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Staff Paper

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

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Staff Paper 2001-27

November 2001



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AEC Staff Paper No. 2001-27

21 pages

November 2001

Key Words: Sub-Saharan Africa, West Africa, Economic Development, Health, Nutrition

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 who have had a healthier upbringing and hence are taller, have healthier children, *ceteris paribus*. This finding is consistent with long-run observations that increases in health (and height) coincide with economic development.

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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 (Craviata and Arrieta, 1986; 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. Why are children in one nation healthier, on average, than children in a neighboring country? The percentage of children classified as stunted, a long-term measure of child health and nutrition, ranges from one-quarter to as much as one-half the population in West Africa¹. 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. Figure 1 illustrates the (short-run) ambiguity between levels of GDP and child health and nutrition. Less wealthy nations, such as Togo and Burkina Faso, report levels of stunting similar to Côte d'Ivoire among children under three, although these countries have less than half the per capita GDP of Côte d'Ivoire.

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 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 key parameters to vary by country, 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 (lifetime income) and maternal education should be the same across all countries. These variables may differ in importance according to the level of economic development and will interact with public policy. 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 diarrhea. 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

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.

opposite result is expected; as knowledgeable as a caregiver may be, treating malaria still requires medicine that must be purchased.

The findings of this analysis suggest that maternal background characteristics, proxied by maternal age-standardized height, have a positive, statistically significant effect that is highly similar in magnitude across all the countries in the sample. This result does not represent merely a genetic influence (WHO, 1995; Thomas et al., 1990). 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

This paper uses 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 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 .

$$U = u(C_i, L_i, H_i, \xi) \quad (1)$$

The reduced form equation incorporates household, child and community characteristics. Household variables include wealth, as a measure of exogenous permanent or lifetime 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 Behrman and Deolalikar, 1988). Unobservable background characteristics are controlled for by maternal anthropometry² (see Strauss, 1990). Child characteristics of particular importance include age, sex and whether he or she is from a multiple birth.

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

Equation (2) above states that the child's health and nutrition (H_{Child}), is a function of household wealth (w), prices (p), a vector of community, household and child characteristics (θ), and a random error term (ε)³.

² The use and interpretation of maternal height is discussed in greater detail in section 4.1.

³ 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 older age cohort if children from wealthier, more educated families are more likely to survive (see Thomas and Strauss 1992).

III. Data & Methods

3.1 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, Inc. 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. We chose this range of ages because measurement error, relative to absolute growth, is large for children under 6 months of age, and because several of the countries did not collect height information on children over 3 years of age. Each of the surveys used similar sampling techniques, based on a complex stratified, clustered sampling process that measured from 1,500 to nearly 4,000 children in each country. Although the DHS studies evolve 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). 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 (mothers and their children) who were 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 varying level of (formal) education across countries. Approximately 60% of mothers and 70% of fathers have at least some formal education in Ghana, while only about 20% of their counterparts in Burkina Faso, Mali, Niger and Senegal report any formal schooling. Apart from Ghana, Togo appears to have made the largest stride 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.

3.2 Empirical Estimation

The empirical analysis in this paper compares parameter estimates of model variables across nine countries. The comparability of these results is addressed in several ways: (1) geography; (2) model specification; (3) functional form; and (4) the choice of variables.

- *Geography:* 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 six-year time span.

- *Model Specification:* Community-level fixed effects estimates are used to control for inter-community variation⁴. Factors such as infrastructure may vary widely in quality and services provided from one country to the next and within country as well. Relative prices also differ both within and across countries, as do the types of foods consumed. Thus, this model looks at the impact of key variables while holding community-level variables constant. The model examines, for example, only the impact of intra-community variation in wealth on child health and nutritional status, not the impact of inter-community differences (to the extent that those are reflected in differing levels of health and educational infrastructure).
- *Functional Form:* 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.
- *Choice of Variables:* 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, expressed as a Z score (HAZ), 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, $n \sim (0,1)$, standardized according to data collected in the U.S. from healthy, well-nourished children. This measure is widely accepted as a good overall indicator of health and nutrition (Martorell, 1995)⁵, although it is not without some controversy (see Seckler, 1982). 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 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 a 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 three levels: (1) not literate, the default; (2) reads with

⁴ This assumes that households within a community face the same prices and access to infrastructure.,

⁵ The World Health Organization Technical Expert Committee reports that in environments with no adverse influences on growth, ethnic differences in growth patterns result in height variability of approximately 1 centimeter in 5-year-old children worldwide (WHO 1995). This low level of variation provides the basis for using the median height and weight from children living in the United States as international standards.

difficulty; and (3) reads easily. We used literacy, rather than years of schooling because literacy is more comparable across countries than formal education, which may vary widely from one country to the next, and even within countries. Paternal education is measured by a dummy variable that takes on a value of one if the father has represents six years or more of schooling. Data on fathers' literacy was unavailable, thus we selected complete primary education 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. The gender of the child, controlled for implicitly by the reference standards calculated, is also controlled for separately to test whether 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).

Ordinary 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 nations studied in West Africa⁶. The most striking result is the robustness of mother's height-for-age, a proxy for background characteristics. This parameter estimate is remarkably similar in magnitude and statistically significantly associated with improved child health and nutritional status across all countries in the sample. One interpretation for this result is that mothers with a healthier, more advantageous upbringing have healthier children.

Among the other key variables of interest, 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 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 improvements to long-term 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.

4.1 Mothers' Background Characteristics

Healthier (taller) mothers have healthier (taller) children. Mothers' height, used to control for unobservable background characteristics, is remarkably similar in magnitude across all 10 sample populations and is highly statistically significant in every case ($p < .01$; see table 2). 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 five years of age, genetic variation in height is minimal – approximately 1 centimeter. For children under three 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 paribus*⁷.

Although it seems plausible to interpret these findings as the result of genetic influence, in young children, such a conclusion would be incorrect. For example, a study of two groups of children, one under-nourished and the other healthy and well-nourished, from Ibadan, Nigeria, finds large differences between the two groups but very little variation within the groups (Eveleth, 1986). Thomas et al. (1990), regressing child height-for-age on similar variables, find a much larger

⁶ The countries are listed from left to right in descending order of per capita GDP at the time of the study.

⁷ See appendix 1 for the parameter estimates from alternative specifications of mother's height, including a natural log, a linear and a quadratic specification. The log and linear height specifications are each consistent across countries and statistically significant ($p < .01$). The results of the quadratic form indicate that the relationship is not parabolic.

effect of mother's height than father's height on child HAZ scores and reject the restriction of equivalent parameter estimates ($p < .01$). Consequently, the authors conclude that mother's height is also controlling for unobservable family background characteristics.

Figure 2 plots the average children and mothers' height-for-age for all 10 countries. There is no indication from the diagram that taller women have taller (healthier) children – no linear relationship is evident between these two factors. The women in Côte d'Ivoire, Benin, Ghana and Togo are shorter on average than the women in the other five 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 further buttresses the WHO (1995) statement that genetic variation plays very little role in determining child height for children under five years of age.

This result is also 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 as they imply that changes in behavior resulting in improved health and nutritional status are sustainable.

Table 3, reporting in more detail mean height-for-age for mothers by age cohort for all countries in the sample, also suggests that mothers' height is not improving in many 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. But we can compare women ages 20 to 24 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.

4.2 Wealth and Parental Education

There is some evidence (see 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.

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, other competing explanations are equally plausible. One interpretation is that these results simply reflect the country’s health and nutritional policies. Health services may be free in certain countries and not in others, which would mitigate the affect of wealth. Knowledge (information processing) of free vaccinations offered at a public health clinic may explain why mother’s education is statistically significant in one country and wealth in another. Some countries may incorporate health into their educational curricula, which can also affect the role of education vis-à-vis wealth in improving child health and nutrition.

The total impact of wealth on child health and nutrition is likely to be understated. This analysis focuses on the impact of key determinants of child health and nutrition at the household level, controlling for inter-community variation. However, wealth, particularly over the longer run, may play an important role at the community level 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 full impact of household wealth is understated by this model.

4.3 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 the child’s life. 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 five 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 six of the nine 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, possibly by spending more time with the primary caregiver (their mothers). Svedberg (1990) documents this pattern of small, but statistically significant height advantages for girls throughout sub-Saharan Africa. Another equally plausible explanation is 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.

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, particularly over the long run. Although growth may be a necessary condition, growth itself does not appear in the short run to be sufficient cause for improving child health. The results of this research suggest that the affects of several key underlying household-level determinants of child health and nutritional status, notably wealth and parental education, vary 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 – a result that is consistent across all the countries studied. This finding is encouraging because it suggests that over time improvements in health and nutrition, presumably through changes in knowledge, attitudes and practices, are passed on from one generation to the next. This result is not simply 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.

For many of the countries studied, women on average do not appear to be getting taller (healthier), which may help to explain why levels of child malnutrition remain so pervasive. One area for future research is to identify more precisely the health and nutritional behaviors that differ between healthier (taller) mothers and their counterparts in other households where children are less healthy and well-nourished, *ceteris paribus*. This type of research is far more difficult from both an empirical and econometric perspective, but is likely to be of much greater interest to policy makers.

Nations face different health obstacles and choose different policy options. Thus, household wealth may be relatively more important factor than mother's education in a country with fee-for-service health care, and vice versa in a country with free access to health services. Another area for further research is to examine the role of households and household income in financing community infrastructure, particularly given the current reductions in government expenditures by many developing countries facing structural adjustment. Households make investments in community infrastructure by building schools, health facilities, repairing pumps, hiring teachers, etc. Previous research on the role of community infrastructure shows that basic services, such as immunizations and stocking basic medicines at health facilities, have a positive effect on child health and nutrition (Thomas et al., 1996). Additional research should seek to investigate the factors that encourage or prevent communities from investing resources directly into local infrastructure.

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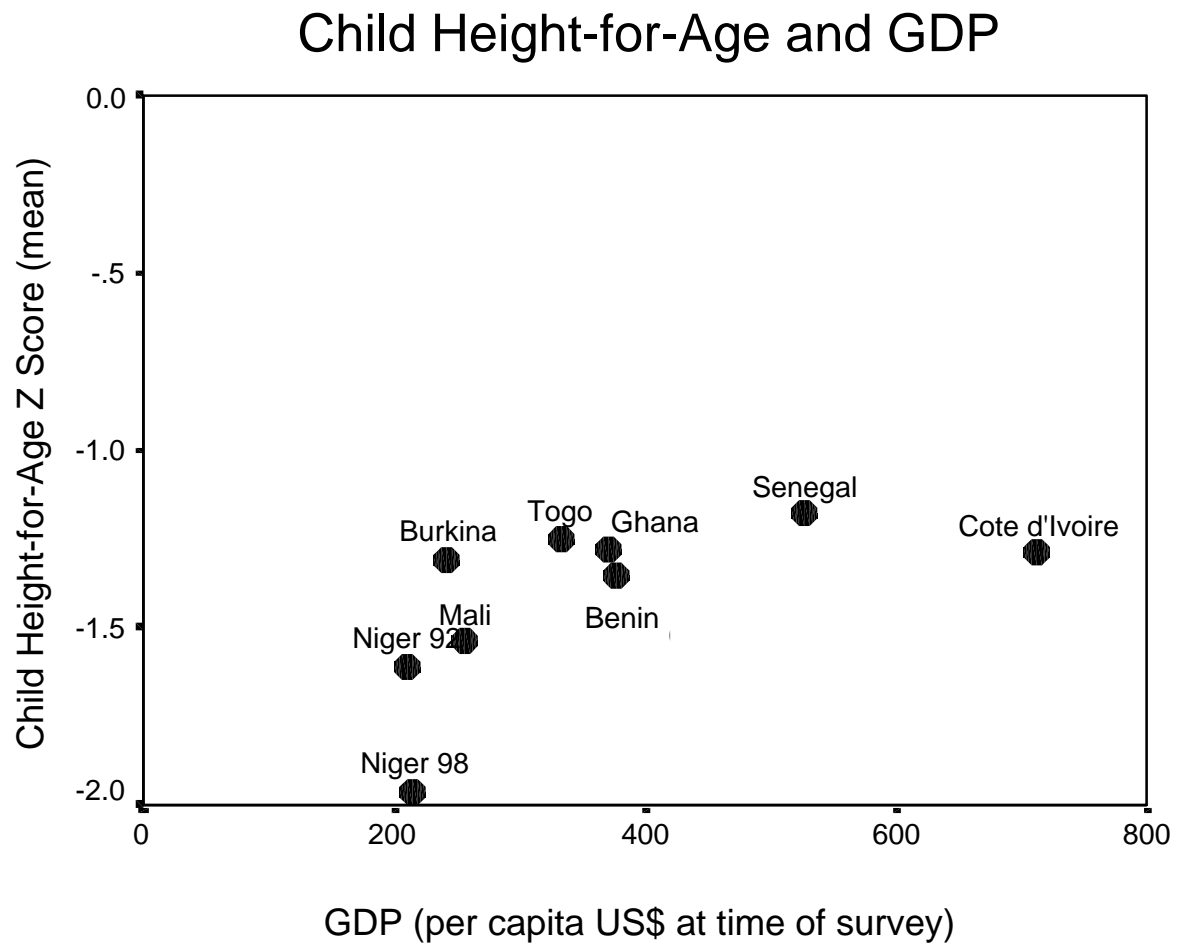
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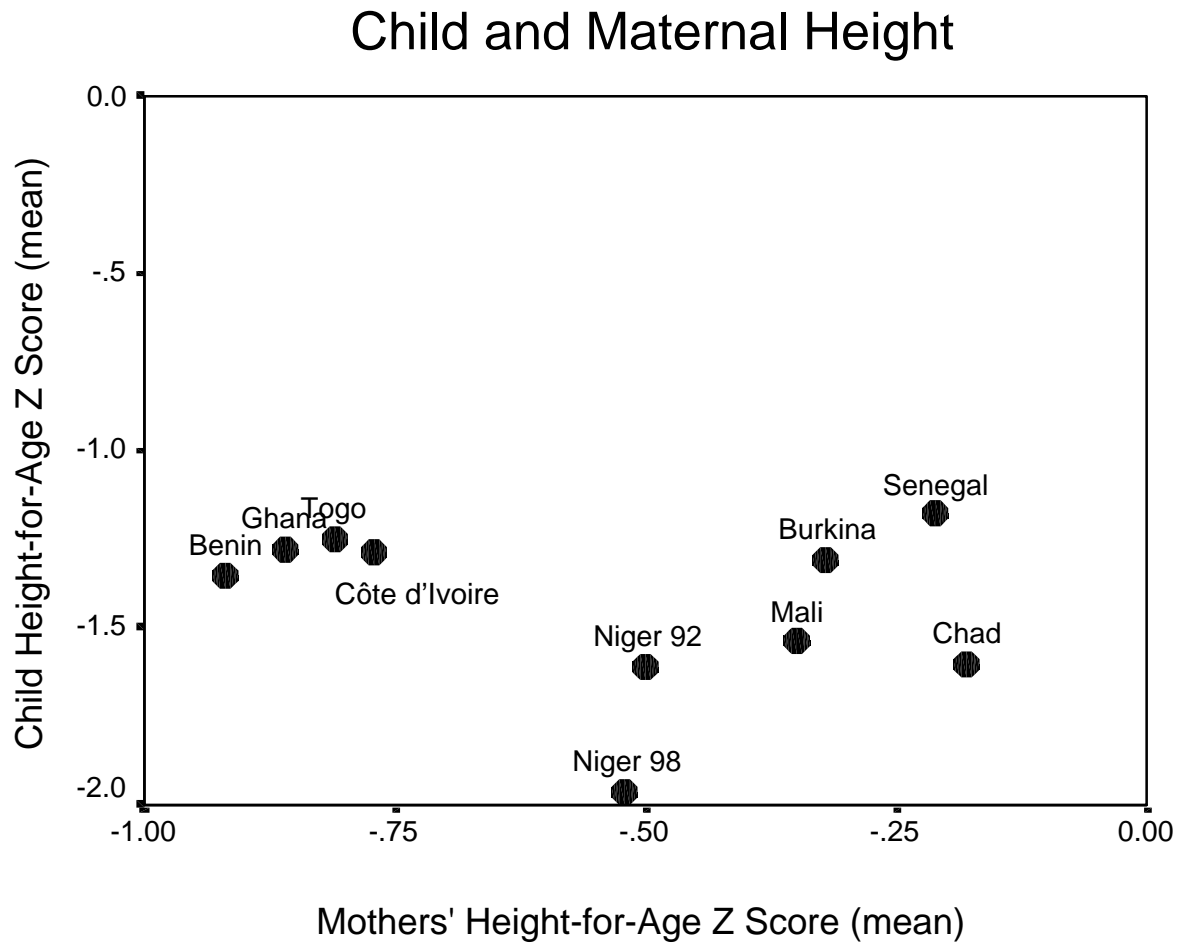
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Figure 1: Child Health and Nutrition by Per Capita GDP for Select Countries, 1992-1998



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

Figure 2: Child and Mother's Health and Nutrition for Select Countries, 1992-1998



Source: Demographic and Health Survey.

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
Annual % Δ last 3 years	-3.7%	-3.9%	4.2%	3.0%	2.7%	2.2%	1.9%	1.7%	2.2%	-7.4%
Annual % 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
Annual % Δ last 3 years	-3.4%	-7.8%	9.6%	4.5%	-0.9%	4.5%	4.5%	3.0%	3.7%	-4.3%
Annual % 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
Annual % 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. (kg.)	104	117	264	120	73	143	234	212	220	230
Annual % 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
<u>Asset Ownership</u>										
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)***
<u>Fathers' Education</u>										
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)**
<u>Mothers' Education</u>										
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)
<u>Mothers' Background</u>										
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)

Table 2 (continued):

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
<u>Child Characteristics</u>										
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)***
<u>Measured Incorrectly</u>										
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)***
<u>Model Properties</u>										
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)
<i>(Mean Child HAZ)</i>	-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.

Appendix 1: Parameter Estimates for Alternative Specifications of Mothers Height[†]

<u>Country</u>	<u>Log of Mother's Height (cm.)</u>	<u>Mother's Height (cm.)</u>	<u>Mother's Height & Mother's Height Squared</u>	
			(cm.)	(cm. ²)
Benin	6.452 (7.617)	0.0407 (7.601)	0.178 (1.088)	-0.0004 (0.842)
Burkina Faso	6.597 (7.707)	0.0406 (7.658)	0.335 (1.653)	-0.0009 (1.451)
Chad	7.382 (9.084)	0.0452 (9.056)	0.144 (1.015)	-0.0003 (0.698)
Côte d'Ivoire	8.303 (11.784)	0.0522 (11.811)	0.731 (0.460)	-0.0001 (0.132)
Ghana	6.995 (6.804)	0.0438 (6.770)	0.231 (1.271)	-0.0006 (1.035)
Mali	6.467 (9.240)	0.0400 (9.241)	0.075 (0.488)	-0.0001 (0.229)
Niger 1992	6.025 (7.262)	0.0372 (7.130)	0.285 (1.907)	-0.0008 (1.654)
Niger 1998	7.448 (11.406)	0.0461 (11.346)	0.303 (2.458)	-0.0008 (2.088)
Senegal	7.591 (8.590)	0.0463 (8.500)	0.473 (2.820)	-0.0013 (2.551)
Togo	7.061 (10.350)	0.0439 (10.193)	0.417 (3.433)	-0.0012 (3.084)

[†]t statistics are reported in parentheses.