responding is high
- Short time series dimension. Increasing the time span of the panel may increase the chances of attrition and increases computational difficulty.

It is unfortunate that most of the problems mentioned above are unavoidable and it is more real especially when one tries to use secondary data, as is the case in this study. However, for time invariant variables, some of the problems of missing data and measurement errors could be solved by replicating a given value if the variable was observed at least once in the panel. Avoiding extreme values is also advantageous.

3.2 Method of Analysis

This study utilizes descriptive statistics such as mean values and percentages, and regression analysis. Using anthropometric measurements to identify the level and classification of nutritional status of children, descriptive analysis is presented in the next chapter. Anthropometric measurements of health/nutritional status used are the child's z-scores of height-for-age (stunting) and weight-for-height (wasting), which are assumed to be indicators of the child's long-run and short run measures of nutritional/health outcomes, respectively.

To draw causal inferences from health/nutrition outcome model, the study estimates reduced form equations.

3.2.1 Analytical Framework

As is shown in Behrman and Deolalikar (1988), Thomas et al. (1990), and Res Networks (2003), the reduced-form equations for child health/nutrition can be derived from a theoretical model of a multimember household. Household analysis is important because households produce health outcomes based on the resources they have, their socio-economic characteristics, and their surrounding environment (WB & MOH, 2005).

In this approach, households may be assumed to choose child nutritional achievement H, leisure L, consumption of goods and services C, as if they are maximizing a household welfare function subject to child nutrition production function constraint and budget constraint. Preferences are assumed to be characterized by a long run utility function[7]

$$U = U(H, L, C; X_h) \qquad (1)$$

where X_h is a vector of household characteristics including the education level of the household head and his spouse. The *k*th child nutrition is generated by a production function

[7] To model child health by integrating a child health production function with a household level utility maximization process, this paper adopts the approach by Res Networks (2003).

$$H_k = F(Y, X_k, X_h, X_c, \mu), \quad (2)$$

where Y is a vector of health inputs such as nutrient intake, health care practices, time spent by parents taking care of children, and disease incidence; X_k is a vector of child characteristics such as age and gender; X_c is a vector of environmental factors that may have a direct impact on child health and μ is a vector summarizing all unobservable characteristics of the child, parents, household, and the community that affect child health. In addition, the choices of households are assumed to be limited by their full income constraint

$$P_cC + WL + P_yY = FI \quad (3)$$

Where P_c, W, P_y, are the prices of vectors of consumption goods, leisure and nutrition inputs including health, respectively, and FI is full income including the value of the time endowment of the household and non-labour income. In this framework, the reduced form function for the *k*th child nutrition outcome is

$$H_k = \Phi(X_k, X_h, X_c, FI, P_c, W, P_y, \mu) \quad (4)$$

Whereby the particular functional form of the function Φ (.) depends on the underlying functions characterizing household preferences and the nutrition production function.

3.2.2 Specification of the Empirical Model

In order to see the relation between child nutritional outcome and its determinants, the reduced form (4) can be estimated using regression frameworks such as :

$$H_{it} = X_{it}\beta + \mu_i + \varepsilon_{it}, \qquad (i = 1\ldots, n; t = 1\ldots,T) \quad (5)$$

where H denotes child nutritional achievement, the X represents explanatory variables including child characteristics (X_k), child's household level variables (X_h) and child's community variables (X_c); β represents the parameters to be estimated; ε_{it} is the usual disturbance term, $\varepsilon_{it} \sim N(0,\sigma^2_{\varepsilon})$, and μ_i denotes time invariant unobserved individual effect. The subscripts i and t represent the ith cross-sectional unit and the tth time period, respectively.

The basic time series cross-section model specified in equation (5) above can be estimated using either fixed effects, random effects or pooled regression approaches, among others. These approaches basically differ one from the other in their inclusion and treatment of μ_i. As a result, different estimates of β could be obtained from each approach using the same data.

For example, if individual effect is observed for all children (i.e. $\mu_i = 0$), then the entire model can be treated as an ordinary linear model and fit by ordinary least squares (OLS). In this case, OLS provides consistent and efficient estimates of common intercept and slope vector β (Greene, 2003).

However, if μ_i really exists and OLS is used on the pooled data, then biased and inconsistent estimates of β would be obtained as a consequence of an omitted variable, μ_i, especially if this variable is correlated with included explanatory variables (Greene, 2003). In addition, even if μ_i is not correlated with regressors, using OLS which does not take into account μ_i will cause a series problem of autocorrelation (Wooldrige, 2003).

Therefore, as discussed in section (3.1) above, the whole idea of using panel data is to control for unobserved individual heterogeneity and thus it is essential to follow estimating methods which control for this heterogeneity across children. The potential candidates chosen which fulfill this requirement are fixed effects (FE) and random effects

(RE). Recall that, the basic time series-cross section model assumed is specified in equation (5) above, following Smith and Haddad (2000)*.

The two alternative specifications of the model differ in their treatment of the individual effect, μ_i. As discussed in Hausman (1978), the so-called fixed effects model treats μ_i as a fixed but unknown constant differing across individuals. Therefore, least squares on equation (5) is appropriate and coefficients are obtained by transforming the variables into deviations from the individual averages:

$$(H_{it} - h_i) = (X_{it} - x_i)\beta + (\varepsilon_{it} - e_i), \quad (6)$$

where all lower case letters represent individual averages. Since μ_i terms are fixed, they drop out of the model due to transformation and, unbiased and consistent estimates are obtained. However, Jones (2000), Strauss and Thomas (1995) and Senaur and Garcia (1991) argue that, though fixed effects model serves as a remedy for the effects of all time-invariant omitted variables, it has the disadvantage of sweeping out time invariant variables of interest (such as sex) and, also the problem of measurement error is likely to be more serious due to differencing involved.

On the other hand, the alternative specification for the time series cross-section model, the random effects model, assumes that μ_i is drawn from an independent distribution, $\mu_i \sim N(0,\sigma^2_\mu)$, and is uncorrelated both with the ε_i and with X_{it} (Hausman, 1978). The specification then becomes:

$$H_{it} = X_{it}\beta + v_{it}, \quad (7)$$

where $v_{it} = \varepsilon_{it} + \mu_i$; and, $E(v_{it}) = 0$ for all t, $E(\varepsilon_{it}) = 0$ for all t, $E(\mu_i \varepsilon_{it}) = 0$ for all t, and $E(\varepsilon_{it} \varepsilon_{is}) = 0$ for all $t \neq s$.

Here, because μ_i is present in each time period, the composite error term, v_{it}, will be autocorrelated with the correlation coefficient given by:

$$\mathrm{Corr}(v_{it}, v_{is}) = \sigma^2_{\mu}/(\sigma^2_{\mu} + \sigma^2_{\varepsilon}), \text{ for all } t \neq s.$$

Thus, because of the serial correlation in the composite error term, v_{it}, OLS cannot be used for the usual least square standard errors ignore this correlation. Instead generalized least squares (GLS) estimator can be used since it eliminates the serial correlation by transforming the variables and then estimating the model by OLS (Wooldrige, 2003).

According to Wooldrige (2003), deriving the GLS transformation that eliminates serial correlation requires sophisticated matrix algebra; but the transformation is simple and defined as:

$$\lambda=1-[\sigma^2_{\varepsilon}/(\sigma^2_{\varepsilon}+T\sigma^2_{\mu})], \tag{8}$$

which is between zero and one. Then the random effects estimator uses the following equation:

$$(H_{it} - \lambda h_i) = (X_{it} - \lambda x_i)\beta + (v_{it} - \lambda v_i), \tag{9}$$

Now, the composite error term, $(v_{it} - \lambda v_i)$, is serially uncorrelated and applying OLS on equation (9) gives efficient estimates. In addition, the transformation in (9) allows for explanatory variables that are constant over time, and this is one advantage of RE over FE. This is possible because RE assumes that the unobserved effect is uncorrelated with all explanatory variables, whether the explanatory variables are fixed over time or not (Wooldrige, 2003).

Therefore, the choice of specification for this study will be determined by conducting two tests: Breusch and Pagan Lagrange multiplier (LM) and Hausman specification tests for the random effects model. LM is based on the OLS residuals [see the LM specification in Greene (2003)] and the hypothesis is that:

H_0: $\sigma^2_\varepsilon = 0$ [or $Corr(v_{it}, v_{is}) = 0$]

H_1: $\sigma^2_\varepsilon \neq 0$

Under H_0, LM is distributed as Chi-squared with one degree of freedom. If the test statistic exceeds the 95 percent critical value with one degree of freedom, it can be concluded that the classical regression model with a single constant term is inappropriate for these data and the decision will be to reject the null hypothesis in favor of the random effect model.

Now, even if the result is so, rejecting H_0 for the LM test does not guarantee the appropriateness of RE specification, however. Because, FE specification might also induce these same results (Greene, 2003). Thus, Hausman specification test will be conducted to choose RE against FE specifications. Under the RE specifications, the estimator of β, βhat_{GLS}, is asymptotically efficient estimator while the fixed effects estimator βhat_{FE} is unbiased and consistent but not efficient. This test is based on the assumption that whether μ_i can be regarded as independent of the X_{it}'s, i.e., whether $E(\mu_i \mid X_{it}) = 0$ (Hausman, 1978).

Thus, according to Hausman (1978), a natural test of the null hypothesis of independent μ_i's is to consider the difference between the two estimators, *qhat*. i.e. $qhat = \beta hat_{FE}$ -

βhat_{GLS}. In other words, the null hypothesis is that individual effects are uncorrelated with the other regressors.

Now, if the specification is correct, the two estimates should be near each other and plim of *qhat* should equal zero and so the null hypothesis cannot be rejected. This suggests that individual effects are uncorrelated with the other variables in the model and thus RE model is the better choice. Alternatively, if the value of Hausman's specification test statistic is found to be large relative to the critical value (i.e. $qhat \neq 0$), then this leads to the rejection of the null hypothesis. This means that FE rather than RE is appropriate for estimating the model (Hausman, 1978).

3.3 Description of Variables

In this study, child characteristics, parental and household characteristics are considered as private determinants while community variables are considered to be public determinants of child nutrition and health status.

Dependent variables:

Height-for-age and weight-for-height Z-scores are used as long run and short run measure of health outcomes, respectively. The Z-scores are standardized using age-sex specific median from the U.S. National Center for Health Statistics (NCHS) standards by employing ANTHRO software and they are directly taken from the data set.

Explanatory variables:

These sets of variables include child specific variables, parent and household specific variables, community specific variables, interaction terms and location dummies. The variables included in this study are selected based on the theoretical framework (refer to section 2.2.1), their importance in the child health and nutrition literature (refer to section 2.3.2) and their availability in the data set.

Child specific variables:

These include age and dummy for gender of a child.

Parent and household specific variables:

These include parental schooling, age of the mother, height of parents (to capture genetic effects), mother's health knowledge, health status of the mother, household size and composition (e.g. presence of other children and adults in the household categorized by age and sex). A dummy whether the mother participates in farm/off farm income earning activities is also included to see whether this affects the mother's time allocation of child caring. The logarithm of consumption expenditure per adult equivalent and the number of livestock holdings (in terms tropical livestock units) measure the long run resource availability of the household. To control for short run shocks such as illness, mother's health status for the last four weeks is considered.

Community variables:

These include the prevalent type of community and household sources of water, type of toilet, and, the average distance between the peasant association (PA) and the nearest health facility.

Interaction terms:

These include interactions between mother's education and the community variables to capture the substitutability or complementarity between provision of public services and parental education. Mother's education is used since the mother's time is likely to be intensively used (relatively to the father's) in child rearing.

Location dummies

As this study is based on the data collected from 6 regions (15 villages) of non-pastoralist farming systems scattered over different agro-ecological set up of the country, region dummies are included as explanatory variables to control for important variables which are not exclusively included in this study such as altitude, ethnicity, religion, culture, political and social factors, respective prices, etc.

Table 2 : Definition of variables

Dependent variables	
HAZ	Height-for-age z-score of children
WHZ	Weight-for-height z-score of children
Child characteristics	
sexCH	sex of child = 1 if male, 0 otherwise
ageCH	age of child in years
Parental and household characteristics	
Partner	marital status of household head = 1 if permanent partner exists, 0 otherwise
ageM	mother's age in years
heightM	mother's height in cm
heightD	father's height in cm
eduMP	mother's schooling = 1 if completed at least a year of primary education but no secondary education, 0 otherwise
eduMS	mother's schooling = 1 if completed at least a year of junior/secondary education or higher, 0 otherwise
eduFP	father's schooling = 1 if completed at least a year of primary education but no secondary education, 0 otherwise
eduFS	father's schooling = 1 if completed at least a year of junior/secondary education but no higher education, 0 otherwise
Hknowledge	knowledge of mother about child health and caring practices = 1 if she knows the main cause of diarrhea, 0 otherwise
workM	Mother involves in farm/off farm activities like pottery, weaver, food and drink preparation for sale etc = 1 if yes, 0 otherwise
healthM	health status of mother = 1 if mother suffered from any illness or injury in the last four weeks, 0 otherwise
childU5	number of children (under five years old)
childFO5	number of girls (between 5 and 15 years old)
childMO5	number of boys (between 5 and 15 years old)
AdultFO15	number of female adults over 15 years old
AdultMO15	number of male adults over 15 years old
HHsize	household size in number
lncon	Consumption expenditure per adult equivalent of the household (in natural logarithm)
TLU	number of livestock owned (in tropical livestock units)
Community variables	
waterCOM	Water source of the community = 1 if piped water/wells/boreholes, 0 otherwise
water	household's water source = 1 if piped water/wells/boreholes, 0 otherwise
toiletCOM	The most common type of toilet in the community (1 if pit latrine or flush toilet, 0 otherwise)
toilet	Type of toilet household uses =1 if pit latrine or flush toilet, 0 otherwise
HealthD	average distance from the PA to the nearest health facility (in Kms)
Interaction terms	Interaction between educational attainment of the mother and community variables
Location dummies	5 Region dummies (the left out region being region 1)

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter presents the results from both descriptive and regression analysis into two sections. While the first section deals with the descriptive analysis, the second one takes on the econometric results.

4.1 Description of the Data and Summary Statistics

As discussed in the previous chapter, the data source of this study is the first four rounds of the Ethiopian Rural Household Surveys (ERHS), a unique longitudinal data set of its kind[8]. Relevant variables that determine child's nutritional status were selected based on UNICEF's theoretical framework, their importance in the empirical literature and their availability in the data set.

Children in this study are defined as those individuals between the ages of one and ten years old. Under-one children were excluded from the analysis mainly because a number of factors could affect their health status and clinical data are not available as the surveys were not conducted for this particular purpose. Moreover, including under-ones may require to control for breastfeeding which may not be relevant for the majority of older children and hence could bias overall results.

A number of factors has contributed in determining the sample size. Initially, only those children whose height-for-age and weight-for-height z-scores available for all of the four

[8] Stephan Dercon and John Hoddinott (2004), The Ethiopian Rural Household Surveys: Introduction (memo). Data set CD-ROM. Note also that z-scores of children were directly taken from the data set.

rounds were selected, given the age limit. This brought about 662 children in 488 households giving the first stage sample. Having this sample, those children whose parental characteristics (including their height, age and education level) available for at least to one of the four rounds were selected (Note that, observing parental height and education level at least once is assumed to be sufficient enough to replicate for the other three rounds since they are not expected to change over time). This criteria decreased the numbers of children and households in the sample to 426 and 309, respectively[9].

In terms of gender, about 51.8 percent of the children are boys. Regionally, the distribution of children in decreasing order is that 126, 122, 65, 44, 36 and 33 belonging to region4 (Oromia), region3 (Amhara), region9 (North Omo zone of Southern Nations and Nationalities peoples'(SNNP)), region8(Gedeo zone of SNNP), region7(Gurage and Kembata zones of SNNP) and region1 (Tigray), respectively. Having said this, the basic descriptive results are discussed as follows (refer the results in the appendix table A1).

4.1.1 Anthropometric measures and child characteristics

Anthropometric measures

In the discussion of child health and nutrition using anthropometric outcomes, the first step is usually to look at the distribution of the z-scores and the overall prevalence from

---

[9] Selecting only those children who were observed for all four rounds may disregard the problem of attrition and thus it may introduce selection bias, especially if those who leave the sample are the ones with low nutritional status. Notwithstanding the possibility of attrition bias, however, a simple comparison over the mean of z-scores was conducted between panels of the sample and the original one. The results indicate that the mean of WHZ & HAZ for the original panel were -.2736263 & -2.172419, respectively while the corresponding values for the sample were -.2797183 & -2.282488. Thus, since the differences in the mean values given are not significant, this may not lead us to conclude selection bias could be a problem. (note that HAZ less than -6, WHZ less than -4, HAZ>6 and WHZ >6 were considered outlier. In addition, if together HAZ <-3.09 & WHZ>3.09 and vice versa, the given value is considered outlier. See Epi Info Software version 3.3, October5, 2004, help memo.)

different angles. As discussed in chapter 2, the cut-off point to define abnormal anthropometry with Z-scores is -2 standard deviations. A more general rule of thumb for evaluating anthropometric Z-scores has been developed by WHO[10], with a score of less than -3 indicating "severe" malnutrition, between -3 and -2.01 "moderate" malnutrition, -2 to -1.01 "mild" malnutrition and -1 and above considered normal. The results for this breakdown are given in table 3 below for those children included in the sample.

Table 3: Z-score classification of nutrition status of children between 1-10 years old

Z-score categories	Degree of malnutrition	Percentage of sample by z-score category: HAZ Boys	HAZ Girls	HAZ Both	WHZ Boys	WHZ Girls	WHZ Both
Below -3	Severe	17.2	13.9	31.1	1.1	1.6	2.7
-3.00 to -2.01	Moderate	12.6	12.5	25.1	4.0	4.0	8.0
-2.00 to -1.01	Mild	10.5	11.9	22.4	10.5	8.7	19.2
-1.00 and above	Normal	9.8	11.6	21.4	36.3	33.8	70.1

Source: own calculation from the pooled data

As can be seen from the table, over the period between 1994 and 1997, malnutrition is a serious problem of children, particularly in terms of long term measure (stunting). Only 21.4 percent of children are found to have a normal nutritional status compared to the international reference standard. The result from the short run measure (wasting) does not seem to be correlated with stunting and it shows that about 70 percent of children do have a normal nutritional status. This could be because as shorter the child's height is, the corresponding weight the child requires to pass the international standard is smaller accordingly.

[10]See Qualitative Techniques for Health Equity Analysis-Technical Note #2 (www.google.com)

The table also indicates that nutrition status of boys proxied by stunting is more severe than girls. By the same token, it is also useful to see health/nutritional status of children in terms of child's age and gender, as it is argued in the literature that growth failure varies with these variables. See the following table.

Table 4: **<u>Mean value of stunting and wasting by age and gender</u>**

Age in years	Group	HAZ	WHZ
1-4	Boys	-2.363446	-.1931757
	Girls	-2.467659	-.3736111
	Both	-2.411369	-.2761496
4.01-10	Boys	-2.183303	-.3737409
	Girls	-1.989434	-.300566
	Both	-2.087987	-.3377644

Source: own calculation from the pooled data

Table 4 indicates that in terms of long-run measure (i.e. stunting), younger children seem to be vulnerable to malnutrition than older ones, and yet, the opposite is true when we consider the short run measure (i.e. wasting). Disaggregating the data by gender shows that girls in the lower age group are the most affected ones relative to their boy counterparts for both health indicators. However, this gender bias seem to be reversed as children grow older and it is evidenced by those children in the higher age category.

Nutritional outcomes over time (trend)

The prevalence of malnutrition in Ethiopia has been and still is very high for so many years. However, as can be recalled from Table 1 (chapter 2 sections 2.3.1), the results of successive surveys have indicated that over time there is a tremendous decrease in the rate of malnutrition measured by stunting and underweight through out the country. Similar statistics can also be derived for the sample that this study utilizes. The following table provides the prevalence of stunting and wasting by gender and survey round for 426 children considered in this study.

Table 5: Prevalence of malnutrition over time (sample)

	Wasting			Stunting		
Round	Boys	Girls	**Both**	Boys	Girls	**Both**
1	10.7	10.0	**10.4**	58.3	58.1	**58.2**
2	6.6	13.4	**10.0**	58.2	54.0	**56.1**
3	7.5	12.1	**9.8**	54.5	53.3	**53.9**
4	14.6	11.3	**12.9**	59.0	54.4	**56.7**

Source: own calculation from the sample of successive rounds

Table 5 indicates that over time there is a gradual decrease in the rate of malnutrition measured by percentages of both wasting and stunting between rounds 1 and 3. Nevertheless, from round 3 to round 4 both wasting and stunting have risen from 9.8 and 53.9 percent to 12.9 and 56.7 percent, respectively for both male and female children. But note that data for the first three rounds were collected between 1994 and 1995 and this close spacing of this successive surveys could explain the slow change in the prevalence of malnutrition. However, data for the fourth round was collected in 1997 after 2 years from the third round and there is a substantial rise in malnutrition especially in terms of wasting. This deterioration of nutritional status may be indicating some kind of shock which might have occurred during the two years period.

The rate of malnutrition given by wasting and stunting for the sample (reported in table 5) are more or less similar to that of reported by CSA (Central Statistical Authority) for the rural sample (reported in table 1, section 2.3.1). But if any thing, malnutrition in terms of wasting for this sample is a bit higher than that of CSA's. This difference could be because under this study those children between the ages of 12 and 120 months are considered while the CSA sample considered only those children between the ages of 3-59 months. Similarly, the data samples for CSA and this study were not collected at similar time periods and this may partly explain the malnutrition rate differentials between the two. Hence, apart from the direction of the trend, direct comparison of malnutrition rates would be inappropriate.

Child nutritional status by household and community characteristics

Nutritional status of children also varies by household and community characteristics. For example, see the mean value of anthropometric outcomes of children by education level of the mother in the table below.

Table 6: Mean value of children's nutrition outcome by mothers education from the pooled data

Mothers education level	HAZ			WHZ		
	Boys	Girls	Both	Boys	Girls	Both
Illiterate/no formal schooling	-2.25	-2.23	-2.24	-.33	-.35	-.34
<=6th grade	-2.17	-1.51	-1.82	-.18	-.15	-.16
>=7th grade	-2.86	-4.26	-3.28	-.53	-1.16	-.72

Source: own calculation from the pooled data

As we can see from the table, on average children from mothers with at least a year of primary education but not higher, have better nutrition outcomes, relatively. Unlike expectations, however, children from mothers with at least a year of junior/secondary education or higher seem to register the worst anthropometric outcomes of the three education categories. But note that there are only three mothers and three children in this category.

On the other hand, figures from the table suggest that boys have a better nutritional outcome in terms of stunting when mothers have at least a year of primary education but not higher. Similarly, girls seem to enjoy a gender bias in terms of short run measure, wasting, in all of the education categories.

A similar description can be made in terms of household's access to safe water source and health services.

Table 7: <u>Mean value of children's nutritional outcome by access to safe water source and distance to the nearest health facility</u>

	HAZ	WHZ
Unsafe water source	-2.179266	-.3717374
Safe water source	-2.25125	-.149225
Distance <= 10km	-2.126085	-.3150943
Distance >10km	-2.329735	-.3205654

Source: own calculation from the pooled data

The evidence given in table 7 shows that on average nutritional status of children in households who have safe water sources seem to be more severe in terms of stunting than those children in households which use water from unsafe sources. However, when we consider the percentage of children who are actually stunted, we found that the percentage of children stunted in households with safe water sources is a bit lower than those found in households with unsafe water sources. On the other hand the evidence from the short run measure is inline with expectations i.e. children from households which use safe water sources have better health outcomes.

Similarly, the table also shows that nutritional status of children varies by the households' access to health facilities. Those children who are located within 10km distance from the nearest health facility have better nutritional outcomes than those children who are located outside the 10km radius.

Malnutrition of children also varies by region. See the table below.

Table 8: <u>Percent of malnourished children by region</u>

Z-score	Region1	Region3	Region4	Region7	Region8	Region9
HAZ	62	57.7	46.9	67.7	62.4	58.6
WHZ	9.5	13.4	5.8	13.7	13.3	12.4

Source: own calculation from the pooled data

Table 8 indicates that on average region 7 and region 4 register the highest and the lowest percentage of malnourished children in terms of both stunting and wasting. In terms of WHZ, region 3 registers the second highest percentage of wasted children, followed by regions 8, 9, and 1 respectively. However, when we consider stunting, next to region 7 region 8 takes the lead followed by regions 1, 9 and 3.

Child characteristics

The data set shows that about 52 percent of children are boys and, over the panel, the mean age of children is 4.9 years while the minimum and maximum values are 1 and 9.63 years, respectively between rounds 1 and 4.

4.1.2 Parental and household characteristics

The descriptive statistics (see table A1 in the appendix) shows that on average about 97 percent of the households in the sample are male headed[11] and about 99 percent of household heads had permanent partner. Over the period between year 1994 and 1997, the average size of households is 8 and in terms of composition adult female and male members account for about 2.4 each, while both female and male children between ages of 5 and 15 constitute about 1.4 independently. Households on average comprise of about 1.7 under-five children over the panel.

The average consumption expenditure per adult equivalent (Conspaeu) of households over the panel in local currency was about 93 Birr, and similarly the mean value of livestock holdings per household (lsuphh) was about 3.4 in tropical livestock units[12]. The minimum and maximum values of Conspaeu & lsuphh over the panel were about 4 Birr and 727 Birr, and 0 and 62, respectively.

Access of households to clean water and the type of toilet that the household uses were controlled by dummies. The result over the panel data shows that only about 24 percent of households had access to safe water source and 12 percent of households reported to use pit latrine or flush toilet[13].

---

[11] Since the study has incorporated father's characteristics as an important explanatory variables in the analysis, it is not a surprise if female headed households are under-represented in the sample. Those female headed households included here are either they are single parent households and had data available on father's characteristics at least once over the panel, and/or they are just households where both parents exist and the head of the households are simply females.

[12] The data on scaled livestock units was simply taken from Dr Tassew Woldehanna and it was directly added to the sample for this study.

[13] Safe water source in this study is defined as a water source which is available through pipe and/or from protected wells/boreholes. In terms of ownership, each of them (i.e. water source and the toilet that the

It is only imperative to talk about parental characteristics in the discussion of child health and nutrition. Some of those characteristics which deserve due emphasis are their height, educational status, mother's age, health and employment status and mother's knowledge about child health and caring practices. Out of households given in the sample, only 12.6 percent of mothers and about 27 percent of fathers had attained at least a year of primary education but not higher while the corresponding values for at least a year of junior/secondary or higher education are about 0.6 and 2.8 percent, respectively. These figures show how low the educational level of parents in the sampled households is. The average height of fathers' was found to be higher than the mothers' with corresponding values being 167 and 156.6 centimeters, respectively. The minimum and maximum height of the mothers were 135 and 179 centimeters while these figures were a bit higher for the fathers i.e. 147 and 189 centimeters, respectively.

The average age of mothers in the sample is 34 years over the panel. The youngest and the oldest mother in the first and last rounds had the age of 17 and 68.2 years, respectively. About 12 percent of the mothers reported to be ill for the last 4 weeks prior to the surveys were undertaken. To account for health knowledge of mothers about child health and caring practices, mothers were asked if they knew about the cause of diarrhea and about 59 percent of them responded to have the knowledge. In an attempt to see work status of mothers, it is found that only about 4 percent of the mothers reported to involve in farm and/or off farm activities like poetry, weaver, food and drink preparation for sale etc., excluding in-house responsibilities.

---

household uses) could either be privately owned and in the house, or they are shared ones and located outside the house.

4.1.3 Community characteristics

Out of the 15 villages considered, 54 percent of them are said to have access to communal water sources which are generally deemed to be safe as defined in footnote 13. However, none of the villages are reported to have communal pit latrine or flash toilets. The average distance from the PAs to the nearest health facility is 8.31 kilometers. This distance varies across communities from 1.5 kms to as far as 25 kms.

4.2 Econometric results

The first step in an attempt to estimate the effect of child, household and community characteristics on child's height-for-age and weight-for-height z-scores was to conduct relevant tests over the suitability of the data for the specified model. To begin with, tests on outliers (or extreme values of biologically implausible range) of child's HAZ and WHZ scores were conducted using the formula stated in footnote 9. Following this formula, some children were found to have z-score value outside the normal range in some of the rounds and these values are avoided from the regression.

Secondly, a pair-wise correlation matrix was constructed among variables to be utilized in the estimation to see if multicollinearity was a problem[14]. Using Gujarati's rule of thumb to identify multicollinearity among regressors[15], the result indicated that except for maternal secondary education and its interaction with water source of the community, (which is common in the presence of interaction terms (Hamilton, 1998)), there was no such problem as expected for multicollinearity is not a problem of panel data.

Third, the model was estimated using simple OLS on the pooled panel, fixed effects and random effects procedures for both HAZ and WHZ. However, to decide which model is the appropriate one, both Lagrange Multiplier and Hausman specification tests were conducted and all indicated that random effect approach best suits the data[16]. Test results

[14] Refer to table A2 in the appendix.
[15] D. N. Gujarati (2003), Basic Econometrics, 4th edition, p.359
[16] The model was allowed to include interaction terms and, estimation and relevant tests were conducted twice for both specifications (i.e. once including interaction terms and then by excluding them).

for both LM and Hausman are attached in the appendix for reference (see table A3 and A4).

Similarly, additional test was conducted on HAZ regression to see if time effects were significant. The result shows that time effects are not important (see Table A5 in the appendix). Thus, the study excluded the time (round) dummies from the analysis.

4.2.1 Regression results from random effects model

Table 9 (see next page) presents the results of estimating equation (9) for the two health outcomes considered, height-for-age and weight-for-height z-scores. Each nutrition and health outcome was estimated twice with and without interaction terms.

Table 9: HAZ and WHZ regressions with and without interaction terms

Explanatory variables	HAZ Without interaction terms	HAZ Including interaction terms	WHZ Without interaction terms	WHZ Including interaction terms
Dummy for Sex of a child (1 if male, 0 otherwise)	-.099 (.15)	-.106 (.15)	-.033 (.08)	-.009 (.08)
Age of a child in years	.124 (.02)***	.125 (.02)***	-.009 (.02)	-.010 (.02)
Dummy for marital status of household head (1 if permanent partner exists, 0 otherwise)	1.018 (.26)***	1.022 (.26)***	.039 (.38)	.052 (.38)
Mother's age in years	.002 (.01)	.002 (.01)	-.003 (.01)	-.001 (.01)
Mother's height in cm	.033 (.01)***	.033 (.01)***	.001 (.01)	.001 (.01)
Mother's schooling (1 if completed at least a year of primary education but not higher, 0 otherwise)	.294 (.16)*	.296 (.34)	.099 (.13)	.453 (.24)*
Mother's schooling (1 if completed at least a year of junior education or higher, 0 otherwise)	.177 (.52)	4.583 (5.07)	-.544 (.51)	-.978 (4.78)
Mother's work (1 if mother involves in farm/off farm activities like pottery, weaver, food and drink preparation for sale etc, 0 otherwise)	.305 (.20)	.317 (.20)	-.171 (.21)	-.183 (.21)
Health status of a mother (1 if mother suffered from any illness or injury in the last four weeks, 0 otherwise)	-.041 (.08)	-.040 (.08)	.004 (.11)	.007 (.11)
Knowledge of mother about child health and caring practices (1 if she knows the main cause of diarrhea, 0 otherwise)	.039 (.16)	.047 (.16)	.116 (.09)	.125 (.09)
Number of children under 5 years old	.191 (.05)***	.190 (.05)***	.129 (.05)***	.134 (.05)***
Number of girls between 5 and 15 years old	.207 (.05)***	.207 (.05)***	.066 (.05)	.059 (.05)
Number of boys between 5 and 15 years old	.004 (.05)	.003 (.05)	.105 (.05)**	.102 (.05)**
Number of female adults over 15 years old	.120 (.04)***	.117 (.04)***	.032 (.04)	.033 (.04)
Number of male adults over 15 years old	.082 (.04)*	.081 (.04)*	.093 (.04)**	.086 (.04)**
Size of household	-.090 (.029)***	-.09 (.03)***	-.075 (.04)**	-.074 (.03)**
Father's height in cm	.0183 (.01)***	.019 (.01)***	-.002 (.01)	-.002 (.01)
Father's schooling (1 if completed at least a year of primary education but not higher, 0 otherwise)	-.094 (.12)	-.091 (.12)	-.210 (.10)**	-.186 (.10)*
Father's schooling (1 if completed at least a year of junior education or higher, 0 otherwise)	-.411 (.32)	-.498 (.34)	-.163 (.26)	-.235 (.27)
Household consumption expenditure per adult equivalent (in natural logarithm)	-.082 (.040)**	-.083 (.04)**	.155 (.05)***	.165 (.05)***
Number of livestock owned (in tropical livestock units)	.012 (.01)	.012 (.01)	.006 (.01)	.006 (.01)
Household's water source (1 if safe, 0 otherwise)	-.428 (.22)**	-.45 (.22)**	.066 (.12)	.136 (.12)
Type of toilet household uses (1 if pit latrine or flush toilet, 0 otherwise)	.233 (.23)	.247 (.24)	-.110 (.13)	-.066 (.13)

Average distance from the PA to the nearest health facility (in Kms)	.003 (.02)	-.001 (.016)	-.001 (.01)	.009 (.01)
Interaction(mother's attainment of at least a year of primary education but not higher and the communities' safe source of water)		-.281 (.29)		.179 (.24)
Interaction (mother's attainment of at least a year of junior education or higher and the communities' safe source of water)		-3.659 (4.18)		.602 (4.08)
Interaction (mother's attainment of at least a year of primary education but not higher and the distance between the PA and the nearest health facility)		.017 (.03)		-.067 (.02)***
Interaction (mother's attainment of at least a year of junior education or higher and the distance between the PA and the nearest health facility)		-.168 (.20)		-.007 (.18)
Location dummy (1 if Region3, 0 otherwise)	.187 (.30)	.184 (.30)	-.227 (.17)	-.205 (.16)
Location dummy (1 if Region4, 0 otherwise)	.360 (.32)	.391 (.32)	.109 (.18)	.047 (.18)
Location dummy (1 if Region7, 0 otherwise)	-.77 (.39)**	-.799 (.39)**	.155 (.22)	.172 (.23)
Location dummy (1 if Region8, 0 otherwise)	-.323 (.36)	-.354 (.36)	-.021 (.20)	.019 (.20)
Location dummy (1 if Region9, 0 otherwise)	.052 (.34)	.022 (.34)	.018 (.19)	.070 (.19)
Constant	-12.151 (1.50)***	-12.232 (1.51)***	-.917 (1.35)	-1.053 (1.35)
No. of obs.	1626	1626	1626	1626
No. of groups	426	426	426	426
R^2	0.103	0.103	0.038	0.045
Wald Prob > chi2	chi2(29)=128.5 0.000	chi2(33)=130.6 0.000	chi2(29)=50.4 0.008	chi2(33)=61.5 0.002

Own estimation from the panel data

Note: standard errors are in parenthesis

*** significant at 10 %, ** significant at 5%, *** significant at 1%.**

The result contained in table 9 shows how each factor affects child's nutritional status independently given all other factors, and the analysis which follow is presented with this understanding in mind. In addition, note also that results are almost similar when the model was specified with and without interaction terms.

As can be seen in the table, gender of a child do not seem to be associated with child's nutritional outcome for both long run and short run measures. Even though it is insignificant, however, the negative coefficient on male dummy across different specifications may be indicating that relatively boys have lower nutritional status. To concretize this argument, this gender differential was also evidenced in the descriptive analysis of the previous section, not to mention the consistency of this finding with similar studies in Ethiopia (e.g. see section 2.3.2.2).

Age of the child is found to be positively and significantly related to height-for-age z-score. But this relation is neither positive nor significant when we consider the short run measure, weight-for-height. This result makes perfect sense if we try to relate it with what was found in the descriptive analysis. Thus, from these evidences we can argue that as children grow older, their long run nutrition outcome improves accordingly. Their current nutritional status, however, goes in the opposite direction. This could be because the care that parents give to older children may decrease especially if there are younger children in the family.

Marital status of the household head is also found to be an important determinant of child anthropometric outcomes. The result shows that children from household heads with permanent partners have on average 1.01 times more HAZ than those children from single headed households. This result is statistically significant at one percent.

Among parental characteristics, both mother's and father's height are found to be strongly associated with HAZ of children and the impact of mother's height is a bit higher than the father's. The coefficients did not change when the model was specified with and without interaction terms. On the other hand, the short run measure, WHZ, do not seem to be explained much by parental height factor. This finding is interesting in that, as people try to argue, it could be because HAZ is highly dependent on genetic factor than WHZ does and the result is significant at one percent.

Primary education of the mother is found to be weakly significant (at 10 percent) in the HAZ regression without interaction terms (i.e. interactions between mother's education and safe water source and the distance between the peasant association and the nearest health facility). In this case, we can say that children from mothers with at least a year of primary education have about 0.29 units higher HAZ than children from mothers with no education. But this association disappears when interaction terms are controlled for.

On the contrary, though weakly significant for WHZ regression with interaction terms, maternal education is no more important when interaction terms are dropped. Thus, an attempt was made to see if this lack of robustness was due to the possible correlation of mother's health knowledge with her education. As a result, the model was re-estimated by including the interaction of mother's education and health knowledge and also again by dropping the health knowledge dummy. But no change was observed in either way.

Similarly, employment status of the mother was also controlled to account for her time allocation to child rearing. However, this did not change the result for education dummy. Therefore, the possible reason could be that, as it is usually argued, her educational attainment has little importance in the rural setting either for its low level and quality or for there are impediments like poverty which limit her from exercising her knowledge which she got from education. This become even truer when we look at mother's secondary education dummy.

The table also shows that father's education in particular primary level is significantly associated with WHZ of children but with the wrong sign (i.e. negative). Thus, since this result is not theoretically supported, the possibility is that perhaps either it is indicating the unobserved effect of family background characteristics that are not picked up by education and height of the father, or that education of the father is not a determinant of child nutrition in rural Ethiopia.

As the mother is usually considered the most important health worker in the household, her knowledge about child health, her own health status, age and employment status were controlled in the regressions of various specifications. However, none of them were found to be significant. Maternal health knowledge have the right sign (i.e. positive) in all specifications. The dummy for illness of the mother for the last four weeks prior to the interviews is found to be negatively associated with HAZ while it has a positive sign with respect to WHZ. Though the former is expected, the latter could be implying that temporary health shocks of the mother may not have a significant impact on current nutritional status of children for there is always some one to look after for children in the household. This argument makes sense if we see the results found related to household composition.

Household composition is found to be important for nutritional outcome of children. The table shows that the numbers of under five children, female and male children between the ages of 5 and 15 years, and male and female adults over 15 years are all found to be positively associated with either one or both of child's HAZ and WHZ. They are all statistically significant at standard levels.

For example, the table shows that the number of under five children in the household is associated with child height positively and it is highly significant and robust for all specifications. This result was not expected a priori because as the number of children under five years of age in the household increases, this implies close spacing of child birth and difficulty in child caring. However, the result found here may be explained by factors which were not controlled explicitly in the analysis but had a positive impact on child health. Among these factors, maternal and child health programs including food aid to households with more younger children are the potential candidates.

The positive association between the number of female children over five years of age[17] with child's HAZ is to be expected as care is argued to be an important determinant of child health and the chance of a child getting proper care increases with the increase in

[17] Note that there are two age categories for female (i.e. 5 -15 years and 15^{+} years). But since both have given similar results, they are combined for discussion purpose.

the number of females in the household. This is particularly true in rural areas where access to education especially to females is limited for various reasons and they are obliged to stay at home and spend their time by involving in household related chores like child caring.

The number of male adults in the household is also positively associated with both height-for-age and weight-for-height z-scores. It is statistically significant at 10 and 5 percents with respect to HAZ and WHZ, respectively. Though it is not clear how this directly affects child health, it could be indicating the increase in the availability of resources that can be translated to the production of child nutrition. This is because, household resources may increase as the number of male adults increases since household full income is the sum of all labor income from labor intensive activities like agriculture which is the mainstay of sampled households. Note that, however, though household full income was controlled by consumption expenditure and livestock holdings, in this case it may be indicating that part of full income not accounted for by the proxies used.

Contrary to the findings regarding household composition, size of the household is found to be negatively associated with both HAZ and WHZ and it is significant at 5 and 1 percents, respectively. This result is robust across different specifications. This leads to the usual argument of competition for available resources since there is a possibility of having more economically inactive members as the household size increases.

As mentioned earlier, the natural logarithm of household consumption expenditure per adult equivalent (lnCon) and the number of livestock holdings in tropical livestock units, (Lsu), were included in the regressions to account for household full income/wealth. The result show that lnCon is positively associated with the short run measure of child nutrition outcome and it is statistically significant at 1 percent. However, with respect to height-for-age, the result is less intuitive for it is negative and significant at 5 percent. It is also robust across different specifications. Though unexpected based on the existing theory, this result has not come as a surprise for there is a similar evidence from a cross-sectional study by Abdulhamid (1996) using Ethiopian urban household data. Therefore, one can argue from this evidence that consumption expenditure is not an important determinant of long run nutritional status in the sampled households. Needless to say, however, it is possible for household consumption expenditure data to have been inaccurately calculated.

Children from households with safe source of water are found to be vulnerable to malnutrition in terms of height-for-age and this result was also observed in the descriptive analysis. Thus, what can be said here is that unlike what the theory narrates, household's access to safe water source does not explain child's long run nutritional status in the sampled areas. However, it is found to be positively associated with short run measure (WHZ), though not significant.

Similarly, household's usage of pit latrine or flush toilet does not seem to be associated with both short run and long run measures of child health. Similar argument can also be made about the distance between the peasant association and the nearest health facility (here the distance variable is used to proxy for access to health care). So, regarding the results of these community characteristics, the possible explanation could be that these infrastructural facilities are found at their low levels in quantity as well as quality and people prefer to use what is traditionally available such as rivers, ponds, etc as a source of water; open space or fields to dispose waste; and traditional healers to seeking treatment. Nevertheless, it was not possible to confirm this for the data used left out those variables as a base for comparison purpose.

Considering the interactions between mother's education and community characteristics such as safe water source and access to health care (proxied by the distance variable), seven of the eight interaction terms in both HAZ and WHZ regressions fail to be significant at standard levels. As Strauss (1990) suggests, this kind of result is partly a reflection of the unimportance of water source or the distance variable in explaining child nutritional outcomes, and partly the low level of education in the sampled areas. But for the significant term in the WHZ regression, one may argue that having at least a year of primary education is a substitute to access to health care. This implies, in the absence of health care facility in the area, children from mothers with at least a year of primary education have a better nutritional outcome than those children from mothers with no education.

In terms of location, region 7 dummy is found to be negative and statistically significant at 5 percent in height-for-age regression and this implies children who reside in Gurage and Kembata zones of SNNP region are shorter for their age than other children from region 1.

In an overall significance test of the results, the x^2 (Wald) test statistics indicate coefficients , jointly, are significantly different from zero at 1 percent level or better for each of the four regressions. On the other hand, the coefficient of determination, R^2, which shows the proportion of the variation in individual nutrition/health status explained by the regressions is small for all of the specifications. However, this is not unusual as Senauer and Garcia (1991) explained it "having low R^2 is quite typical of studies in this area".

Finally, following Gujarati's (2003: 418) suggestion, the four specifications of the model were rerun with *White's* heteroscedasticity corrected estimation procedure (using STATA 9) to find efficient estimates if there were heteroscedasticity of any kind[18]. However, this didn't bring about major changes on standard errors and the significance levels which could change the basics of the analysis given from uncorrected standard errors of the GLS estimation. But if any thing, significance levels of variables including *AdultFO15* from HAZ regression with interaction terms and *childU5* from both specifications of the WHZ estimation have changed from 1 percent to 10 percent levels while *MPedu* from WHZ regression with interaction terms has lost its 10 percent significance level emphasizing the less importance of maternal education on nutritional status of children.

[18] Table of White's heteroscedasticity corrected results is attached in the appendix for reference. See table A6.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary and Conclusions

The paper has examined the determinants of child nutritional achievement in a sample of households living in 15 villages located across the diversified farming systems of rural Ethiopia. In order to meet the study objectives, both descriptive and regression analysis have been utilized. An attempt was made to take full advantage of the longitudinal data by testing for unobserved individual effects. Not all the findings of this paper may be consistent with similar works and expectations in the country. Yet, from the advantage of panel data it has, it is believed that the study has identified the reality well. The major findings are summarized below.

Both the descriptive and econometric results have indicated that children's nutrition/health status differ by their gender and age. Male children in general are found to be vulnerable to malnutrition. Height-for-age is found to improve as the child grows implying that younger children are vulnerable to growth faltering. Similar result was obtained by Hoddinott and Kinsey (2001) from the Zimbabwean longitudinal data. But unlike the child's height-for-age, the opposite is true here for weight-for-height results.

Among parental and household characteristics, height of both parents, marital status of household head where permanent partner exists, and the number of females older than five years of age in the household are all found to be positively and significantly associated with child's long run measure, height-for-age. Whereas the number of male children between the ages of 5 and 15 and father's attainment of at least a year of primary education but not higher are strongly associated with only weight-for-height and the signs are positive and negative, respectively.

On the other hand, the number of children under five years of age, the number of adult males in the household and mother's attainment of at least a year of primary education but not higher are all found to be positively associated with both long run and short run nutrition outcomes and the association for each is significant at standard levels.

Household size is also found to be important in both measures of child nutrition outcomes and the association is negative and significant. Consumption expenditure, though significant for both measures, the association is found to be negative for height-for-age while it is positive for weight-for-height. The negative sign could be indicating that the data is of bad quality .

Similarly, safe water source of the household and the region 7 dummy are found to be negatively and significantly associated with height-for-age of children. Among the interaction terms, only the interaction of mother's attainment of at least a year of primary education but not higher and the communities' safe source of water is found to be significant and it is negative.

In general, the results summarized above indicate how each factor affects nutritional status of children given all other factors, and some of the results are less intuitive. A number of reasons could be attached to it. As it was indicated in the theoretical framework, child nutritional status in general is the outcome of interactions between household resources, care and a proper health environment and services. Thus, if one or more of the factors is missing or available in inadequate amounts, its effect could work as a bottleneck not allowing other factors to influence child health appropriately and that seems the reality we have here.

To support the above argument, some evidences could be forwarded. For example, it was indicated in the descriptive analysis that out of the households considered, only 12.6 percent of mothers attained at least a year of primary education but not higher and it was only 0.6 percent of them who have higher attainment. In addition, only 59 percent of mothers in the sample have the knowledge about the main cause of diarrhea, and yet only 54 percent of the 15 villages have access to communal water sources which are generally deemed to be safe. Moreover, none of the villages have communal pit latrine or flash toilets.

On the other hand, selection of those children whose z-scores available for all of the four rounds and whose parental characteristics are not missing might have introduced selection bias and this may partly explain the less intuitive results reported.

Finally, from the evidences given one can conclude that, despite the existing constraints, age of the child, parental height and primary education, existence of permanent partner to the household head, household size and composition, consumption expenditure and water source of the household are an important determinants of child health/nutrition outcomes.

5.2 Policy Recommendations

Ethiopia ranks one of among the worst in the world in its nutritional status of children as measured by anthropometric outcomes and this has a very serious implication. The causes of poor health in childhood are said to be complex, multidimensional and interrelated which require a careful understanding of the problem to implement effective policies and programs.

Thus, in an attempt to identify appropriate policy directions, this study has adopted a quantitative analysis to the problem and based on the results from both the descriptive and regression analysis, it has come up with the following recommendations. In the long run, policies should aim at:

1. special child health programs (whose benefit cannot be appropriated by other family members) at the first few years of childhood;
2. the general improvement of nutritional status of the population as this implies better stature (genetic makeup) of future parents;
3. improvement in mother's access to primary education;
4. programs which give special support to single headed households ; and
5. population policy which controls for large family size.

In addition, although some of the variables are not found to be statistically significant in the regression analysis, the evidences from their sign and from the descriptive analysis show that they are associated with at least one of child health/nutrition outcomes considered. Hence, policies which improve maternal own health and her knowledge about child health, access to health care facilities, and access to safe water and toilet facilities would have paramount importance. On top of these, the provision of these facilities could also be justified by fundamental human right and distributional grounds.

References

Abay Asfaw (date not specified) "How Poverty Affects The Health Status And The Health Care Demand Behavior Of Households? The Case of Rural Ethiopia." Centre for Development Research (ZEF), University of Bonn, http://www.chronicpoverty.org/pdfs/conferencepapers/Asfaw.pdf

Abdulhamid B. Kello (1996) "Poverty And Nutritional Status In Urban Ethiopia." The Ethiopian Economy Poverty and Poverty Alleviation in Bereket Kebede and Mekonnen Taddesse edition. Addis Ababa

Alderman, H. (1990) "Nutritional Status In Ghana And Its Determinants." Social Dimension of Adjustment in Sub-Saharan Africa, Working Paper No. 3, The World Bank, Washington, D.C.

Alderman, H., Hoddinott, J., Kinsey, B. (2002) "Long Term Consequences Of Early Childhood Malnutrition" mimeo, Dalhousie University, Halifax Canada

Alemu Mekonnen, Bekele Tefera, Tassew Woldehanna, Jones, N., Seager, J., Tekie Alemu, Getachew Asgedom (2005b) "Child Nutritional Status In Poor Ethiopian Households: The Role Of Gender, Assets And Location" Working Paper No. 26, Young Lives, Save the Children UK

Alemu Mekonnen, Jones, N., Bekele Tefera (2005a) "Tackling Child Malnutrition In Ethiopia: Do Sustainable Development Poverty Reduction Programme's Underlying Policy Assumptions Reflect Local Realities?" Working Paper No. 19, Young Lives, Save the Children UK

Appleton, S. and Mackinnon, J. (1993) "Education and Health In LDCs." Center for the Study of African Economies, University of Oxford

Attanasio, O., Gomez, L.C., Gomez, A., Hernandez, M.V. (2005) "Child Health In Rural Colombia: Determinants And Policy Interventions" Centre for the Evaluation of Development Policies, The Institute For Fiscal Studies, EWP04/02

Barrera, Albino (1990) "The Role Of Maternal Schooling And Its Interaction With Public Health Programs In Child Health Production." Journal of Development Economics, Vol. 32 (69-91) Elsevier Science Publishers B.V. North-Holland

Barrera, Albino (1991) "The Interactive Effects Of Mother's Schooling and Unsupplemented Breastfeeding On Child Health" Journal of Development economics, 34 (81-98) Elsevier Science Publishers B.V. North-Holland

Behrman, J. and Deolalikar, A. (1988) "Health And Nutrition." Handbook of Development Economics, Volume I, edited by H. chenery and T.N. Srinivasan, Elsevier Science Publishers B.V. North-Holland

Bilisuma Bushie (2004) "Determinants Of Child Stunting In Urban Ethiopia" Msc Thesis. AAU, June.

Blossner, M. de Onis, M (2005) "Malnutrition: Quantifying The Health Impact At National And Local Levels." Environmental Burden of Diseases Series, No. 12, WHO

Case, A., Lubotsky, D. and Paxson, C. (2002) "Economic Status And Health In Childhood: The Origins Of The Gradient." The American Economic Review, Vol. 92, No. 5, (1308-1334)

Chaudhuri, A. (2003) "Program Impact On The Health And Nutritional Status Of Children: Evidence From Rural Bangladesh." University of Washington

Children, Youth and Family Welfare Organization (1992) "Convention On The Rights Of The Child." Addis Ababa

Christiaensen, L. and Alderman, H. (2001) "Child Malnutrition In Ethiopia: Can Maternal Knowledge Augment The Role Of Income." Africa Region Working Paper Series, No. 22

Collier, P. Dercon, S. and Mackinnon, J. (2002) "Density Versus Quality In Health Care Provision: Using Household Data To Make Budgetary Choices In Ethiopia" The World Bank Economic Review, Vol. 16, No. 3 (425-448)

Dercon, Stefan and Hoddinott, John (2003) "Health, Shocks And Poverty Persistence" World Institute of Development Economics Research, Helsinki, part of the United Nations University, January.

Escobal, J., Saavedra, J., Suarez, P., Huttly, S., Penny, M., Lanata, C., Villar, E. (2005) "The Interaction Of Public Assets, Private Assets, And Community Characteristics And Its Effect On Early Childhood Height-For-Age In Peru" Working Paper No. 14, Young Lives, Save the Children UK

Federal Democratic Republic Of Ethiopia (FDRE), (2004) "Health Sector Millennium Development Goals Needs Assessment In Ethiopia." Draft Report. Addis Ababa

Federal Democratic Republic of Ethiopia (FDRE), (2005) "National Nutrition Strategy For Ethiopia." Unpublished. Addis Ababa

Glewwe, P. (1999) "Why Does Mother's Schooling Raise Child Health In Developing Countries? Evidence From Morocco." The Journal of Human Resources, Vol. 34, No.1 (124-159).

Goplan, C. (2001), "Undernutrition: Measurement And Implications." Measurement of Inequality and Poverty edited by S. Subramanian, Readers in Economics, Oxford University Press

Greene, William H. (2003) "Econometric Analysis" New York University, 5th edition, Pearson Education, Inc. India Branch.

Gujarati, Damodar N. (2003) "Basic Econometrics" US Military Academy, 4th edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Hamilton, Lawrence C. (1998) "Statistics With Stata 5" University of New Hampshire, Duxbury Press, An International Thomson Publishing Company

Hausman J. A. (1978) "Specification Tests In Econometrics" Econometrica, Vol. 46, (1251-1271).

Hoddinott J., and Kinsey B. (2001) "Child Growth In The Time Of Drought" Oxford Bulletin of Economics and Statistics, Vol. 63, No. 4

Jensen, R.T, and Richter, K. (2001) "Understanding The Relationship Between Poverty And Children's Health." European Economic Review, 45 (1031-1039), Elsevier.

Jones, A.M. (2000) "Health Econometrics." Handbook Of Health Economics, Vol. I, Edited by A.J. Culyer and J.P. Newhouse, Elsevier.

Kovested, J., Pörtner, Cl.C., Tarp, F. (2002) "Child Health And Mortality: Does Health Knowledge Matter?" October.

Maxwell, D., Levin, C., Klemesu, M.A., Ruel, M., Morris, S. and Ahiadeke, C. (2000), "Urban Livelihoods And Food And Nutrition Security In Greater Accra, Ghana." International Food Policy Research Institute, Research report No. 112

Quisumbing, Agnes R. (2003) "Food And Child Nutrition In Rural Ethiopia" Food Consumption and Nutrition Division, International Food Policy Research Institute, FCND Discussion Paper No. 158

Res Networks (2003) "Child Health, Poverty And The Role Of Social Policies", The Latin American Research Network Project, Call for Research Proposals, Washington, DC

Sahn, D.E., and Stifel, D. C. (2002) "Parental Preferences For Nutrition Of Boys And Girls: Evidence From Africa" The Journal of Development Studies, Vol. 39, No. 1, October 2002, A Frank Cass Journal, Great Britain

Save the Children UK(SC-UK), (2002) "Wealth, Health And Knowledge: Determinants Of Malnutrition In North Wollo, Ethiopia." Addis Ababa

Schultz, T.P. (2002) "Wage Gains Associated With Height As A Form Of Health Human Capital." The American Economic Review, Vol. 92, No. 2 (349-353)

Senauer, B. and Garcia, M. (1991) "Determinants Of The Nutrition And Health Status Of Preschool Children: An Analysis With Longitudinal Data." Economic Development and Cultural Change, Vol. 39, No. 2, (371-389)

Sentayehu Gebre Giorgis (1994) "Determinants Of The Health And Nutritional Status Of Children In Rural Ethiopia: The Case Of Sidamo." Msc Thesis. AAU, July.

Silva, Patricia (2005) "Environmental Factors And Children's Malnutrition In Ethiopia." Policy Research Working Paper 3489. The world bank, environment Department, January

Smith, L.C. and Haddad, L. (2000)* "Explaining Child Malnutrition In Developing Countries: A Cross-Country Analysis." IFPRI Research Report 111. Washington, D.C. International Policy Research Institute.

Smith, L.C. and Haddad, L. (2000) "Overcoming Child Malnutrition In Developing Countries: Past Achievements And Future Choices." IFPRI Discussion Paper 30. Washington, D.C. International Policy Research Institute.

Strauss, J. (1990) "Households, Communities, And Preschool Children's Nutrition Outcomes: Evidence From Rural Cote d'Ivoire." Economic Development and Cultural Change, vol. 38, No. 2 (231-261),

Strauss, J. and Thomas, D. (1995) "Human Resources: Empirical Modeling Of Household And Family Decisions." in Handbook of Development Economics, Vol. 3A. Eds. T.N. Srinivasan and Jere Behrman. Amsterdam: North Holland, pp. 1883-2023.

Strauss, J. and Thomas, D. (1998) "Health, Nutrition And Economic Development." Journal of Economic Literature, vol XXXVI, pp.766-817

Thomas, D. (1994) "Like Father, Like Son; Like Mother, Like Daughter: Parental Resources And Child Height" The Journal Of Human Resources, XXIX,4 (950-988)

Thomas, D., Strauss, J., Henriques, Maria-Helena (1990)a "Child Survival, Height For Age And Household Characteristics In Brazil" Journal of Development Economics, 33 (197-234). North Holland

Thomas, D., Strauss, J., Henriques, Maria-Helena (1990)b "How Does Mother's Education Affect Child Height?" Journal of Human Resources, XXVI. 2

WMS, (2004) "Welfare Monitoring Survey: Analytical Report." Statistical Bulletin 339-A, The Federal Democratic Republic of Ethiopia, Central Statistical Authority, Addis Ababa.

Woldemariam Girma and Timotiows Genebo (2002) "Determinants Of The Nutritional Status Of Mothers And Children In Ethiopia" Calverton, Maryland, USA: ORC Macro

Wooldrige, Jeffrey M. (2003) "Introductory Econometrics: A Modern Approach" 2nd edition, South Western Publishers

World Bank and Ministry of Health (WB and MoH), (2005) "A Country Status Report On Health and Poverty-Ethiopia." Vol. 2 : Main Report, No. 28963-ET , Africa Region Human Development, the World Bank and Ministry of Health Ethiopia.

Yamano, Takashi; Alderman, Harold; Christiaensen, Luc (2003) "Child Growth, Shocks, And Food Aid In Rural Ethiopia" World Bank Policy Research Working Paper No.3128. The World Bank

(Publisher missing), (1998) "Major Human Rights Instruments: A Selected Collection". 50th Anniversary of the Universal Declaration of Human Rights. Commercial Printing Enterprise, Addis Ababa.

Appendices

Table A1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
whzCH	1626	-.3169988	1.402879	-4	6
hazCH	1626	-2.196974	1.677685	-6	4.81
sexCH	1626	.5190652	.4997901	0	1
ageCH	1626	4.918979	1.89221	1	9.63
sexhh	1626	.9766298	.1511228	0	1
partner	1626	.9913899	.0924186	0	1
ageM	1626	34.2324	8.428993	17.08333	68.25
heightM	1626	156.6292	6.313766	135	179
MPedu	1626	.1260763	.3320374	0	1
MSedu	1626	.0061501	.0782049	0	1
workM	1626	.0356704	.185524	0	1
illM	1626	.1217712	.327122	0	1
Hknowledge	1626	.5867159	.4925744	0	1
childU5r	1626	1.738007	1.108954	0	10
childFO5r	1626	1.423739	1.109135	0	6
childMO5r	1626	1.440344	1.227559	0	7
AdultFO15r	1626	2.372079	1.492936	1	12
AdultMO15r	1626	2.378844	1.486479	1	10
DPedu	1626	.2724477	.445356	0	1
DSedu	1626	.0276753	.1640912	0	1
heightD	1626	167.1433	6.797411	147	189
hhsize	1626	8.258918	3.335773	2	31
lnCon	1626	4.21188	.8019675	1.292509	6.58909
lsu	1626	3.442005	4.155984	0	61.85
waterSHH	1626	.2460025	.4308125	0	1
toiletHH	1626	.1193112	.3242541	0	1
waterCOM	1626	.5467405	.4979637	0	1
HealthD	1626	8.312116	6.35873	1.5	25
MPedu_wate~M	1626	.0713407	.2574723	0	1
MSedu_wate~M	1626	.0055351	.0742146	0	1
MPedu_Heal~D	1626	.8293358	2.905421	0	25
MSedu_Heal~D	1626	.0375154	.718422	0	25

Table A2: Pairwise correlation among variables utilized in the estimation

	hazCH	whzCH	sexCH	ageCH	sexhh	partner	ageM
hazCH	1.0000						
whzCH	-0.0590	1.0000					
sexCH	-0.0314	-0.0044	1.0000				
ageCH	0.1381	-0.0642	-0.0489	1.0000			
sexhh	0.0059	-0.0210	0.0058	0.0215	1.0000		
partner	0.0113	0.0418	-0.0405	-0.1143	-0.0146	1.0000	
ageM	0.0257	-0.0279	0.0136	0.2216	-0.0120	-0.0621	1.0000
heightM	0.1299	-0.0006	0.0608	0.0068	0.0482	0.0024	-0.0554
MPedu	0.0682	0.0590	-0.0337	-0.0533	0.0592	0.0172	-0.2373
MSedu	-0.0430	-0.0205	0.0279	0.0005	0.0119	0.0072	-0.0792
workM	0.0044	-0.0431	-0.0420	0.0992	-0.0744	-0.0157	0.0351
illM	-0.0498	0.0265	-0.0248	-0.0459	-0.0488	-0.0032	0.0712
Hknowledge	0.0307	0.0848	0.0553	0.0339	-0.0664	0.0107	0.0009
childU5	0.1071	0.0407	0.0816	-0.1954	-0.0005	0.0789	-0.0727
childFO5	0.0529	0.0035	-0.1642	0.1699	0.0797	0.0129	0.2361
childMO5	-0.0127	0.0031	0.1395	0.1768	0.0526	-0.0071	0.3045
AdultFO15	0.0945	0.0032	0.0726	0.0431	0.0223	-0.0023	0.3429
AdultMO15	0.0645	0.0558	0.0229	0.0533	0.0231	-0.0574	0.3504
heightD	0.1188	0.0017	-0.0249	-0.0576	-0.0200	-0.0090	-0.1232
hhsize	0.0925	-0.0031	0.0453	0.2246	0.0682	-0.0314	0.4991
DPedu	0.0202	-0.0264	-0.0100	-0.1097	0.0346	0.0158	-0.2971
DSedu	-0.0568	0.0001	-0.0099	0.0180	-0.0449	0.0159	-0.0573
lnCon	0.0045	0.0887	-0.0245	0.0327	0.0813	0.0902	-0.1721
lsu	0.1273	0.0191	0.0292	0.0135	-0.0418	0.0329	0.1277
waterSHH	-0.0266	0.0633	0.0544	-0.0313	0.0892	0.0252	-0.0098
toiletHH	0.0411	0.0054	0.0802	0.0064	0.0572	-0.0233	0.0125
HealthD	0.0531	-0.0036	0.0623	-0.0252	-0.3404	-0.0012	-0.0582
waterCOM	-0.0002	0.0129	0.0110	-0.0248	0.1065	0.0395	0.0623
MPedu_wateCOM	0.0769	0.0594	-0.0195	-0.0247	0.0427	0.0259	-0.1564
MSedu_wateCOM	-0.0501	-0.0180	0.0216	0.0163	0.0113	0.0069	-0.0716
MPedu_HealthD	0.0762	-0.0140	0.0629	-0.0515	0.0439	0.0190	-0.2065
MSedu_HealthD	-0.0028	-0.0197	0.0391	-0.0314	0.0079	0.0048	-0.0662

	heightM	MPedu	MSedu	workM	illM	Hknowlge	childU5r
heightM	1.0000						
MPedu	0.1123	1.0000					
MSedu	-0.0141	-0.0294	1.0000				
workM	0.0029	-0.0073	-0.0148	1.0000			
illM	0.0075	0.0135	-0.0052	-0.0333	1.0000		
Hknowledge	0.0496	0.1866	0.0642	0.0261	0.0599	1.0000	
childU5	0.0160	0.0152	-0.0015	-0.0632	0.0179	0.0356	1.0000
childFO5	0.0145	-0.0712	-0.0360	0.0758	-0.0096	0.0826	-0.0655
childMO5	0.0442	-0.1217	-0.0465	-0.0074	0.0444	0.0141	-0.0090
AdultFO15	0.1123	-0.1029	-0.0446	-0.0046	0.0983	0.1110	0.2788
AdultMO15	-0.0382	-0.0467	0.0642	-0.0247	0.0648	0.1266	0.0917
heightD	0.2161	0.1097	-0.0074	-0.0013	-0.0073	0.0344	0.0288
hhsize	0.0088	-0.1576	-0.0356	0.0266	0.0552	0.1077	0.3558
DPedu	0.0433	0.3447	0.0216	0.1221	-0.0688	0.0702	0.0495
DSedu	-0.0051	0.0754	0.2685	0.1218	0.0248	0.1261	-0.0094
lnCon	0.0602	0.1618	0.0451	-0.0210	-0.0358	-0.0431	-0.0435
lsu	0.0429	-0.0190	0.0255	-0.0242	0.0057	0.0085	0.0614
waterSHH	0.0904	0.0407	0.0624	-0.0305	0.0176	-0.1044	0.0915
toiletHH	0.0390	0.2008	-0.0283	-0.0127	-0.0160	0.1463	0.0852
HealthD	-0.0488	-0.1143	-0.0258	-0.0609	0.0132	-0.0482	-0.0617
waterCOM	0.1900	0.0082	0.0552	0.1073	0.0331	0.0086	0.0863
MPedu_wateCOM	0.1067	0.7205	-0.0211	0.0334	-0.0115	0.1459	0.0280
MSedu_wateCOM	-0.0192	-0.0278	0.9484	-0.0140	-0.0272	0.0608	0.0037
MPedu_HealthD	0.0741	0.7414	-0.0218	-0.0390	-0.0109	0.1362	0.0540
MSedu_HealthD	0.0095	-0.0195	0.6641	-0.0098	0.0449	0.0426	-0.0182

	childFO5	childMO5	AdultFO15	AdultMO15	heightD	hhsize	DPedu
childFO5r	1.0000						
childMO5r	0.0556	1.0000					
AdultFO15r	0.1010	0.2766	1.0000				
AdultMO15r	0.0156	0.1815	0.3302	1.0000			
heightD	-0.0139	0.0714	0.0148	0.0504	1.0000		
hhsize	0.4324	0.5802	0.6725	0.5080	0.0257	1.0000	
DPedu	-0.0352	-0.0529	-0.0372	-0.0614	0.2458	-0.0712	1.0000
DSedu	0.0693	-0.0255	-0.0605	0.0089	0.0200	-0.0150	-0.1036
lnCon	-0.1139	-0.1482	-0.1473	-0.0557	0.0530	-0.2235	0.0866
lsu	-0.0102	0.2145	0.0783	0.1898	0.0541	0.1816	-0.0339
waterSHH	-0.0248	0.0955	0.1060	0.1654	0.0316	0.1186	-0.0592
toiletHH	0.0291	0.0666	0.1179	0.1383	0.0638	0.1431	0.1133
HealthD	-0.1423	0.0062	-0.1466	0.0498	0.0524	-0.1153	-0.0947
waterCOM	0.0052	0.0989	0.1842	0.1175	0.0548	0.1504	0.0217
MPedu_wateCOM	-0.0584	-0.0560	-0.0719	0.0089	0.1454	-0.0893	0.2263
MSedu_wateCOM	-0.0276	-0.0395	-0.0505	0.0532	-0.0112	-0.0296	0.0096
MPedu_HealthD	-0.1351	-0.0780	-0.1029	-0.0733	0.0957	-0.1453	0.2846
MSedu_HealthD	-0.0473	-0.0464	-0.0052	0.0343	0.0106	-0.0458	0.0604

	DSedu	lnCon	lsu	waterSHH	toiletHH	HealthD	waterCOM
DSedu	1.0000						
lnCon	0.0505	1.0000					
lsu	-0.0301	0.1903	1.0000				
waterSHH	0.0771	0.1879	0.0311	1.0000			
toiletHH	0.0483	-0.0550	-0.0314	0.0219	1.0000		
HealthD	-0.0852	-0.0122	0.1126	-0.1299	-0.1471	1.0000	
waterCOM	0.0109	0.1856	0.1895	0.4634	0.0340	-0.3270	1.0000
MPedu_wateCOM	0.0097	0.1249	0.0608	0.1599	0.2164	-0.0871	0.2529
MSedu_wateCOM	0.2844	0.0445	0.0279	0.0704	-0.0269	-0.0488	0.0669
MPedu_HealthD	-0.0206	0.1478	0.0186	0.0658	0.2050	0.1188	0.0007
MSedu_HealthD	0.0527	0.0295	0.0043	-0.0061	-0.0188	0.0451	0.0049

	MPedu_watCOM	MSedu_watCOM	MPedu_HealthD	MSedu_HealthD
MPedu_wateCOM	1.0000			
MSedu_wateCOM	-0.0201	1.0000		
MPedu_HealthD	0.5237	-0.0206	1.0000	
MSedu_HealthD	-0.0140	0.4117	-0.0145	1.0000

Table A3: Breusch and Pagan Lagrangian multiplier test for random effects:

A31)Height-for-age Z-score (HAZ)

hazCH[Uind_id,t] = Xb + u[Uind_id] + e[Uind_id,t]

Estimated results:

	Var	sd = sqrt(Var)
hazCH	2.814627	1.677685
e	.6809158	.8251762
u	1.976144	1.405754

Test: Var(u) = 0

chi2(1) = 1120.33

Prob > chi2 = 0.0000

Conclusion: we reject the null in favor of the random effects model

Note: a similar test was conducted for the specification including interaction terms. However, the result did not change and hence not reported here.

A32)Weight for height Z-score (WHZ)

```
Breusch and Pagan Lagrangian multiplier test for random effects:

        whzCH[Uind_id,t] = Xb + u[Uind_id] + e[Uind_id,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+-----------------------------
                   whzCH |   1.968068       1.402879
                       e |   1.729283       1.315022
                       u |   .1834543       .4283156

        Test:   Var(u) = 0
                              chi2(1) =    16.81
                          Prob > chi2 =     0.0000
```

Conclusion: we reject the null in favor of the random effects model

Note: a similar test was conducted for the specification including interaction terms. However, the result did not change and hence not reported here.

Table A4: Hausman's Specification Test

A41) Height-for-age Z-score (HAZ)

	---- Coefficients ---- (b) fixed	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
ageCH	-1.166022	.1240029	-1.290025	2.481356
partner	1.061583	1.018833	.0427499	.0509163
ageM	1.290373	.0021578	1.288216	2.481032
heightM	.0360719	.0326296	.0034423	.004193
MPedu	.2391028	.2938266	-.0547238	.1137966
MSedu	.4900881	.1766935	.3133946	.3045579
workM	.3038441	.3051121	-.001268	.1011126
illM	-.008182	-.0412919	.0331099	.0152517
childU5	.1048104	.1905998	-.0857894	.0369588
childFO5	.1556566	.2071849	-.0515284	.0499307
childMO5	-.0617669	.0038744	-.0656413	.0161075
AdultFO15	.0627119	.1197152	-.0570033	.0599831
heightD	.0114263	.0182962	-.0068699	.0044719
DPedu	-.1875726	-.0935713	-.0940013	.079546
DSedu	-.3809066	-.4107423	.0298357	.2602392
hhsize	-.0882145	-.0898468	.0016323	.0125224
lnCon	-.0830545	-.0820581	-.0009964	.0113183
lsu	-.0030651	.0115154	-.0145805	.0078697

```
                          b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                 chi2(18) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       21.14
                Prob>chi2 =      0.2723
                (V_b-V_B is not positive definite)
```

Conclusion: we do not reject the null i.e. RE is the appropriate estimating procedure.

Note: similar test was conducted for the specification including interaction terms. However, the result did not change and hence not reported here.

Table A6: Robust HAZ and WHZ regressions with and without interaction terms

Explanatory variables	HAZ Without interaction terms	HAZ Including interaction terms	WHZ Without interaction terms	WHZ Including interaction terms
Dummy for Sex of a child (1 if male, 0 otherwise)	-.099 (.15)	-.106 (.15)	-.033 (.08)	-.009 (.08)
Age of a child in years	.124 (.02)***	.125 (.02)***	-.009 (.02)	-.010 (.02)
Dummy for marital status of household head (1 if permanent partner exists, 0 otherwise)	1.018 (.26)***	1.022 (.26)***	.039 (.38)	.052 (.38)
Mother's age in years	.002 (.01)	.002 (.01)	-.003 (.01)	-.001 (.01)
Mother's height in cm	.033 (.01)***	.033 (.01)***	.001 (.01)	.001 (.01)
Mother's schooling (1 if completed at least a year of primary education but not higher, 0 otherwise)	.294 (.16)*	.296 (.34)	.099 (.13)	.453 (.24)*
Mother's schooling (1 if completed at least a year of junior education or higher, 0 otherwise)	.177 (.52)	4.583 (5.07)	-.544 (.51)	-.978 (4.78)
Mother's work (1 if mother involves in farm/off farm activities like pottery, weaver, food and drink preparation for sale etc, 0 otherwise)	.305 (.20)	.317 (.20)	-.171 (.21)	-.183 (.21)
Health status of a mother (1 if mother suffered from any illness or injury in the last four weeks, 0 otherwise)	-.041 (.08)	-.040 (.08)	.004 (.11)	.007 (.11)
Knowledge of mother about child health and caring practices (1 if she knows the main cause of diarrhea, 0 otherwise)	.039 (.16)	.047 (.16)	.116 (.09)	.125 (.09)
Number of children under 5 years old	.191 (.05)***	.190 (.05)***	.129 (.05)***	.134 (.05)***
Number of girls between 5 and 15 years old	.207 (.05)***	.207 (.05)***	.066 (.05)	.059 (.05)
Number of boys between 5 and 15 years old	.004 (.05)	.003 (.05)	.105 (.05)**	.102 (.05)**
Number of female adults over 15 years old	.120 (.04)***	.117 (.04)***	.032 (.04)	.033 (.04)
Number of male adults over 15 years old	.082 (.04)*	.081 (.04)*	.093 (.04)**	.086 (.04)**
Size of household	-.090 (.029)***	-.09 (.03)***	-.075 (.04)**	-.074 (.03)**
Father's height in cm	.0183 (.01)***	.019 (.01)***	-.002 (.01)	-.002 (.01)
Father's schooling (1 if completed at least a year of primary education but not higher, 0 otherwise)	-.094 (.12)	-.091 (.12)	-.210 (.10)**	-.186 (.10)*
Father's schooling (1 if completed at least a year of junior education or higher, 0 otherwise)	-.411 (.32)	-.498 (.34)	-.163 (.26)	-.235 (.27)
Household consumption expenditure per adult equivalent (in natural logarithm)	-.082 (.040)**	-.083 (.04)**	.155 (.05)***	.165 (.05)***
Number of livestock owned (in tropical livestock units)	.012 (.01)	.012 (.01)	.006 (.01)	.006 (.01)
Household's water source (1 if safe, 0 otherwise)	-.428 (.22)**	-.45 (.22)**	.066 (.12)	.136 (.12)
Type of toilet household uses (1 if pit latrine or flush toilet, 0 otherwise)	.233 (.23)	.247 (.24)	-.110 (.13)	-.066 (.13)

Average distance from the PA to the nearest health facility (in Kms)	.003 (.02)	-.001 (.016)	-.001 (.01)	.009 (.01)
Interaction(mother's attainment of at least a year of primary education but not higher and the communities' safe source of water)		-.281 (.29)		.179 (.24)
Interaction (mother's attainment of at least a year of junior education or higher and the communities' safe source of water)		-3.659 (4.18)		.602 (4.08)
Interaction (mother's attainment of at least a year of primary education but not higher and the distance between the PA and the nearest health facility)		.017 (.03)		-.067 (.02)***
Interaction (mother's attainment of at least a year of junior education or higher and the distance between the PA and the nearest health facility)		-.168 (.20)		-.007 (.18)
Location dummy (1 if Region3, 0 otherwise)	.187 (.30)	.184 (.30)	-.227 (.17)	-.205 (.16)
Location dummy (1 if Region4, 0 otherwise)	.360 (.32)	.391 (.32)	.109 (.18)	.047 (.18)
Location dummy (1 if Region7, 0 otherwise)	-.77 (.39)**	-.799 (.39)**	.155 (.22)	.172 (.23)
Location dummy (1 if Region8, 0 otherwise)	-.323 (.36)	-.354 (.36)	-.021 (.20)	.019 (.20)
Location dummy (1 if Region9, 0 otherwise)	.052 (.34)	.022 (.34)	.018 (.19)	.070 (.19)
Constant	-12.151 (1.50)***	-12.232 (1.51)***	-.917 (1.35)	-1.053 (1.35)
No. of obs.	1626	1626	1626	1626
No. of groups	426	426	426	426
R^2	0.103	0.103	0.038	0.045
Wald Prob > chi2	chi2(29)=126.3 0.000	chi2(33)=131.4 0.000	chi2(29)=52.7 0.005	chi2(33)=118.7 0.000

Own estimation from the panel data

Note: White's (robust) standard errors are in parenthesis

*** significant at 10 %, ** significant at 5%, *** significant at 1%.**

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all source of materials used for the thesis have been duly acknowledged.

Declared by:

Name: Daniel Ayalew

Signature: ______________________

Date: 7/8/'06

Confirmed by Advisor:

Name: Tassew Woldehanna

Signature: ______________________

Date: 7/8/2006

Place and date of submission: ______________________.