The Impact of Household-Level Determinants on Child Health and Nutrition: Cross-Country Evidence from West Africa

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Abstract:

Poor child health and nutrition persist throughout West Africa. This research analyzes the impact of key economic variables, including income, education and background characteristics, on child health and nutrition across nine different countries. The results are interpreted in the context of differing levels of economic development among these nations. The findings do not show wealth and parental education to be robust across the sample, but maternal background characteristics have a positive, statistically significant and highly consistent effect across all the countries. The importance of mothers' height does not simply represent a genetic influence, but can be interpreted to signify that women with a healthier upbringing, and hence taller, have healthier children, ceteris parabus. This finding is consistent with long run observations that increases in health (and height) coincide with economic development.

Key Words:

West Africa, Economic Development, Health, Nutrition

I. Introduction

Child malnutrition continues to plague much of sub-Saharan Africa. Apart from the normative considerations associated with this issue, poor child health and nutrition also represents a major economic concern for these nations. Moderate and even mild health and nutritional problems can result in growth retardation, which reduces the body's ability to perform work (Martorell 1995), while severe episodes may retard mental development as well (Sigman et al. 1989). Growth retardation, a principal indicator of child malnutrition, is the result of inadequate dietary intake, disease and the interaction of these two factors (WHO 1995).

While poor health and nutrition is pervasive throughout sub-Saharan Africa, there is also substantial variation in levels across countries. The percentage of children classified as stunted, a long-term measure of child health and nutrition, ranges from 26% to as high as 48% in West Africa[1]. Over the long run, economic development coincides with populations becoming taller, more productive and living longer (see Fogel 1994). Despite this long-term observation, higher GDP does not necessarily translate into better levels of child health and nutrition in the short run. Countries such as Togo and Burkina Faso, which report levels of stunting similar to Côte d'Ivoire among children under 3, have less than half the per capita GDP of Côte d'Ivoire. Figure 1 illustrates the (short-run) ambiguity between levels of GDP and child health and nutrition.

The purpose of this research is to examine how the effects of underlying, household-level determinants of child health and nutrition differ across nations at various levels of economic

[1] Stunted refers to children's age and sex standardized height falling 2 or more standard deviations below the reference mean. Data cited here are from the most recent Demographic and Health Surveys undertaken during the 1990s for children ages 6 to 35 months.

development. Specifically, the analysis focuses on the impact of income, education and background characteristics on child health and nutrition across nine different countries in West Africa. This study differs from earlier studies by allowing the results from household-level analysis to vary, rather than pooling or aggregating the data and estimating a single set of parameters for all countries in the sample (for example, see Pritchett and Summers 1996; Smith and Haddad 2000; Sahn and Stifel 2001).

To the extent that health and other problems vary across countries, there are no *a priori* expectations that the effects of wealth (permanent income) and maternal education should be consistent as well. These variables may differ in importance according to the level of economic development. Even countries with similar levels of GDP may face substantially different health obstacles that lead to different empirical results. For example, in one country where diarrhea is a serious impediment to child health and nutrition, the ability to provide oral rehydration solution (sugar, salt and water) depends much less, if at all, on household income, and much more on a caregiver's ability to diagnose and treat. In this case, care-giving, as proxied by education, is expected to be more strongly, positively correlated with child health than wealth. If in another country malaria is of primary concern, the opposite result is expected. As knowledgeable as a caregiver may be, malaria still requires medicine that must be purchased.

This analysis focuses on the impact of key determinants of child health and nutrition at the household level, controlling for inter-community variation. One of these factors, wealth (permanent income), can improve children's health within the household, through the purchase of health and nutritional inputs. Wealth can also affect children's health collectively (inside and outside of the household but within the community) by improving health and other infrastructure. Thus, to the extent that communities in West Africa use self-taxation to provide collective goods, such as local health facilities, schools, water infrastructure and sanitation, the true impact of household wealth may be understated.

The findings of this analysis suggest that maternal background characteristics, proxied by maternal age-standardized height, have a positive, statistically significant and highly consistent effect across all the countries in the sample. This result does not, according to the World Health Organization (1995), represent merely a genetic influence. Rather, it is interpreted to mean that women with healthier upbringing, who are consequently taller, have healthier children. This result is consistent with long run observations that increases in health (and height) coincide with economic development. The results of other parameter estimates across countries are discussed in section IV.

II. Analytical Framework

We use a standard microeconomic model of household behavior (see Strauss and Thomas 1995) to analyze the impact of exogenous household- and community-level variables on a measure of long-term child health and nutritional outcomes. This model of behavior views nutritional outcomes as the process of household decisions, constrained by time, income and, in the case of health and nutrition, a physical or biological production function. In a static, one-period model, utility, shown below in equation (1), is a function of the consumption of goods and services –

both market and home produced – C_i, leisure, L_i, the health and nutrition, H_i, of all household members, and tastes and preferences of the household, ξ.

$$U = u(C_i, L_i, H_i, \xi) \tag{1}$$

The reduced form equation incorporates household, child and community characteristics. Household variables include: wealth, as a measure of exogenous permanent income (see Freidman 1957); parental education; child characteristics; and other background characteristics known to, but not influenced by, the household (Pitt and Rosenzweig 1984). Other household characteristics, such as household size and composition, are excluded from the model in order to avoid potential problems of endogeneity (for a discussion of endogeneity see for example Behrman and Deolalikar 1988). Unobservable background characteristics are controlled for by maternal anthropometry (see Strauss 1990). Child characteristics of particular importance include age, sex and whether he or she is from a multiple birth.

$$H_{Child} = f(E, p, \theta, \varepsilon), \text{ where } \varepsilon \sim N(0,\sigma^2) \tag{2}$$

Equation (2) above states that the child's health and nutrition (H_{Child}), is a function of household wealth (E), prices (p), a vector of community, household and child characteristics (θ), and a random error term (ε)[2].

[2] The model is conditional on the child being alive and in the household at the time of measurement. This condition may introduce a source of bias into the parameter estimates, particularly for the 24-35 month age cohort if children from wealthier, more educated families are more likely to survive (see Thomas and Strauss 1992).

III. Data & Methods

The Demographic and Health Surveys

The analysis makes use of household socio-economic and anthropometric data collected as part of the Demographic and Health Surveys (DHS), conducted in various West African nations throughout the 1990s by Macro International for the United States Agency for International Development (USAID). These studies were generally conducted with the assistance of the Central Statistical Office and the Ministry of Health in the participating countries. Age- and sex-standardized heights are analyzed for children between the ages of 6 and 35 months. Measurement error, relative to absolute growth, is large for children under 6 months of age, and several of the countries did not collect height information on children over 3 years of age. Each of the surveys uses similar sampling techniques, based on a complex stratified, clustered sampling process, that measured from 1,500 to nearly 4,000 children in the different countries. Although the DHS studies change over time, they are remarkably similar across countries.

The nine nations studied are: Benin, Burkina Faso, Chad, Côte d'Ivoire, Ghana, Mali, Niger, Senegal and Togo. Two surveys were conducted in Niger, the first in 1992 and the second in 1998; both are included in the analysis. The criteria for selecting these countries are simply their geographical proximity and data collected on maternal height (an important proxy for unobservable background characteristics). Indeed, maternal height was not collected in the first round of the DHS studies (DHS I), but was collected more often than not in subsequent rounds

(DHS II and DHS III). Respondents who are not residents of the household but were visiting at the time of the interview are excluded.

Table 1 reports information on child health and other important underlying determinants of health and nutritional status, such as parental education, along with key macroeconomic variables at the time of the survey. Of note is the level of (formal) education across countries. Approximately 60% of mothers and 70% of fathers have at least some formal education in Ghana, while roughly just 20% of their counterparts in Burkina Faso, Mali, Niger and Senegal report any schooling. Apart from Ghana, Togo appears to have made strides in the educational level of men and women. In Togo, more than half of the men in the sample report some formal education, while approximately 50% of women age 20 to 24 have some formal education, as opposed to only 16% of women aged 40 to 44.

Empirical Estimation

The analysis addresses the issue of comparability of results across studies in several ways: (1) geography; (2) model specification; (3) functional form; and (4) the choice of variables. Health and nutritional challenges differ, but many of the problems faced by these countries are similar as well. Consequently, this research is limited to nations only in West Africa, and all 10 studies occurred within a 6-year time span. Second, community-level fixed effects estimates are used to control for inter-community variation. Factors such as infrastructure, which may vary widely in quality and services provided from one country to the next (and within country as well) and prices, particularly since the types of foods consumed may differ substantially across the sample, are accounted for using a community fixed-effects specification[3].

Third, the data are not pooled across countries, as in some studies, so that parameter estimates can be judged for robustness across the sample of countries. Single, cross-country pooled or aggregate regressions require that a unit change for a given parameter have the same marginal expected change on child health. Fourth, the variables used to estimate the reduced form equation (discussed below) were selected carefully to help ensure comparability. For example, quality of schooling may vary substantially but "literacy" should be reasonably uniform. Therefore literacy, rather than years of education, is used to denote a mothers' level of education.

Height-for-age (HAZ), expressed as a Z score, is used as the dependent variable to represent the health and nutritional status of preschool children. The "Z" in Z score represents a standard normal distribution, n~(0,1), standardized according to data collected in the U.S. during the 1970s. This measure is not without some controversy (see Seckler 1982), but is widely accepted as a good overall indicator of health and nutrition (Martorell 1995)[4]. Small height-for-age, also referred to as *stunted*, is a longer-term proxy for poor health and nutrition (WHO 1995). Growth retardation is the product of inadequate dietary intake, disease and the interaction of these two factors (WHO 1995). Disentangling health from nutritional status is difficult, both empirically and conceptually (Bradley and Keymer 1984), as the maintenance of vital functions receives a

[3] This does assume that households within a community face the same prices and access to infrastructure, a reasonable but perhaps erroneous assumption.

[4] The World Health Organization Technical Expert Committee reports that 5 year-old children from well-nourished populations throughout the world have a variation in attained height of approximately only 1 centimeter (WHO 1995), which provides the basis for using the median height and weight from children living in the United States as international standards.

higher priority than growth (Martorell 1995). Consequently, what is often referred to as "malnutrition" in developing countries, when measured by child anthropometry, more accurately reflects both health and nutritional status. Children are excluded if their HAZ score falls 6 standard deviations above or below the reference mean. Children are unlikely to have such a score; consequently, it is more likely to represent measurement error than an actual valid observation.

Wealth is approximated by the ownership of certain assets. The default is no asset ownership or simply owning a bicycle or radio. The first level of "wealth" is noted by owning both a radio and a bicycle; the second level includes any household with a motorcycle, television or refrigerator; and, the third level indicates ownership of multiple items or ownership of a car. Maternal education is represented by two levels of literacy: (1) not literate, the default; (2) reading with difficulty; and (3) reading easily. Literacy, rather than years of schooling, is selected because it is more comparable across countries than formal education, which may vary widely from one country to the next, and even within countries. Paternal education represents 6 years or more of schooling; data on literacy was unavailable, thus a complete primary education is selected as the next best alternative to maintaining comparability across countries.

For mothers with missing information on height, mean values were used and a dummy variable was constructed to reflect the missing value. Gender, controlled for implicitly by the reference standards calculated, is also controlled for separately in case one sex receives preferential treatment. Children over two years of age who were measured lying down are marked by a dummy variable (lying = 1); these children should have been measured while standing, and vice versa for children under two years (stand = 1).

Least squares regression was used to estimate the models in this analysis. The Breusch-Pagan test for heteroscedasticity rejects the null hypothesis of homoscedasticity for all iterations of the models presented at a significance level of .05. Consequently, estimates of the standard errors robust to heteroscedasticity are calculated using White's correction. All regressions are estimated using Stata software (release 6). Summary statistics describing the model variables are not presented here due to the number of large countries, but are available from the authors.

IV. Empirical Results

Table 2 presents the results of the community fixed-effects regression of child height-for-age on household variables for nine countries in West Africa[5]. Among the key variables of interest, only the parameter estimate on mothers' height-for-age, as a proxy for family background characteristics, is robust across the sample of countries. No immediate patterns emerge among wealth, mothers' or fathers' education. In fact, there is substantial variation in these effects on child health and nutrition. Paternal education is positively and significantly associated with improvements to long-term health for children ages 6 to 35 months in four of the cases being examined. In Mali, Benin and Niger, the marginal expected change in child HAZ scores associated with households where fathers have at least a primary education is approximately a 0.2 increase. Maternal education is also found to be positively and significantly associated with

[5] The countries are listed from left to right in descending order of per capita GDP at the time of the study.

improvements to long-tem health in five cases, where the two levels of literacy are associated with a range from 0.2 to 0.4 expected increase in child height-for-age. A positive impact from higher levels of household wealth is found in six of the countries. Higher levels of wealth in these countries are associated with a 0.2 to 0.4 expected increase in child's HAZ score.

Wealth and Parental Education

There is some evidence in table 2 that suggests fathers' education and household wealth (asset ownership) are more likely to be positive and statistically significantly associated with child height-for-age in countries with relatively lower levels of health and nutrition. On the other hand, mothers' education (literacy) appears more likely to have a positive and significant affect on child height in countries with relatively better health and nutrition. In Mali and Niger, countries with very low average HAZ scores, wealth and fathers' education are important determinants of improved health and nutrition. However, in Senegal, Togo and Burkina Faso – all countries with substantially better average HAZ scores than Mali and Niger – mothers' literacy is a key variable associated with better growth in young children.

The importance of a fathers' education may relate to child health indirectly through the level of wealth and the availability of resources within the household, and less directly via care. Mothers' literacy, on the other hand, is hypothesized to directly influence child health and nutrition through better care, easier access to information and improved information processing skills. Assortive mating suggests that educated women are more likely to be found in wealthier households (Becker 1981). Higher levels of education could also lower child health and nutrition if the higher opportunity cost of the mothers' time resulted in less care-giving behavior or increased care from a less capable care-giver (for a detailed discussion of the causal pathways between mothers' education and child health, see Schultz 1984).

One hypothesis is that at very low levels of child health and nutrition, access to food and health care are of primary concern. For example, in Niger, the mean HAZ score in 1998 in sample was -1.96, implying that roughly half of the children studied are "malnourished". In countries such as Niger and Mali, wealth, indicated by both asset ownership and fathers' education, is a relatively more important factor associated with better child health and nutrition. The second part of the hypothesis is that as health and nutrition improve, utilization of food and health services increases in (relative) importance as a pathway for improving Z scores. Consequently, mothers' education becomes increasingly relevant – as appears to be the case in Senegal, Togo and Burkina Faso.

However, there are several other explanations that cast doubt on whether such a hypothesis, although intuitive, is supported by the empirical evidence shown in table 2. For example, one explanation is that these results reflect the country's health and nutrition policies. Health services may be free in certain countries and not in others, which would mitigate the affect of wealth. Also, it should be noted that in Ghana, where formal schooling is much more prevalent than any of the other countries, none of the education or the wealth variables was statistically significantly associated with better child growth outcomes.

Mothers' Background Characteristics

Mothers' age-standardized height is used to control for unobservable background characteristics. The parameter estimates for mothers' HAZ shown in table 2 are remarkably consistent across countries, and are all highly statistically significant ($p < .01$). A one standard deviation increase in mothers' height-for-age is associated with approximately a 0.25 standard deviation in child height. According to the World Health Organization (1995) for children under 5 years of age, genetic variation in height is minimal – approximately 1 centimeter. For children under 3 years of age, this variation will be even smaller. Consequently, one interpretation of these results is that taller mothers, indicative of better health and nutrition during their childhood, have children that are healthier and/or better nourished, ceteris parabus. This result is consistent with the findings of Fogel (1994) noted earlier regarding secular improvements in health and nutrition. However, this inter-generational transfer of health and nutrition operates over much longer time periods and in itself is not a policy variable. Nevertheless, such robust results are encouraging.

Table 3 reports average mothers' height-for-age by age cohort for all countries in the sample; the average child HAZ score (in sample) is also included in the table as a point of reference, and the countries are still ordered by GDP (decreasing from left to right). Two results warrant further comment. First, countries with the tallest women do not necessarily have the healthiest (tallest) children. The women in Côte d'Ivoire, Benin, Ghana and Togo are shorter on average than the women in the other 5 countries. However, their children are on average as healthy (tall) as children in Senegal and Burkina Faso, and are substantially healthier (taller) than children in Chad, Mali and Niger. Women from Chad, Mali and Niger are some of the tallest on average in the sample, yet their children are among the most unhealthy (shortest). This result buttresses the

WHO (1995) statement that genetic variation plays very little role in determining child height for children under 5 years of age.

Second, mothers' height does not appear to be improving in most of these countries. This trend is particularly troubling, and may help explain why levels of child health and nutrition have not been improving in sub-Saharan Africa in recent years. Due to sample size, it is difficult to make statements about women in the age cohorts over 39 years. The fact that women in the youngest age cohort may not have stopped growing makes it difficult to comment on women under 20. Consequently, women ages 20 to 24 are compared with women ages 35 to 39, a 15 year interval – not quite a generation. Mean HAZ scores for women in the younger cohort, age 20 to 24, are generally worse than heights for women from the older cohort (30 to 34) within the same country. There is some evidence that women's heights are improving in Côte d'Ivoire, Senegal and Burkina Faso, but health (height) appears to be deteriorating in Chad, Benin, Togo, Mali and Niger. One explanation could be the Sahelian drought of the mid 1970s; however, Burkina Faso does not show a similar decline.

Child Characteristics

The dummy variables used to control for the age of the child are highly significant across all countries ($p < .01$). This declining pattern of height-for-age is well documented throughout developing countries (Martorell and Habicht 1986) and is in part due to the nature of growth retardation. Stunting is permanent; consequently, any stunting that occurred in a preceding period remains present throughout. If the behavior that resulted in previous noxious insults continues, then further growth retardation will occur. Thus, there is a steady decline in height-for-age. As children get older (over 5 years) these effects are more difficult to identify; growth patterns become less homogeneous and absolute growth much larger.

Girls appear to have a small growth advantage relative to boys, a result that is somewhat robust – statistically significant in 6 of the 9 countries ($p < .10$). Child height-for-age is standardized by sex, in addition to age. One interpretation is that girls receive preferential treatment to boys. Svedberg (1990) documents this pattern of small, but statistically significant height advantages for girls throughout sub-Saharan Africa. Another explanation may be that the current growth standards do not accurately reflect the different growth patterns among boys and girls. Finally, children that are part of a multiple birth (several sets of triplets were observed) are consistently at a disadvantage in terms of health (height) to children from single births ($p < .01$). The magnitude of this coefficient is large, ranging from –0.6 to –1.2 expected decrease in the children's HAZ scores.

Education Among Other Household Members

A recent article by Gibson (2001) shows that other literate members within the household can make a significant contribution to improved health and nutritional outcomes even though the parents of the children are uneducated or illiterate. Table 4 presents the results of two different model specifications that include the presence of other household members (other than the mother and father) with a sixth grade education or higher[6]. Only minor changes occurred in the model variables, even among asset ownership, fathers' education and mothers' literacy. Consequently, parameter estimates for the (standard) model variables are suppressed for convenience.

[6] This information was not available for Chad and the 1992 Niger study.

The first specification is a dummy variable for any member of the household with a sixth grade education (or higher). A primary education for any member of the household was not found to be positive and statistically significant in any country ($p > .10$), although Ghana and Mali both have reasonably large coefficients. Moreover, the parameter estimate is negative and statistically significantly related to child height-for-age in Côte d'Ivoire and Senegal ($p < .10$) – contrary to *a priori* expectations.

The second model disaggregates the household education dummy variable according to gender to determine whether women are more likely to share information, discuss health issues with one another or are simply more knowledgeable about health and nutrition. When disaggregated for Senegal, neither coefficient is statistically significantly different from zero, although both coefficients are negative. In Côte d'Ivoire, disaggregation by gender yields a parameter estimate for other educated females that is negative and statistically significant ($p < .01$). In addition to Côte d'Ivoire, both Benin and Ghana have sizeable negative coefficients on the presence of other women in the household with at least a sixth grade education. By and large, these results are counter-intuitive. Only in Ghana is additional primary education in the household (of men) positively associated with better child health and nutrition ($p < .10$); the pathway through which this effect operates – directly through improved care or indirectly through higher incomes – remains ambiguous.

V. Discussion

Poor child health and nutrition continues to plague West Africa. Economic growth has long been viewed as a vital component to improving livelihoods and reducing poverty. Although growth appears to be a necessary condition, growth itself does not appear to be sufficient cause for improving child health. The results of this research suggest that the impact of several key underlying household-level determinants on child health and nutritional status, notably wealth and parental education, differs widely across countries. Only maternal height-for-age, a proxy for family background, is robust.

Mothers with a healthier upbringing, who are subsequently taller, have healthier, better nourished children. This result, consistent across all the countries studied as part of this research, is encouraging because it implies that over time improvements in health are passed on from one generation to the next within a given country. However, for many of the countries studied, women on average do not appear to be getting taller (healthier). Maternal height-for-age is a proxy for background characteristics, not a control for genetic factors. Taller women across countries do not necessarily have taller children; otherwise, the children in Chad and Niger would be relatively taller than most, rather than being the shortest. However, women that are relatively taller than one another within a given country, where genetic variation is less of a factor, have taller children.

There is some evidence from this study to suggest that for countries with lower levels of child health and nutrition, household wealth and fathers' education is (relatively) more important. As child health improves, mothers' education appears to be increasingly important. *A priori*, wealth and education are expected to have a positive impact on child health and nutrition. Nevertheless, it is not clear that wealth and education should have similar affects across countries, particularly those at differing levels of economic development. Furthermore, nations face different health obstacles and choose different policy options. Thus, household wealth may be a much more important factor in a country with fee-for-service health care than in a country with free access to health services.

One area for further research is to examine the role of infrastructure in determining child health and nutritional outcomes across countries. This analysis focuses specifically on the impact of household-level determinants, ignoring the role that investments in community infrastructure play in improving child health. In addition to governments and other non-governmental organizations, households also invest in community infrastructure by building schools, health facilities, repairing pumps, hiring teachers, etc. Consequently, the full impact of household income on child health and nutrition is difficult to determine and may be understated. Additional research should seek to incorporate these other pathways through which income may operate.

This study highlights the need for policy makers to consider the context of their respective countries when seeking to make decisions regarding health and nutrition. There is no magic bullet that will cure child malnutrition, and economic growth should not be viewed as a panacea. The observation that healthier mothers appear to raise healthier children is encouraging, but indication that heights are not increasing in many countries is troublesome. Further research will help shed light on the discussion over the impact of maternal height as a proxy for family background characteristics vis-à-vis genetic influence.

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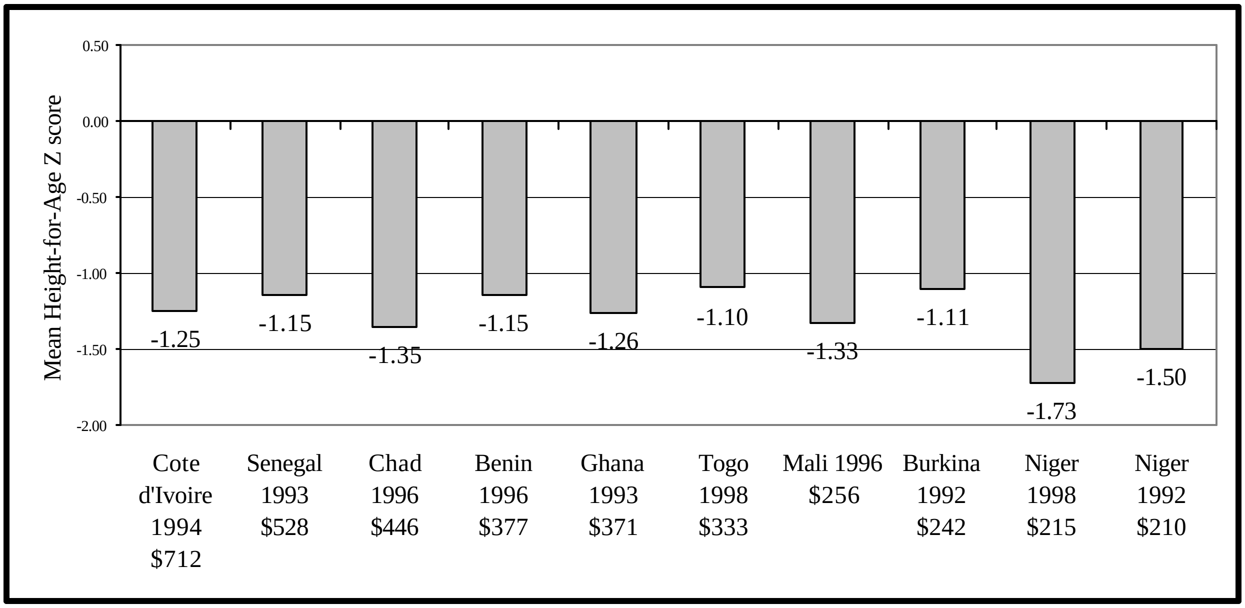
Figure 1: Child Health and Nutrition by GDP for Select Countries, 1992-1998



Source: Demographic and Health Survey; World Bank African Development Indicators 2000.

Table 1: Basic Economic and Health Indicators for Select Countries, West Africa

Indicators:	**Côte d'Ivoire** 1994	**Senegal** 1993	**Chad** 1996	**Benin** 1996	**Ghana** 1993	**Togo** 1998	**Mali** 1996	**Burkina Faso** 1992	**Niger** 1998	**Niger** 1992
GDP										
Per capita	$712	$528	$446	$377	$371	$333	$256	$242	$215	$210
% Δ last 3 years	-3.7%	-3.9%	4.2%	3.0%	2.7%	2.2%	1.9%	1.7%	2.2%	-7.4%
% Δ 1980-89	-2.9%	0.2%	2.1%	-0.6%	-1.4%	-1.9%	-1.8%	1.5%	-3.6%	-3.6%
Value Added Ag.										
Per capita	$201	$101	$155	$130	$77	$131	$109	$78	$89	$81
% Δ last 3 years	-3.4%	-7.8%	9.6%	4.5%	-0.9%	4.5%	4.5%	3.0%	3.7%	-4.3%
% Δ 1980-89	-3.6%	-0.8%	-0.1%	1.3%	-3.0%	1.8%	-0.3%	1.4%	-1.8%	-1.8%
Exports Ag.										
Per capita - 3yr moving avg.	$116	$20	$35	$24	$23	$29	$25	$10	$4	$7
% Δ 1980-89	-5.8%	3.3%	-2.3%	-0.7%	-9.7%	0.5%	-0.3%	-1.3%	-8.8%	-8.8%
Cereal Production										
Per capita - 3yr moving avg.	104	117	264	120	73	143	234	212	220	230
% Δ 1980-89	0.1%	1.4%	-1.0%	2.4%	2.0%	18.9%	5.3%	4.5%	-2.7%	-2.7%
Child Health (6-35 months)										
% "Stunted"	28%	26%	41%	30%	31%	28%	37%	32%	48%	39%
Mean HAZ	-1.29	-1.18	-1.61	-1.29	-1.35	-1.24	-1.53	-1.32	-1.95	-1.62
Education										
Father = None	56%	81%	58%	62%	30%	45%	82%	82%	85%	85%
Mother = None	67%	79%	73%	79%	38%	62%	84%	81%	85%	83%
Mothers' Age Cohort (None):										
20-24	61%	73%	68%	76%	29%	52%	81%	76%	81%	78%
25-29	69%	81%	73%	73%	36%	59%	83%	81%	81%	83%
30-34	72%	77%	80%	81%	44%	59%	85%	84%	87%	85%
35-39	73%	82%	77%	88%	42%	73%	85%	88%	89%	90%
40-44	84%	85%	78%	93%	53%	84%	87%	93%	94%	97%

Source: Africa Development Statistics, World Bank, Washington, D.C.; Demographic and Health Surveys, Macro International, Calverton, Md.

Table 2: Regression Results from Standard Model of Child Height-for-Age (t statistics in parentheses)

Explanatory Variables[‡]**:**	**Côte d'Ivoire** 1994	**Senegal** 1993	**Chad** 1996	**Benin** 1996	**Ghana** 1993	**Togo** 1998	**Mali** 1996	**Burkina Faso** 1992	**Niger** 1998	**Niger** 1992
Asset Ownership										
Radio & Bicycle	0.083 (0.88)	-0.156 (0.83)	0.247 (2.30)**	0.124 (1.53)	-0.199 (1.25)	0.061 (0.91)	-0.073 (1.09)	-0.0252 (0.28)	0.205 (1.77)*	-0.030 (0.19)
Moto, TV, Fridge	0.101 (1.04)	-0.372 (1.71)*	0.203 (1.48)	0.261 (2.75)***	-0.389 (1.03)	0.070 (0.71)	0.051 (0.65)	0.044 (0.53)	0.241 (1.67)*	-0.192 (1.21)
Car or multiple assets	0.317 (4.78)***	-0.107 (1.07)	0.404 (2.51)**	0.118 (0.98)	0.036 (0.26)	0.061 (0.62)	0.180 (1.78)*	0.276 (2.12)**	0.337 (3.18)***	0.310 (3.06)***
Fathers' Education										
6 years & up	0.035 (0.56)	0.147 (1.39)	0.100 (1.11)	0.190 (2.03)**	-0.020 (0.19)	0.029 (0.47)	0.213 (2.30)**	0.132 (1.08)	0.208 (2.45)**	0.272 (2.16)**
Mothers' Education										
Reads w/ difficulty	-0.156 (-1.82)*	0.236 (1.69)*	0.012 (0.11)	-0.009 (0.07)	0.069 (0.68)	0.058 (0.72)	-0.143 (1.09)	0.290 (1.95)*	-0.134 (0.96)	-0.197 (1.28)
Reads easily	0.078 (1.09)	0.114 (0.99)	0.226 (1.87)*	0.260 (1.92)*	0.158 (1.24)	0.168 (1.93)*	-0.006 (0.05)	0.380 (2.70)***	0.095 (0.92)	0.149 (1.27)
Mothers' Background										
HAZ	0.311 (11.8)***	0.276 (8.49)***	0.269 (9.02)***	0.243 (7.61)***	0.260 (6.71)***	0.261 (10.2)***	0.238 (9.18)***	0.243 (7.70)***	0.276 (11.4)***	0.222 (7.13)***
Missing HAZ	0.226 (0.74)	-0.480 (1.79)*	0.307 (0.92)	0.073 (0.30)	-0.532 (0.87)	0.697 (1.80)*	-0.068 (0.24)	-0.152 (0.50)	0.372 (1.21)	-0.104 (0.31)

Explanatory Variables (con't):	**Côte d'Ivoire** 1994	**Senegal** 1993	**Chad** 1996	**Benin** 1996	**Ghana** 1993	**Togo** 1998	**Mali** 1996	**Burkina Faso** 1992	**Niger** 1998	**Niger** 1992
Child Characteristics										
Sex (1 = Female)	0.099 (2.00)**	0.123 (2.02)**	0.071 (1.19)	0.172 (2.77)***	0.139 (1.81)*	0.179 (3.56)***	0.081 (1.66)*	0.081 (1.31)	0.054 (1.16)	0.058 (1.01)
Twin (1 = yes)	-0.828 (5.72)***	-1.278 (4.78)***	-0.770 (4.12)***	-1.013 (7.31)***	-1.145 (5.85)***	-1.048 (7.47)***	-0.741 (4.97)***	-1.251 (5.96)***	-0.937 (6.83)***	-0.640 (4.05)***
Age 12-17 months	-0.706 (9.45)***	-0.638 (6.94)***	-0.831 (9.58)***	-0.500 (5.20)***	-0.655 (5.41)***	-0.703 (8.95)***	-0.842 (11.8)***	-1.014 (11.0)***	-0.793 (11.4)***	-0.789 (9.25)***
Age 18-23 months	-1.128 (13.2)***	-1.208 (11.5)***	-1.639 (16.4)***	-0.847 (8.70)***	-1.205 (9.98)***	-1.249 (14.3)***	-1.603 (20.3)***	-1.451 (14.2)***	-1.340 (15.79)***	-1.416 (14.78)***
Age 24-29 months	-0.664 (7.94)***	-0.710 (7.42)***	-1.028 (10.7)***	-0.633 (5.47)***	-0.752 (5.62)***	-0.482 (5.49)***	-0.844 (9.99)***	-1.062 (9.83)***	-0.847 (10.8)***	-1.081 (11.7)***
Age 30-35 months	-0.958 (11.8)***	-0.961 (9.34)***	-1.646 (16.3)***	-0.983 (10.1)***	-1.219 (9.91)***	-0.918 (11.8)***	-1.351 (16.1)***	-1.281 (12.3)***	-1.052 (13.3)***	-1.108 (10.9)***
Measured Incorrectly										
Lying	0.63 (0.54)	0.085 (0.69)	0.433 (2.95)***	-0.194 (1.37)	0.179 (0.71)	0.656 (4.89)***	0.420 (2.72)***	0.069 (0.54)	0.140 (1.71)*	0.370 (2.58)**
Standing	-0.353 (3.77)***	-0.535 (3.04)***	-0.852 (4.34)***	-0.399 (3.26)***	-0.569 (3.28)***	-0.745 (8.02)***	-0.621 (7.27)***	-0.361 (2.60)***	-0.356 (3.61)***	-0.426 (2.87)***
Model Properties										
F Statistic	17.79***	33.19***	11.49***	76.77***	43.11***	6.32***	55.78***	12.89***	20.77***	37.92***
R-Squared	0.32	0.32	0.32	0.33	0.43	0.32	0.29	0.33	0.30	0.38
Sample Size	2589	1952	2653	1799	1459	2719	3603	1970	3048	2145

"*" denotes significance of $p < .10$; "**" $p < .05$; and "***" $p < .01$.

Table 3: Mothers' Height-for-Age by Age Cohort†

Mothers' Age Distribution‡:	**Côte d'Ivoire** 1994	**Senegal** 1993	**Chad** 1996	**Benin** 1996	**Ghana** 1993	**Togo** 1998	**Mali** 1996	**Burkina Faso** 1992	**Niger** 1998	**Niger** 1992
Age 15 to 19	-0.85 (397)	-0.20 (200)	-0.33 (385)	-1.16 (163)	-1.02 (124)	-1.03 (191)	-0.54 (451)	-0.38 (221)	-0.67 (458)	-0.54 (283)
Age 20 to 24	-0.75 (793)	-0.18 (553)	-0.18 (900)	-1.00 (565)	-0.91 (400)	-0.85 (668)	-0.35 (1014)	-0.31 (655)	-0.59 (888)	-0.54 (661)
Age 25 to 29	-0.74 (832)	-0.19 (584)	-0.21 (917)	-0.89 (584)	-0.88 (482)	-0.79 (941)	-0.33 (1110)	-0.32 (654)	-0.48 (907)	-0.52 (788)
Age 30 to 34	-0.71 (618)	-0.17 (518)	-0.10 (589)	-0.81 (439)	-0.75 (413)	-0.76 (781)	-0.37 (938)	-0.23 (482)	-0.42 (729)	-0.44 (497)
Age 35 to 39	-0.90 (326)	-0.26 (378)	-0.07 (393)	-0.88 (334)	-0.89 (228)	-0.79 (468)	-0.29 (674)	-0.42 (318)	-0.52 (519)	-0.44 (314)
Age 40 to 44	-0.81 (141)	-0.25 (172)	-0.12 (133)	-0.94 (120)	-0.78 (112)	-0.84 (203)	-0.28 (273)	-0.36 (118)	-0.57 (198)	-0.54 (135)
Age 45 to 49	-0.85 (43)	-0.59 (36)	-0.16 (36)	-0.83 (37)	-0.71 (31)	-0.95 (72)	-0.28 (61)	-0.24 (33)	-0.33 (60)	-0.23 (30)
Total	-0.77 (3150)	-0.21 (2441)	-0.18 (3353)	-0.92 (2242)	-0.86 (1790)	-0.81 (3324)	-0.35 (4521)	-0.32 (2481)	-0.52 (3759)	-0.50 (2708)
(Mean Child HAZ)	*-1.29*	*-1.18*	*-1.60*	*-1.35*	*-1.28*	*-1.25*	*-1.54*	*-1.31*	*-1.96*	*-1.61*

†Age-standardized heights are only applicable for the youngest age cohort; all other cohorts use the same standard.
‡Sample sizes are reported in parentheses; the sample includes the mothers of all children ages 0 to 35 months.

Table 4: Regression Results of Household Education Variables on Child Height-for-Age†

Explanatory Variables‡:	**Côte d'Ivoire** 1994	**Senegal** 1993	**Benin** 1996	**Ghana** 1993	**Togo** 1998	**Mali** 1996	**Burkina Faso** 1992	**Niger** 1998
Model 1								
Any Member – 6 Years & up	-0.137 (2.37)**	-0.152 (1.92)*	-0.058 (0.51)	0.128 (1.37)	0.039 (0.53)	0.161 (1.58)	0.008 (0.09)	0.049 (0.65)
% w/ 6th Grade Education	*26%*	*27%*	*8%*	*33%*	*15%*	*7%*	*15%*	*12%*
Model 2								
Male – 6 Years & up	-0.008 (0.12)	-0.107 (1.25)	0.019 (0.15)	0.163 (1.68)*	0.041 (0.52)	0.103 (0.94)	-0.030 (0.30)	0.082 (0.93)
% w/ 6th Grade Education	*20%*	*21%*	*7%*	*28%*	*12%*	*6%*	*11%*	*8%*
Female – 6 Years & up	-0.250 (3.13)***	-0.050 (0.51)	-0.291 (1.52)	-0.219 (1.41)	0.050 (0.43)	0.113 (0.71)	0.179 (1.44)	-0.044 (0.43)
% w/ 6th Grade Education	*11%*	*14%*	*2%*	*8%*	*5%*	*3%*	*7%*	*6%*

†Only parameter estimates for the household educational variables are reported, all others are suppressed for convenience.
‡Test "t" statistics are reported in parentheses; *denotes significance of $p < .10$; **denotes significance of $p < .05$; and, ***denotes significance of $p < .01$; below the test statistics are the percent of households with members who have a sixth grade education.