NUTRITIONAL STATUS IN GHANA AND ITS DETERMINANTS

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Social indicators for Ghana reflect the cumulative impact of economic mismanagement since independence as much as current policies. Indeed, many of the policies inn place since 1983 represent a major break with the previous decade. By a number of measures, this economic recovery program has been successful in turning the economy around; GNP per capita has grown every year since 1983, a sequence which is unprecedented in post-independence history. The magnitude of the decline prior to the recovery program was sufficiently large, however, that this appreciable progress is still only a partial recovery.

This report presents data based on the Ghana Living Standards Survey first year (1987-88), which indicate that levels of malnutrition in Ghana remain relatively high compared to other African countries. The nutritional status of children is nevertheless improved compared to a variety of data covering the period 1982-86. These anthropometric measures of nutritional status show a strong regional pattern, with malnutrition increasing roughly from south to north.

Econometric analysis also revealed strong effects of household composition and intergenerational effects through the mother's height. Since this latter effect is far larger than the similar positive correlation of height-for-age and the father's height, it is likely to indicate the influence of the womb environment more than genetics and, as such, a lagged nutritional effect. No gender bias was observed, consistent with other African evidence. Levels of chronic malnutrition (low height-for-age) but not acute malnutrition (weight-for-age) decrease as income increases, although the statistical precision of this relationship is comparatively low. There is, however, a strong effect of income on body mass indices (BMI) for adult women. The study also indicates that BMI decreases with higher parity, which was introduced into the analysis as an instrumented variable to control for individual heterogeneity and possible reverse causality.

While the positive relationship between income and nutritional levels observed in this study may be deemed obvious, it is surprisingly difficult to demonstrate and often contradicted. The results, however, confirm a similar study based on Côte d'Ivoire data. Many of the long-term impacts of current economic policies, although introduced for reasons other than nutrition, will likely affect nutrition through this income relationship. A revival of Ghana's once noteworthy educational system may also affect nutrition via income, rather than directly shifting the effectiveness of input utilization.

FOREWORD

The effects of macroeconomic and sectoral policies on the poor are a subject of increasing concern, especially in sub-Saharan Africa, where research on the characteristics and behavior of the poor has been lacking. In response to the need to better identify the poor so as to determine the effect of policy reform on vulnerable households, CFNPP is undertaking a number of studies on the causes and characteristics of poverty, food insecurity, and malnutrition in sub-Saharan Africa, as well as analyses of household behavior and decision making. These are designed to set the stage for further research concerning how policy reform measures have affected welfare.

This first CFNPP Working Paper on nutritional status and its determinants will be followed by other poverty analyses in Ghana and elsewhere throughout the region. The work contained in this study will also feed into modeling efforts now underway in Ghana as part of a multicountry case study to determine the effectiveness of macroeconomic and sectoral adjustment programs and their distributional and welfare implications. The overall research in Ghana is being undertaken under a Cooperative Agreement between CFNPP and the Africa Bureau of the U.S. Agency for International Development (USAID). However, this particular study on nutrition in Ghana was jointly financed by the Social Dimensions of Adjustment Unit of the World Bank and the Africa Bureau of USAID.

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David E. Sahn
Deputy Director, CFNPP

1. INTRODUCTION

While economists generally assume that changes in household incomes are unambiguous indicators of changes in the welfare of the household, many planners and government officials consider health and nutritional status as additional indicators of social welfare. This reflects both potential externalities from health improvements as well as societies' specific aversion to malnutrition (Tobin 1979). Consequently, information on the nutritional status of a population provides information on the health of the economy. Moreover, insights into the etiology of undernutrition assist planners in effectively meeting their social objectives.

There is clearly a basis for concern for health and nutrition in Ghana. Life expectancy at birth in 1987 was only 54 years (World Bank 1989). This is identical to the average for all low income countries, excluding India and China, according to World Bank estimates. Infant mortality rates are 90 deaths per 1,000 births. While somewhat lower than the average for low-income countries, this figure does not represent appreciable progress relative to estimates from a decade before. In a related vein, the World Development Report for 1989 indicates that food availability per capita in 1986 was not only one of the lowest in the world, it was appreciably lower than 10 or 20 years before (World Bank 1989).

The comparatively low levels of social indicators reflect the cumulative impact of economic mismanagement since independence more than current policies.[1] Indeed, many of the policies in place since 1983 represent a major break with previous economic policies. By a number of measures this economic recovery program has been successful in turning the economy around; GNP per capita has grown every year since 1983, a sequence that is unprecedented in post-independence history. The magnitude of the decline prior to the recovery program was sufficiently large, however, that this significant progress is still only a partial recovery.

One illustration of the medium-term task can be derived by noting that GNP *per capita* declined at an average annual rate of 1.6 between 1965 and 1987 (World Bank 1989). Assuming a population growth rate of 3 percent, a figure which is somewhat lower than the average for 1980-87, it would require an average GNP growth rate of 5.8 percent in order to restore GNP per capita to its 1965 level by the end of the century. There is nothing, of course, magic about the year 2000, nor is this illustration necessarily robust to alternative starting points. It does, however, provide an indication of the scope of the real task of recovery and puts short-term measures of success in

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1 See Rimmer (forthcoming) for an economic history.

perspective. Moreover, for many, full recovery only implies recovery into poverty. Such poverty is not a product of current policies, but is nevertheless its challenge.

One means of addressing this challenge is the Program of Actions to Mitigate the Social Costs of Adjustment (PAMSCAD) designed by the Government with donor support in 1987. Mitigate is, perhaps, an inappropriate word as many of the poverty issues the program seeks to address predate the recovery program. Nevertheless, PAMSCAD addresses a variety of social concerns not always linked with economic recovery programs.

As an input into these and other programs to alleviate poverty and its consequences, this study presents information on nutrition in Ghana in 1987/88 as indicated in the first-year data from the Ghana Living Standards Study (GLSS).[2] The indicators of nutrition derived from this survey are also compared with the limited information available from earlier years in order to provide a perspective on changes in living standards in recent years as well as to serve as a baseline for further comparisons. The report also goes beyond descriptive statistics and investigates the determinants of malnutrition. It is hoped that this analysis can contribute to the design of nutrition programs in Ghana as well as to the general understanding of household behavior.

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2 Methodology and descriptive statistics covering the entire survey are presented in Republic of Ghana (1989).

2. THE EXTENT OF MALNUTRITION IN GHANA

NUTRITIONAL STATUS OF PRESCHOOL-AGED CHILDREN

During the period October 1987 to September 1988, 30.6 percent of preschool children aged under five years were found to be chronically malnourished as indicated by slow linear growth. Using a measure of emaciation or wasting, 7.8 percent of this preschool population could be classified as acutely malnourished. Before reporting how this national average distributes over age groups, gender, or agroecological zones, it is interesting to compare the overall nutritional status measures with similar indicators from other countries and with other data from Ghana. This, in turn, necessitates a discussion of methodology, for different researchers chose different criteria for presenting nutritional status.

Most commonly, a low height-for-age relative to a reference population is used as a measure of past or chronic malnutrition while low weight-for-height indicates current or acute malnutrition (Waterlow 1973). This, however, begs the question of the definition of "low." A cutoff point of two standard deviations below the U.S. National Center for Health Statistics (NCHS) reference median is employed for this study. Alternative criteria frequently employed are below 90 percent of reference height-for-age and 80 percent of reference weight-for-height. These percentages of median cutoff points, however, are not equivalent to the standard deviation criteria (Waterlow et al. 1977). The differences between the two criteria are often not trivial. For example, using the percent of median cutoff criteria, chronic and acute malnutrition levels were 19.6 percent and 5.1 percent in Ghana in 1987-88. By this definition, then, levels of both acute and chronic malnutrition are two-thirds of what they are, using a two-standard deviation cutoff point. Since an age invariant probability statement can be made using the standard deviation presentation while the distribution of the percentages of the reference vary by age and size, the former methodology is preferred.

Table 1 presents measures of malnutrition for selected African and Asian countries. Ghana and Côte d'Ivoire are strictly comparable not only because of the similarity of survey methodology but also because the Ivoirian data are the only other data from Africa that use a standard deviation criterion for determining levels of malnutrition. To broaden the scope of comparison, Table 1 also includes a percent of median cutoff indicator of malnutrition in Ghana as well as an indicator in terms of weight-for-age.

Chronic malnutrition is much higher in Ghana than in its immediate neighbor to the west, although levels of acute malnutrition are similar. This pattern may reflect the fact that in 1986 the Ivoirian economy had declined sharply from previous years while Ghana in 1987-88 had experienced

Table 1 - Indicators of Malnutrition in Selected Developing Countries

Country	Survey Year	Chronic Undernutrition		Acute Undernutrition		Underweight[a]	
		Rural	Urban	Rural	Urban	Rural	Urban
Ghana	1988	34.8	22.0	8.6	6.1	22.9	14.3
	1988	22.8[a]	12.3[a]	5.8[b]	3.5[b]	34.8[d]	23.5[d]
Côte d'Ivoire	1985	18.4	11.3	6.5	5.0	..	..
	1986	19.4	11.2	6.8	8.4	..	..
Egypt	1978	23.8[a]	12.7[a]	0.7[b]	0.4[b]	9.9	5.2
Cameroon	1977	22.4[a]	15.7[a]	1.1[b]	0.7[b]	23.0[d]	12.1[d]
Liberia	1976	20.2[a]	13.8[a]	1.6[b]	1.7[b]	25.5[d]	20.5[d]
Togo	1977	20.5[a]	11.4[a]	2.3[b]	0.8[b]	16.5	8.9
Sierra Leone	1977	26.6[a]	13.8[a]	3.2[b]	2.4[b]	32.4	21.3
Niger[e]	1974	..	..	11.4[b]	..	..	..
Mali[e]	1974	..	..	10.7[b]	..	..	..
	1975	..	..	5.3[b]	..	..	..
Mauritania[e]	1974	..	..	9.9[b]	..	..	..
	1975	..	..	6.1[b]	..	..	..
Chad[e]	1974	..	..	22.5[b]	..	..	..
	1975	..	..	12.1[b]	..	..	..
Burkina Faso[e]	1974	48.0[a]	..	9.1[b]	..	..	..
	1975	43.8[a]	..	8.1[b]	..	..	..
Kenya	1977	28.7[a]	..	4.4[b]	..	..	..
Sri Lanka	1976	34.7[a]	..	6.6[b]	..	42.0	..
	1976	44.0	..	8.4	..	..	..
	1980-82	36.3	..	13.8	..	..	..
Nepal	1975	51.9[a]	..	6.6[b]	..	49.9	..

Sources: USAID (1975, 1976a, 1976b, 1977a, 1977b, 1977c), USHEW (1974, 1975), Kenya (1979), Sahn (1987, 1988). Table adapted from Kumar (1985).

[a] Children below 90 percent of reference height-for-age.
[b] Children below 80 percent of reference weight-for-height.
[c] Children below 75 percent of reference weight-for-age, except where noted.
[d] Children below 80 percent of reference weight-for-age.
[e] Surveys covered only the rural sedentary population of that part of each country estimated to be most affected by the drought. The affected zone varied from a relatively small part of Burkina Faso to nearly all of Niger. Geographical coverage for the area was about one-third.

appreciable recent growth. Thus, they may have reached similar levels of short-term malnutrition from different antecedents. This conjecture is supported by the fact that acute malnutrition is higher in Côte d'Ivoire in 1986 than the previous year, although the statistical significance of this difference is not known.

The percentage of Ghanaians who are below 90 percent of the reference height is roughly similar to the percentage in other West African countries, except Burkino Faso. The African levels are, however, far below the levels of chronic malnutrition in South Asia. Thus, it is somewhat surprising that the percentage of children in Ghana who are below 80 percent of the standard for weight-for-height is closer to the levels in Nepal and Sri Lanka than to those in Sierra Leone, Togo, Liberia, and Cameroon.[3] Current acute malnutrition in Ghana is also similar to rural Mali and Mauritania in post-drought recovery years but substantially less than in those countries or neighboring countries during the 1974 drought. A comparison with nationwide surveys in Lesotho and Swaziland (USAID 1986, 1977), for which an urban rural breakdown is not available, reveals a similar pattern; the Southern African countries had levels of chronic malnutrition roughly comparable to Ghana but had levels of acute malnutrition that were far lower. Table 1 indicates, furthermore, that the percentage of Ghanaian children who are underweight, either due to current or past malnutrition, is also high relative to most of the African countries for which comparable data are available.

Despite the relatively high current levels of malnutrition in Ghana, the situation appears to have improved compared with earlier years in the decade. For example, a nationwide survey of 14,000 children conducted by the Nutrition Department, Ministry of Health, and UNICEF in November and December 1986 found that 58.4 percent of preschool children fell below 80 percent of NCHS weight-for-age standards (Levinson 1988).[4] This is roughly twice the level of the first national survey carried out in 1961-62. The current study found that 31.4 percent of children fell below 80 percent of the weight-for-age standard. This implies, then, that malnutrition has declined since 1986 but remains above the levels reported for the early post-independence years. Note that the weight-for-age standard cannot distinguish between chronic and acute malnutrition. Many of the children who appeared malnourished in 1986 were likely stunted during the period of low food availability following the 1983 drought and bush fires. By 1987 most, but not all, of these cohorts would have left the preschool bracket.

Another indication of the changing pattern of malnutrition in the decade comes from data collected by the Catholic Relief Service. While these data suffer from selection bias--the results are based on children who attended

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3 Intercountry comparisons are not likely to reflect ethnic differences. It is widely observed that growth of middle class children in various countries conforms to the international standards at least until the prepuberty growth spurt.

4 Details of this study have not yet been published.

clinic-based feeding centers--the information in Figures 1a and 1b indicates the severity of the nutritional problem between 1982 and 1984 relative to the beginning of the decade or to 1986. The CRS data use the 3rd percentile from Harvard weight-for-age standards. These are roughly comparable to 80 percent of NCHS weight-for-age standards. Consequently, the 1986 National Nutrition Survey appears high relative to CRS data for that year, while the GLSS data are similar to the most recent year of the CRS series.

Table 2 breaks down the GLSS data by age and by gender. While it is often observed that girls in South Asia are more likely to be malnourished than are boys, females do not appear to be at a relative disadvantage in nutrition in Africa in general (Svedberg 1988) nor in Ghana in specific. Levels of acute malnutrition for boys are appreciably higher than for girls in the 6-24-month age brackets. This is the case for the most severe cases (Z-scores less than -2) as well as more moderate cases (Z-scores between -2 and -1). The gap closes and actually reverses in the older age bracket. This age bracket, however, has relatively little acute malnutrition. On the other hand, the older children have the highest levels of chronic malnutrition consistent with the view that low stature represents the cumulative effects of nutritional shocks. In a similar vein, levels of chronic malnutrition for youngest children do not differ from levels of current malnutrition, as the only past these children have is a recent past.

Table 3 indicates that malnutrition is particularly high in the savannah agroecological zone.[5] This is consistent with studies that report higher levels of malnutrition in the northern regions earlier in the decade (Levinson 1988, CRS 1987). This pattern was also observed in the early 1960s (Rimmer forthcoming). Greater Accra has the lowest levels of both acute and chronic malnutrition in the current study. The remainder of the coastal agroecological zone has appreciably less chronic malnutrition than the forest or savannah regions but has relatively high levels of chronic malnutrition. Note, however, that the cell size for each ecological zone is fairly small. Thus, confidence intervals are wide.

Levels of malnutrition by per capita expenditure deciles are indicated in Table 4. The deciles were ranked using a pooled sample of all children below five years. Since rural areas are relatively poorer, children in the lower deciles are disproportionately from rural regions (including those classified as semiurban). Using this manner of ranking, the urban and nonurban populations in a given decile have the same real expenditures. This would not be the case if rankings were based only on relative expenditures within a sector. The data indicate that at a given expenditure level, urban children are less likely to be either stunted or wasted. This may reflect differences in sanitation and access to health care. There may be an element of self-selection of parents into urban areas as well.

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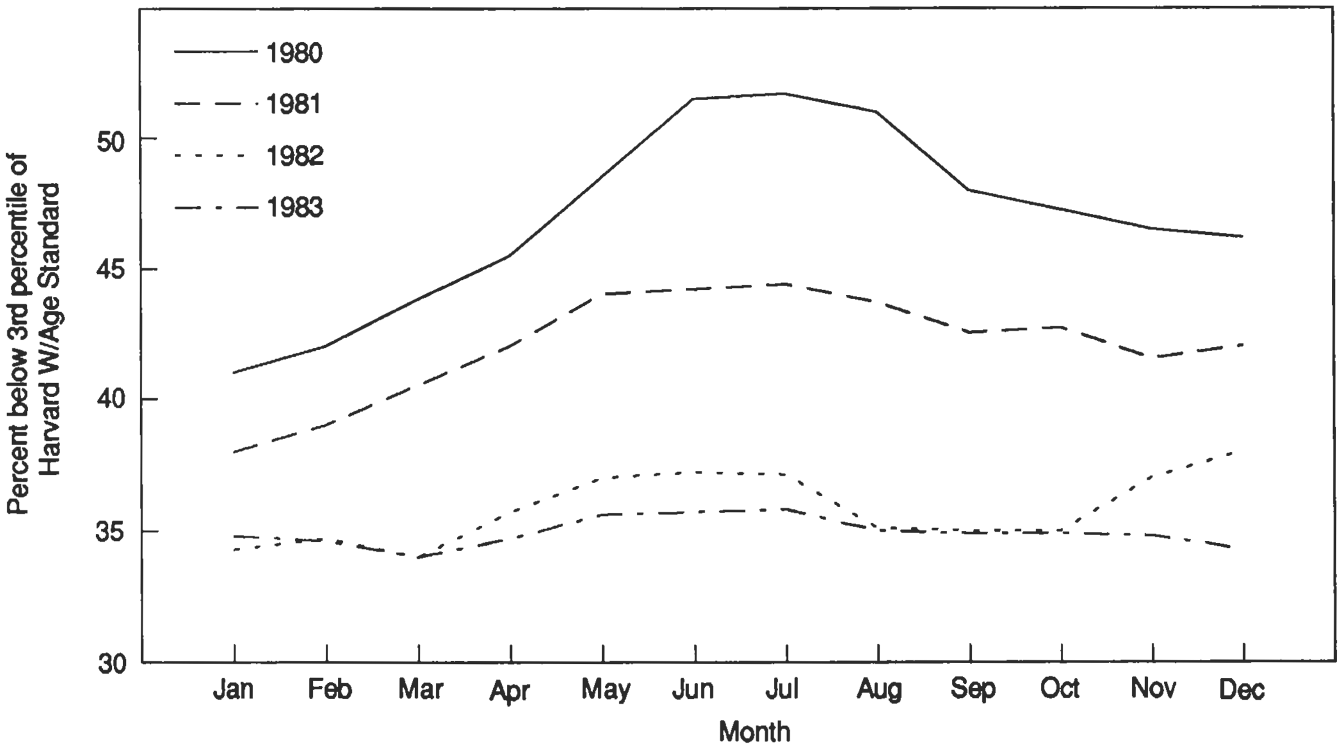
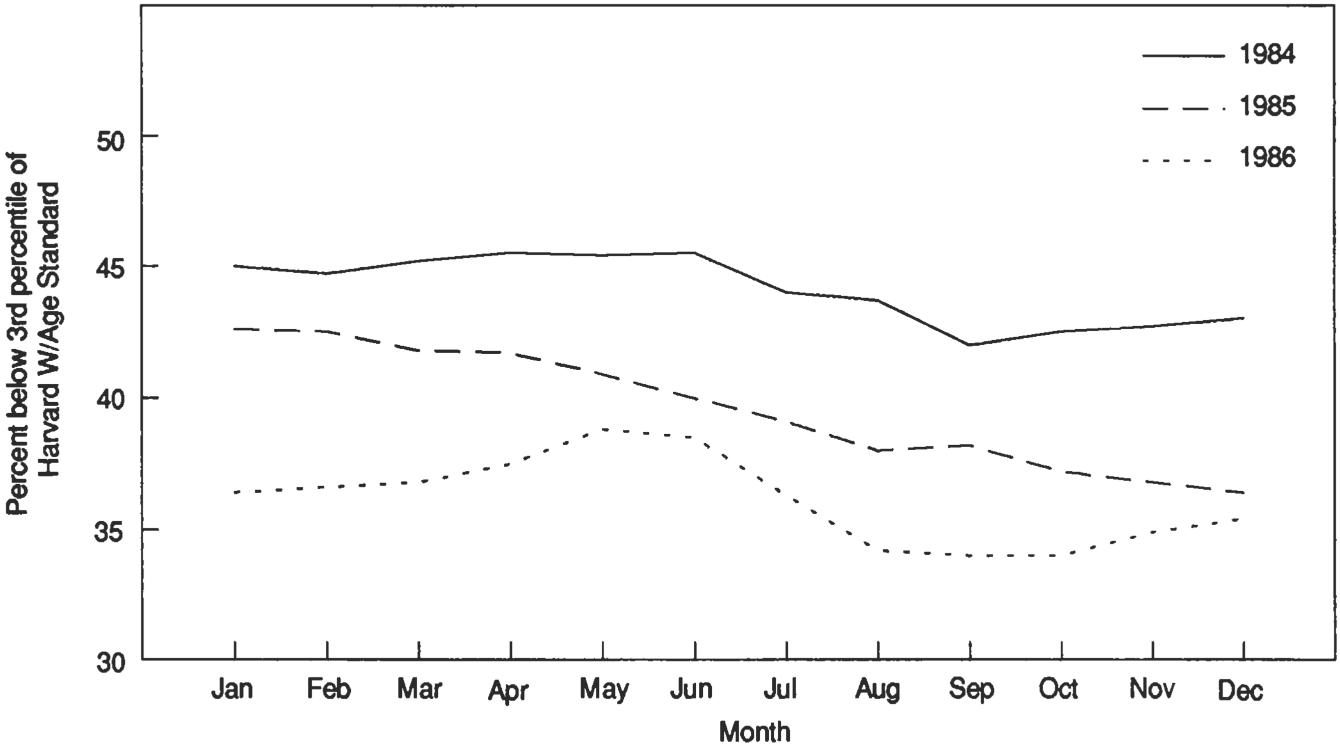
5 Although the sample was not designed for regional comparisons, malnutrition appears higher in the three northern regions compared to savannah agroecological zones within other regions.

Figure 1a - Weight-for-Age of Children Ages 7-42 Months Attending Clinics by Month, 1980-83 (percent below 3rd percentile of Harvard W/Age standard)



Source: Catholic Relief Service Growth Surveillance System: Annual Report 1986. Accra, September 1987.

Figure 1b - Weight-for-Age of Children Ages 7-42 Months Attending Clinics by Month, 1984-86 (percent below 3rd percentile of Harvard W/Age standard)



Source: Catholic Relief Service Growth Surveillance System: Annual Report 1986. Accra, September 1987.

Table 2 - Nutritional Indicators by Age and Gender, Ghana, 1987-88 (percent of cell population in each category)

Category	Age Group (in months)				
	0 - 6	6 - 12	12 - 24	24 - 60	All
Males					
Height-for-Age[a]					
Z-Score <= -2	4.35	11.02	33.33	39.50	31.19
-2 < Z-Score <= -1	13.77	29.13	25.67	26.82	25.33
-1 < Z-Score <= 0	39.13	30.71	19.16	18.66	22.36
0 < Z-Score <= 1	22.46	20.47	11.11	9.04	12.21
1 < Z-Score <= 2	13.04	5.51	7.66	3.50	5.69
Z-Score > 2	7.25	3.15	3.07	2.48	3.22
Weight-for-Height[b]					
Z-Score <= -2	4.35	14.17	18.77	4.66	8.66
-2 < Z-Score <= -1	15.22	47.24	37.16	24.05	28.30
-1 < Z-Score <= 0	27.54	27.56	28.74	45.04	37.71
0 < Z-Score <= 1	39.13	7.87	12.64	22.89	20.96
1 < Z-Score <= 2	11.59	3.15	2.68	2.33	3.55
Z-Score > 2	2.17	0.00	0.00	1.02	0.83
Females					
Height-for-Age[a]					
Z-Score <= -2	4.70	10.64	31.69	39.11	30.22
-2 < Z-Score <= -1	11.41	18.44	33.74	25.79	24.78
-1 < Z-Score <= 0	24.16	38.30	22.63	21.06	23.72
0 < Z-Score <= 1	33.56	19.86	9.88	9.31	13.57
1 < Z-Score <= 2	17.45	8.51	0.82	3.15	5.04
Z-Score > 2	8.72	4.26	1.23	1.58	2.68
Weight-for-Height[b]					
Z-Score <= -2	4.03	9.22	13.99	5.44	7.39
-2 < Z-Score <= -1	12.08	41.13	33.33	26.07	27.54
-1 < Z-Score <= 0	32.89	40.43	32.92	40.83	38.26
0 < Z-Score <= 1	31.54	7.09	14.81	23.35	20.80
1 < Z-Score <= 2	16.78	1.42	4.12	4.15	5.36
Z-Score > 2	2.68	0.71	0.82	0.14	0.65

Source: GLSS data.

[a] Low height-for-age Z-score indicates chronic undernutrition.
[b] Low weight-for-height Z-score indicates acute undernutrition. Some percentages may not add to exactly 100.00 due to rounding.

Table 3 - Nutritional Indicators by Agroecological Zone and Gender, Ghana, 1987-88

Agroecological Zone	Males			Females			All		
	Number	Percent with Chronic Malnu-trition	Percent with Acute Malnu-trition	Number	Percent with Chronic Malnu-trition	Percent with Acute Malnu-trition	Number	Percent with Chronic Malnu-trition	Percent with Acute Malnu-trition
Coast (excluding Accra)	256	27.6	7.4	298	21.8	9.1	554	24.0	8.3
Greater Accra	150	20.7	6.7	113	23.9	6.2	263	22.0	6.5
Forest	531	34.1	7.7	559	32.7	6.4	1,090	33.4	7.1
Savannah	275	35.3	12.0	261	36.8	6.9	536	36.0	9.5

Source: GLSS data.

Notes: Chronic malnutrition refers to height-for-age Z-score less than -2.0; acute malnutrition refers to weight-for-height Z-score less than -2.0.

Table 4 - Indicators of Child Malnutrition by Per Capita Expenditure Decile

		Rural			Urban		
Per Capita Expenditure Decile	Average per Capita Expenditure	Percent with Chronic Malnutrition	Percent with Acute Malnutrition	N	Percent with Chronic Malnutrition	Percent with Acute Malnutrition	N
1	12,226	33.5	11.1	215	25.9	7.4	27
2	19,545	33.8	7.3	204	33.3	2.3	42
3	24,628	37.9	10.1	208	22.9	2.9	35
4	29,342	41.2	7.2	194	24.0	10.0	50
5	34,930	30.9	2.7	188	20.0	3.6	55
6	40,497	34.3	9.5	169	21.1	2.6	76
7	47,170	36.9	5.5	146	26.8	5.1	97
8	55,969	28.8	9.9	142	22.5	7.8	102
9	67,789	37.6	9.4	117	17.9	7.8	128
10	100,428	22.6	16.0	106	18.3	7.3	137

Source: GLSS data.

Notes: Individuals are ranked by household per capita expenditure adjusted for monthly inflation. N refers to the number of individuals within each cell.

It is somewhat surprising that Table 4 reveals no clear pattern of nutritional status by expenditure levels. There is only a slight tendency toward lower levels of chronic malnutrition as expenditure per capita increases. Moreover, the pattern is clearly not monotonic. There is no pattern at all regarding acute malnutrition. While small cell sizes again reduce the accuracy of any decile average, aggregation into quintiles does not lead to a different picture. Similarly, the picture does not change if households are ranked by expenditures rather than the ranking being constructed on an individual basis according to the expenditures of the household in which the individuals live.

It is useful to discuss these results in the context of the Demographic and Health Survey (DHS), which was also conducted by the Ghana Statistic Survey in 1988 (Ghana Statistic Survey). The DHS reports levels of malnutrition among 1,841 children between the ages of 3 and 36 months. The 30 percent of the sample reported with chronic malnutrition is comparable to the data reported here for children in the same age bracket. While the survey did not have data on income or expenditure, the regional breakdown indicated higher levels of malnutrition in the North, and two Upper Regions, comparable to the savannah agroecological zone in this paper. The study also indicated relatively high levels of malnutrition in the Central Region, regional breakdown which is not indicated in the current study. Also, the overlapping study provides verification of the absence of any gender specific pattern of nutrition.

Other tabulations indicated in the DHS anticipate results investigated using multivariate techniques, which are reported below. For example, the report indicates that children who are first born or who were born more than two years after their older sibling are less likely to have either chronic or acute malnutrition. Children who recently had diarrhea have higher rates of malnutrition, although the statistical significance of this and similar differences is not indicated. Finally, the DHS reveals a pronounced difference in the rates of malnutrition of children whose mothers have more than a middle level of education. Differences at lower levels of education, however, are less apparent. Nor is it possible to say whether the effect of education works through child care or through the presumably higher incomes of the more educated households.

NUTRITIONAL STATUS OF ADULTS

Relatively little attention is given to the nutritional status of adults, in part because they are less vulnerable to severe consequences of undernutrition. Indeed, Seckler (1982) argues that smallness in adults is actually adaptive (see also Beaton 1989). On the other hand, McGuire and Austin (1987) present evidence of economic and health consequences of being small, as opposed to consequences of growth faltering or becoming small.[6]

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6 See Strauss (forthcoming) for a review of nutrition and productivity from an economist's perspective.

A particular concern is the nutritional status of women as an indicator of adult health as well as the possible consequences for birth outcome and subsequent infant mortality (Martorell and Gonzalez-Cossio 1987, Thomas et al. 1988).

One difficulty in studying the nutrition of adults is that, to a large degree, adult nutrition, particularly height, is determined in childhood, possibly as early as the first two years of life. As such, there is relatively little of current policy relevance that is indicated by studying adult stature. While indices such as the body mass index (BMI--weight in kilograms over height in meters squared) are relatively independent of height, there is less information on which to base expectations for a healthy population. Payne (1986), however, reports a few studies from actuary tables in developed countries, which indicate that adult mortality risk rises with BMI below 19 or 20 or above 22. Dugdale (1985) offers 19 as a lower limit for adequate health, but in view of data from India, Indonesia, and Thailand, Payne suggests a lower cutoff at 18. James et al. (1988), while stating that any standards are to a fair degree arbitrary, suggest that levels above 18.5 should be considered normal. They suggest individuals with levels below 18.5 should be subdivided into three subgroups, with those having BMIs below 16 being classified as being in a third, or most severe, grade of chronic energy deficiency. The Royal College of Physicians (1983) presume a risk for health with BMI levels below 18.4 for males and 17.5 for females. This group also has a higher cutoff point for either overweight or obesity.

Table 5 indicates the distribution of BMI for adult males and females (excluding those reported as pregnant or lactating[7]) for urban and rural populations following the classification of the Royal College of Physicians. In general, rural residents are thinner than their urban counterparts. Moreover, males are leaner than females overall, although more women are observed in the lowest categories. There is, in addition, a surprisingly large number of females with BMIs in the higher brackets indicating overweight or obesity. Table 6 breaks the population into expenditure groups and indicates that increased BMI among adults is more closely associated with increased total household expenditures than are similar measures of nutrition among preschoolers. The pattern is, however, not monotonic. Note that adult heights also increase with *current* family expenditures. Under the assumption that adult heights are influenced by the level of family income in their childhood, this likely indicates a strong correlation of expenditures between generations. Reverse causality--from stature to expenditures--is logically possible and in keeping with research on productivity referred to above, but is probably not the only pathway. When individuals are ranked by predicted income a similar pattern is observed.

In many countries there has been a secular trend toward taller generations. This may be due, in part, to income growth as well as improved health

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7 Lactating women were found to have significantly lower BMI than nonlactating women although the difference is small. The difference in the means of BMI is 0.37 (t=2.9).

Table 5 - Ranges of Body Mass Indices for Adults Age 20 and Over, 1987-88
(percent of cell population)

BMI[a] Range	Classification[b]	Urban	Rural	Pooled
Males		(n=1,029)	(n=1,710)	(n=2,739)
BMI <= 18.4	Health Risk	12.9	19.0	16.7
18.4 < BMI <= 19.9	Underweight	20.4	25.3	23.4
19.9 < BMI <= 25.0	Acceptable	56.9	53.5	54.8
25.0 < BMI <= 29.9	Overweight	8.6	1.9	4.4
BMI > 29.9	Obese	1.2	0.3	0.6
Females		(n=1,127)	(n=1,962)	(n=3,089)
BMI <= 17.5	Health Risk	6.5	11.1	9.4
17.5 < BMI <= 18.6	Underweight	5.8	11.4	9.4
18.6 < BMI <= 23.8	Acceptable	54.1	64.3	60.6
13.8 < BMI <= 28.5	Overweight	20.7	10.4	14.1
BMI > 28.5	Obese	13.0	2.8	6.5

Source: GLSS data.

[a] BMI is calculated as the ratio of weight in kgs to height squared (in square cms).

[b] While BMI cutoff points for a healthy population are still provisional, the above classification was proposed in 1983 by the Royal College of Physicians in London to characterize the limits of the acceptable weight range for height-by-gender.

Table 6 - Body Mass Indices and Adult Heights by Expenditure Deciles

	Males						Females					
	Urban			Rural			Urban			Rural		
Decile	BMI	Height	Number	BMI	Height	Number	BMI	Height	Number	BMI	Height	Number
1	19.8	164.1	40	19.7	164.2	252	20.8	155.7	56	20.4	155.9	214
2	20.8	167.9	51	19.5	165.1	260	22.7	156.9	58	20.1	156.6	206
3	19.6	167.0	58	19.9	164.9	239	21.3	156.3	51	20.7	156.4	190
4	20.5	166.5	73	19.8	166.3	210	21.1	158.2	86	20.4	156.0	191
5	20.4	166.4	108	20.0	165.7	188	21.6	156.3	106	20.5	156.4	161
6	20.2	166.5	135	20.1	165.1	181	22.7	158.0	114	20.8	156.7	124
7	20.7	168.3	117	19.6	166.0	199	22.5	158.0	115	21.7	156.7	149
8	20.7	169.0	130	20.1	166.8	205	24.1	157.5	147	21.2	156.9	138
9	21.0	168.9	181	20.2	167.1	174	23.0	158.2	144	20.5	157.3	125
10	21.3	170.1	259	20.5	169.0	162	24.3	159.2	159	22.2	158.3	62

Source: GLSS data.

environments. Such a trend, however, should be modest in Ghana given the uneven, and often negative, income growth. Older adults in the sample are clearly shorter, although this could also reflect the normal process of aging. When heights are regressed in a very simple model using age, age squared, and location dummy variables, a quadratic pattern emerges for adult males. This has a peak age between 28-36 years depending on the age cutoff at the lower tail--that is, the age at which an individual is considered adult. The lower age for the turning point was associated with the higher age for the cutoff (25 years). This pattern could, however, be generated by the inclusion of males who have not yet finished their growth or by a fairly uniform pattern in a portion of the data and a slight decline among the oldest. For females the time trend is linear with older women significantly shorter. There does, then, appear to be some evidence of a secular trend in height, although the data and technique are not sensitive enough to determine whether the children who came of age in the 1970s or later had their growth affected by the economic decline.

3. DETERMINANTS OF MALNUTRITION

The standard model of individual utility maximization using home-produced goods (including nutrition) as arguments provides the underlying basis for most empirical studies of nutrient consumption or nutritional outcome.[8] These models are now well known and only a few features need be discussed here. Of particular importance is the fact that food enters the utility function in two manners--directly as a consumer good and indirectly as an input into the production of health. Other items, such as health care, enter into health production as inputs but do not directly contribute to household utility.

Ideally, the role of income or other variables that indirectly influence nutrition could be derived simultaneously from production functions and input demands. The nutritional health derivative is the sum of coefficients for the inputs in the production function times the respective derivatives in the input demand functions. Improvements in nutritional status with increases in income or other changes in the constraints that influence a household's budget allocation, then, depend not only on the demand for nutrients or other inputs but also on the magnitude of the response in the production function.

One limitation is the difficulty of identifying instruments for inputs into the nutritional status production function. Since inputs are endogenously determined, there is a potential for bias in estimates that use observed levels of inputs. On the other hand, predicted inputs are often predicted with low precision. Moreover, identification may depend on arbitrary restrictions or on variables such as infrastructure and distances to various facilities that may have little explanatory power. One alternative is a reduced-form approach or variations of that approach that includes predicted income (Thomas et al. forthcoming, Sahn 1989). This differs from a conventional reduced-form model in that it employs a linear combination of the independent variables that explain income rather than those variables themselves. Such an approach is useful for explaining the impact of policy instruments, but sacrifices some of the potential to elucidate pathways to nutritional status that would be revealed by a health production function.

Both approaches are presented in the analysis that follows. The distinction is more in concept than in practice as there are few variables available in the data that can be considered as inputs into the production of nutrition. The GLSS data are the most complete data set available for Ghana and are, in many respects, superior to most household surveys from developing

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8 See, for example, Pitt and Rosenzweig (1985). Rosenzweig and Schultz (1983) describe a similar model for the household production of health.

countries. Nevertheless, the structure of the analysis is severely constrained by limitations in data that are currently available.

The household survey *per se* does not contain consumer prices. While these were collected in a complementary cluster or market survey, such prices were not available at the time of the analysis. Moreover, with a maximum of three observations per commodity, in order to utilize these supplementary data, one would have to account for missing prices as well as within-cluster price variation. Similarly, the survey design included the collection of information on community infrastructure. Such data were also unavailable for this study.

While one generally cannot determine the coefficients of variables for which observations are not available, it is possible to include such information implicitly in the instrumenting equations.[9] Each village or cluster is assumed to represent a single market and is surveyed over an interval of only a few days. Consequently, there is virtually no within-cluster price variation nor for the large part any variation in infrastructure or other community variables. Cluster fixed-effect estimates, then, allow one to remove the potential missing variable bias that might result from the exclusion of price and infrastructure variables. Moreover, cluster averages on observed variables contain information on the impact of these excluded variables that help provide variation useful in studying the impact of endogenous variables. Such an approach is enhanced when the number of clusters is relatively large and when the clusters cover an extensive range of economic and physical environments as is the case here.

Such fixed-effect models are formulated in terms of deviations from village means. The general form of this model is:

$$Y_{(vi)} - \overline{Y}_v + (\overline{X}_{(vi)} - X_v)B \quad (1)$$

where the i subscripts denote observations on individuals and the v's denote villages or clusters. This model can, however, be equivalently expressed in terms of dummy variables:

$$Y_i = X_i B + K_v C_v \quad (2)$$

where K_v denotes a vector of dummy variables, which are defined as 1 if the individual is from the vth village or cluster and 0 otherwise. When all cluster observations are collected during the same time period, then equation (2) is virtually equivalent to an equation with a seemingly more complete specification of exogenous price (P_v) and infrastructure variables (Z_v):

$$Y_i = X_i B + P_v D + Z_v O \quad (3)$$

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9 Griliches (1986) correctly observes that although econometricians often lament the absence of adequate data, it is precisely such issues that make their work interesting.

Equations (2) and (3) differ mainly in terms of their error structure that has some potential consequences for instrumental variables derived from them.

A variation of this approach, which is used here, is to include the cluster mean value of the left-hand side variable on the right-hand side of the estimating equation. This average implicitly contains information on prices and infrastructure that is useful for identifying the impact of the variable that is being instrumented. This average could also be added to the predicted value from equation (1) before conducting the second-stage estimation. In this case, however, it would be difficult, if not impossible, to correct the standard errors using two-stage least square estimations or the methods discussed by Murphy and Toppel (1985) as well as Duncan (1987).[10]

RESULTS OF REGRESSIONS FOR CHILDREN'S NUTRITIONAL STATUS

The nutritional status of a child, as measured by either height-for-age or weight-for-height is produced by two main inputs, food and health care. Since the GLSS data do not measure food in quantity terms, household consumption of nutrients cannot be directly calculated. Nor, of course, is the individual consumption by the child observed. Accordingly, the logarithm of predicted per capita household food expenditures is used as a proxy for food inputs.[11] Health inputs are generally difficult to measure--one needs to distinguish between curative and preventative inputs--and are indicated here by predicted days of illness per child. Both food and illness are instrumented using cluster fixed-effect models that include, among other variables, household composition and predicted per capita expenditures. Separate urban and nonurban prediction equations for this latter variable are reported in the appendix.

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10 While in large samples the coefficients of such instruments in subsequent OLS regressions are consistent, the standard errors are biased downward and, thus, any t-statistics are biased upwards. The standard adjustments require information about the covariance matrix of the parameters in the first step (instrumenting) equations. This would be readily available from estimates derived from eq. (2) or eq. (3), but is not obtained when instruments are the sum of village means plus the predicted deviation derived from eq. (1). Note also that if one assumes that the cluster mean value of the instrumenting equation is less likely to be correlated with the error in the subsequent OLS regression than a village dummy variable would, the approach used here is less likely to give a biased result.

11 Within a commodity group quality differences are generally small. Food expenditures, however, also vary due to shifts between commodity groups, which are often appreciable as incomes rise. Accordingly, food expenditures are only weakly correlated with the amount of any given nutrients purchased. Food expenditures, therefore, should be disaggregated to the greatest degree possible.

While the discussion above indicates that the fixed-effect approach allows the analysis to proceed without a set of community variables, it is nevertheless fair to at least indicate what factors may influence the illness instrument that are not expected to enter directly into the nutrition production function. This set may include information on the distance to clinics and the quality of health care personnel. These factors could, in principle, influence nutrition directly through public health education and maternal nutrition. Other variables such as malarial prevalence, coliform bacterial counts in water, and other disease vectors, however, would affect nutrition only through disease patterns.

In addition to these inputs, nutritional status may be influenced by a number of characteristics of the child including age, gender, and number of siblings. While community factors are implicitly included in the input functions, additional regional differences are possible. Thus, the regressions include dummy variables for agroecological zones as well as for Accra and Tema and a variable for semiurban communities. At a given level of inputs, the level of education of the parents may influence the efficiency with which these (and other) inputs are used and are, therefore, included in the regressions.

Behrman and Wolfe (1987) have argued that maternal education may proxy for other environmental and human capital factors. Thomas et al. (1988) find partial support in that they observe a decline in the coefficients of education when parental heights are included. Education, however, remained highly significant in their study of Brazilian children. The current study, therefore, includes variables for both the education and size of the parents. A strong prior assumption is that the mother's height will have a stronger impact than the father's. This is based not on factors related to nonformal training or experience, but rather on biology, although not necessarily genetics. While the genetic contribution of both parents is equal, the mother also has an environmental effect through the womb environment. As one does not observe the genotype but only the phenotype--that is, the physical manifestation of the genotype in interaction with the environment-- measurement of the genetic pathway is biased downward by errors in variables while the environmental pathway is not.

Inclusion of parental characteristics presents an additional problem; not every parent was present in the household. Slightly more than 10 percent of all mothers were not measured for height. Conditional on the mother being present, 27 percent of the fathers in rural areas were not resident, either due to travel or establishment of separate households, while the corresponding number in the urban sample was 34 percent. Preliminary tests with models, which exclude father-specific variables, indicate that parameters do not differ between sample subsets with and without fathers present. Although there is no obvious difference in the subsamples, the truncation does have a cost in terms of reduced sample size and correspondingly larger standard errors.

The results of the regression explaining height-for-age are presented in Table 7. Chronic malnutrition is more or less cumulative and, therefore, the

Table 7 - Children's Height-for-Age Equations - Pooled Rural and Urban Sample
(standard errors in parenthesis)

Variable	(1)	(2)	(3)	(4)	(5)
Intercept	-15.60 (2.84)	-16.37 (2.91)	-17.48 (2.97)	-17.03 (2.92)	-14.19 (1.72)
Age in Months	-0.101 (0.009)	-0.099 (0.009)	-0.098 (0.009)	-0.097 (0.009)	-0.097 (0.009)
Age Squared	0.00115 (0.0001)	0.00111 (0.0001)	0.0011 (0.0001)	0.0010 (0.0001)	0.00111 (0.0001)
Female	0.034 (0.077)	0.026 (0.077)	0.027 (0.077)	0.025 (0.077)	0.025 (0.077)
Household Size	0.061 (0.027)	0.061 (0.027)	0.065 (0.027)	0.066 (0.028)	0.041 (0.019)
Older Sibling	-0.228 (0.062)	-0.233 (0.062)	-0.231 (0.062)	-0.230 (0.062)	-0.244 (0.061)
Older Half Sibling	0.003 (0.068)	0.005 (0.069)	0.030 (0.067)	0.017 (0.069)	0.024 (0.069)
Younger Sibling	0.386 (0.095)	0.371 (0.095)	0.373 (0.095)	0.375 (0.095)	0.352 (0.093)
Younger Half Sibling	0.159 (0.109)	0.191 (0.109)	0.189 (0.108)	0.186 (0.109)	0.177 (0.108)
Urban	0.109 (0.113)	0.080 (0.116)	0.098 (0.116)	-0.053 (0.117)	0.109 (0.107)
Semiurban	-0.202 (0.111)	-0.193 (0.111)	-0.200 (0.111)	-0.210 (0.112)	-0.193 (0.111)
Accra	-0.291 (0.193)	-0.330 (0.195)	-0.371 (0.197)	-0.414 (0.201)	-0.350 (0.193)
Tema	-0.102 (0.330)	-0.101 (0.333)	-0.093 (0.332)	-0.130 (0.334)	-0.097 (0.333)
Forest Zone	0.033 (0.187)	0.023 (0.187)	0.019 (0.187)	0.040 (0.190)	0.017 (0.189)
Forest*Age	-0.011 (0.005)	-0.011 (0.005)	-0.011 (0.005)	-0.012 (0.005)	-0.012 (0.005)
Savannah Zone	-0.514 (0.219)	-0.470 (0.219)	-0.475 (0.219)	-0.410 (0.233)	-0.471 (0.227)
Savannah*Age	0.0002 (0.006)	0.002 (0.006)	0.002 (0.006)	0.001 (0.006)	0.001 (0.006)
Mother Primary Education	0.113 (0.126)	0.130 (0.126)	0.122 (0.126)	0.115 (0.126)	0.107 (0.127)
Mother Middle Education	0.158 (0.110)	0.134 (0.110)	0.123 (0.110)	0.113 (0.111)	0.122 (0.111)
Mother Secondary or Higher	0.356 (0.347)	0.369 (0.350)	0.355 (0.350)	0.299 (0.352)	0.335 (0.351)

(continued)

Table 7 (continued)

Variable	(1)	(2)	(3)	(4)	(5)
Father Primary Education	-0.098 (0.145)	-0.087 (0.147)	-0.083 (0.147)	-0.085 (0.148)	-0.073 (0.147)
Father Middle Education	-0.160 (0.109)	-0.187 (0.110)	-0.185 (0.110)	-0.221 (0.112)	-0.191 (0.109)
Father Secondary or Higher	-0.215 (0.181)	-0.213 (0.181)	-0.194 (0.182)	-0.226 (0.184)	-0.177 (0.179)
Mother's Height	0.0047 (0.0006)	0.0045 (0.0006)	0.0045 (0.0006)	0.0045 (0.0006)	0.0045 (0.0006)
Father's Height	0.0021 (0.0006)	0.0023 (0.0006)	0.0023 (0.0006)	0.0022 (0.0006)	0.0022 (0.0006)
Mother's Age	0.017 (0.006)	0.018 (0.006)	0.018 (0.006)	0.018 (0.0061)	0.017 (0.006)
Log* Expenditures Per Capita	0.399 (0.223)	0.454 (0.231)	0.312 (0.242)	0.293 (0.245)	
Days Ill*	--	-0.031 (0.021)	-0.037 (0.021)	-0.042 (0.021)	-0.039 (0.021)
Expenditures* Per Ilness	--	0.040 (0.043)	0.032 (0.043)	0.035 (0.043)	0.041 (0.043)
Log Food* Expenditures Per Capita	--	--	0.264 (0.139)	--	--
Log Cereal* Expenditures Per Capita	--	--	--	-0.056 (0.080)	0.0673 (0.080)
Log Root Crop* Expenditures	--	--	--	-0.023 (0.052)	-0.013 (0.051)
Log Meat* Expenditures Per Capita	--	--	--	0.147 (0.089)	0.147 (0.089)
Log Other Food* Expenditures	--	--	--	0.113 (0.131)	0.139 (0.129)
R^2	0.217	0.219	0.221	0.223	0.206
Number	1,560	1,526	1,526	1,526	1,526

* Predicted variables.

height-for-age declines relative to standards until the child is above age four. No gender bias is observed nor is an urban bias indicated. This latter result is surprising given the descriptive statistics. Note that predicted variables entered as instruments are estimated separately for rural and urban populations. Differences in incomes or disease prevalence in the communities are incorporated in these instrumental variables.

Children from the savannah zone are significantly smaller relative to age- and gender-specific standards than other children. This difference is large in magnitude (approximately half a standard deviation). Moreover, regional differences in illness prevalence and average income also work to the detriment of these children. There is no apparent difference between children from the forest zone and those from the coastal zone (the excluded regional variable) on the average. The age interaction term, however, indicates that older children from the forest are smaller than their cohorts. A similar interaction is not significant for the savannah region. One interpretation that can be tested on subsequent surveys is that the stature of older children reflects former conditions that have subsequently improved relative to the coastal zone.[12]

As expected, there is a strong relationship between a mother's height and her child's. Since another correlate of the mother's human capital--her education--is also in the model, this influence is likely through the biological pathways referred to above. Also, as expected, the significant influence of the father's height is less than the mother's. The BMI of both parents are simultaneously determined with the child's nutrition and, therefore, the variables are not included in the model. Alternative specifications (not presented here) including BMI, however, show that the combination of genetic, behavioral, and economic factors that influence a parent's BMI also correlate with the long term nutrition of a child. The relationship is, however, only significant in the case of the mother.

Parental education is a puzzle. The education of the father has a negative influence and the positive influence of the mother is not significant. This departure from prior expectations may reflect low quality education for women currently in childbearing years. Education, however, has an indirect effect through the demand for other inputs and through income as well as the direct effect. There is, in addition, one other pathway from the mother's background to the child's stature; older women have taller children. It is not possible to distinguish whether this has to do with the biological hazards of adolescent pregnancies or the experience and maturity of the mother. Note, furthermore, that holding the size of the household constant, children with a full sibling less than two years older (including twins) are significantly shorter than cohorts without such a sibling. This again can be a long-term influence of prenatal conditions or current competition for

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[12] A decline in conditions in the coast is unlikely. Such a trend should also be indicated in the interaction term for the savannah.

resources. The presence of half siblings, however, has no effect on heights for age.[13]

Children with younger siblings are significantly taller than their cohorts. The magnitude of the effect is larger if the sibling is a full sibling. This may be an artifact of nonlinearities in the age relationship; the youngest children in the sample have no full siblings and fewer half siblings within two years of their age.[14] An additional pathway that would influence full siblings is through the age of weaning. While early weaning is potentially detrimental, very late weaning is as well. Further analysis of such relationships may be illuminated using household fixed-effect models similar to Strauss and Horton.

Predicted days of illness has the expected negative impact, implying that investments in health will indirectly increase stature relative to standards. The average amount a household spends per disease incident does not appear to have an impact in any of the specifications including that which excludes the weakly correlated income instrument (5). This variable, total household resources as measured by the logarithm of total expenditures per capita, has an appreciable impact on nutritional status.[15] The significance, however, is marginal after adjusting for the fact that the variable is estimated in a previous step. Note that the change in the coefficient when food expenditures or components of food expenditures are included is comparatively small.

The total food expenditure variable predicted in cluster fixed effect models is significant only when the standard errors are unadjusted. The coefficients of the individual components of food expenditures are imprecisely measured with or without the inclusion of the total expenditure variable. While there is a conceptual difficulty in using food expenditures as a proxy for nutrients, which is discussed below, the low coefficients are still difficult to explain. Moreover, the difficulty is highlighted by the fact that expenditures have an apparent influence that is not mediated through the purchase of food or health inputs. A number of recent studies by both economists and nutritionists have indicated that a marginal increase in

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[13] Half siblings are defined as living in the same household but having different mothers and the same relationship to the household head. If they are in a three generational household with two married sons, they may, in addition, have different fathers and hence not be siblings at all. There are, however, very few cases in the sample where such an extended household was observed.

[14] In a personal communication, Paul Glewwe has pointed out that the absence of a younger sibling may reflect childhood mortality. The factors that contribute to this may be correlated among family members.

[15] Although the Hausman test for exogeneity gives only weak justification for the use of such an instrument, conceptually such a long-run measure is more appropriate for regressions explaining height.

household food consumption has only a small impact on nutritional status although a few of these studies indicate a stronger association with income (Alderman 1989). Not only does the absence of a pronounced and robust impact of food consumption challenge concepts about nutrition or at least the measurement of it, the income effect poses a challenge as income should influence nutrition through inputs. While these inputs may include housing (or the choice of residence) or other variables that are not included in this model, the pathway is not well understood.

To put these results in perspective, Model 2 implies that a 10 percent increase in income will reduce the number of children in the savannah who indicate chronic malnutrition by 4 percent. This reduction increases to 9 percent with a 25 percent increase in income, but the reduction is over 11 percent with the smaller increase in income and some primary schooling for each mother. The percentage decline in malnutrition in other agroecological zones following increase in income is slightly higher, although starting from a smaller base. Note, however, that with a higher percentage of women already having an education, a 10 percent income increase plus a minimum of primary schooling for each woman does not have as large an impact in these areas as in the savannah.

Unlike height-for-age, which measures the cumulative effect of nutritional shocks, weight-for-height is a short-term indicator. As most of the variables in the regression are state variables rather than time-varying measures, it is more difficult to explain weight-for-height than height-for-age.[16] Such is the case here. Few variables in the regressions reported in Table 8 are significant. The significant age pattern confirms that weight-for-height declines until about three years of age. As in the regressions explaining stature, children with either full or half siblings less than two years older are lighter relative to height than their cohorts. Also, children with younger siblings appear better off, although the half sibling variable in this case is anomalous.

The influence of either predicted illness or food expenditures is inconsequential, as is any of the components of food expenditures (not reported in Table 8). Total expenditures also appears to be a poor predictor. The coefficient of the logarithm of expenditure is, however, between 0.8 and 1.1, depending on the specification, in an unpooled urban equation. Despite this difference, pooling could not be rejected on the basis of the appropriate statistical test.

RESULTS OF REGRESSIONS EXPLAINING WOMEN'S NUTRITIONAL STATUS

There is a special concern for the nutrition status of women inasmuch as the maternal malnutrition may translate into low birth weight children and,

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16 Even illness, which is a short-term event, is replaced with predicted illness which is a long term probability. Total expenditures is, however, the observed current value.

Table 8 - Children's Weight-for-Height Equations - Pooled Urban and Rural Sample
(standard errors in parenthesis)

Variable	(1)	(2)	(3)
Intercept	-0.919 (1.05)	-0.835 (1.05)	-2.01 (1.30)
Age in Months	-0.037 (0.0001)	-0.038 (0.007)	-0.037 (0.007)
Age Squared	0.00074 (0.00010)	0.0007 (0.00010)	0.0007 (0.00010)
Female	0.043 (0.052)	0.067 (0.052)	0.067 (0.052)
Household Size	0.003 (0.011)	0.002 (0.011)	0.011 (0.013)
Older Sibling	-0.081 (0.041)	-0.088 (0.041)	-0.085 (0.041)
Older Half Sibling	-0.065 (0.046)	-0.065 (0.046)	-0.073 (0.046)
Younger Sibling	0.081 (0.041)	0.091 (0.062)	0.097 (0.062)
Younger Half Sibling	-0.046 (0.073)	-0.051 (0.072)	-0.049 (0.073)
Urban	-0.161 (0.071)	0.152 (0.071)	0.155 (0.071)
Semi Urban	0.065 (0.07)	-0.053 (0.07)	0.045 (0.074)
Accra	0.266 (0.126)	0.255 (0.127)	0.222 (0.128)
Tema	-0.149 (0.223)	-0.164 (0.223)	-0.163 (0.233)
Forest Zone	0.238 (0.125)	0.245 (0.125)	0.249 (0.125)
Forest*Age	-0.007 (0.003)	-0.007 (0.003)	-0.007 (0.003)
Savannah Zone	0.252 (0.142)	0.249 (0.142)	0.259 (0.142)
Savannah*Age	0.0072 (0.004)	0.0070 (0.004)	-0.007 (0.004)
Mother's Primary Education	-0.009 (0.085)	-0.0009 (0.085)	-0.003 (0.084)
Mother's Middle Education	-0.007 (0.074)	-0.023 (0.073)	0.016 (0.074)

(continued)

Table 8 (continued)

Variable	(1)	(2)	(3)
Mother's Secondary or Above	0.183 (0.23)	0.216 (0.23)	0.020 (0.23)
Father's Primary Education	0.127 (0.098)	0.119 (0.099)	0.120 (0.099)
Father's Middle Education	0.095 (0.071)	0.088 (0.072)	0.085 (0.072)
Father's Secondary or Above	0.118 (0.119)	0.107 (0.119)	0.111 (0.119)
Mother's Height	0.0001 (0.0004)	0.00002 (0.0004)	0.00004 (0.0004)
Father's Height	0.0005 (0.0004)	0.0005 (0.0004)	0.0005 (0.0004)
Mother's Age	0.006 (0.004)	0.005 (0.004)	0.005 (0.004)
Log Expenditures per Capita*	-0.077 (0.052)	-0.068 (0.053)	0.109 (0.059)
Days Ill*	--	-0.116 (0.014)	-0.014 (0.014)
Expenditures Per Illness*	--	-0.003 (0.029)	-0.001 (0.029)
Log Food Expenditures*	--	--	0.152 (0.099)
R^2	0.05	0.06	0.06
Number	1,566	1,532	1,532

* Predicted variables.

consequently, high infant mortality rates (Martorell and Gonzales-Cussio 1987).[17] As mentioned, a mother's height--that is, nutrition lagged one generation--may influence child survival (Thomas et al. forthcoming). Adult height is, however, to a fair degree, a product of early childhood nutrition as is discussed above. Height may also be influenced by nutrition during adolescence, especially if pregnancy occurs before growth is completed. Given the variability of timing of both the start and completion of puberty, however, it is difficult to use age specific growth standards to model nutrition for adolescents. The study of the nutrition of women attempted here, then, concentrates on body mass index (BMI) of adult, nonpregnant women. To the degree that this short-term measure correlates with birth outcome or other outcome variables, determinants of BMI are also likely correlates for these measures. Note, however, that BMI is uncorrelated with adult heights.

The model employed is similar to the model used for children in that cluster fixed-effect models are used to estimate instruments for inputs into the production of nutritional status. There is one principal difference--the influence of parity (number of pregnancies) on short term nutritional status is tested. While modern forms of family planning are not widely practiced,[18] traditional methods including temporary abstinence and delayed marriage also influence the number of births. Consequently, the variable is treated as endogenously determined. Parity was determined using the fertility module in the questionnaire, which was administered to one woman of childbearing age (including post-menopause) per household. A regression based on this subsample was used to estimate predictors for all adult women in the sample.

While a maternal depletion syndrome of worsening nutrition with multiple pregnancies has been postulated (Jelliffe and Jelliffe 1978) and tested (Huffman et al. 1985, Merchant and Martorell 1983), multivariate approaches to adult women's nutrition are not common in the literature. It is, therefore, difficult to disassociate the effects of age (or lagged economic conditions for which age may proxy) and parity. Moreover, as parity is likely affected by education and assets, as well as a variety of factors known to the woman but not the researchers which may influence both the number of children and the woman's nutrition, the instrumented multivariate approach used here represents a potential methodological improvement over earlier approaches.

The results indicate a negative coefficient for parity. Parity is predicted from a subsample who reported their reproductive history largely on

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17 Leslie (1989) argues that there is a need for a concern with women's nutrition not just maternal nutrition. This is obviously true in that they are half the population, but the main measurable consequences are generally in terms of fetal outcome or maternal depletion.

18 Ghana Statistical Service (1988) indicates that 20 percent of women aged 15-49 have ever used a modern method. Only 5 percent of the 4,488 women surveyed indicated that they were currently using birth control.

the basis of age, income, and education, all of which are also included in all variations of the model presented in Table 9. Unlike the food and commodity fixed-effect equations, the price and infrastructure variables that are implicit in the parity model provide little additional information, and it is likely that correction for bias in the standard error will have an appreciable impact on the currently significant t-statistics. Subsequent research that pools the second year sample may add to the variation of the instrument as well as reduce the standard error of the coefficient through the increase in sample size.

The parity parameter is reasonably robust across variations of the estimates in Table 9 and most plausible missing variable biases are controlled. Consequently, it offers some support for the prior expectation of a maternal depletion syndrome and, consequently, offers an additional explanation for the negative relationship between a child's birth order and long-run nutritional status modelled by Horton (1988).[19] Note, however, that a maternal depletion hypothesis does not necessarily imply a direct effect on subsequent children.

Birth spacing as well as parity likely contribute to maternal depletion. A dummy variable for women who are currently lactating, which correlates to some degree with recent delivery, is insignificant and positive. The variable, however, is not precise. Although virtually every mother breastfeeds her child, breastfeeding continues, on average, until one-and-a-half years. The lactation variable, then, includes the post-partum period, as well as the cumulative effects of nursing a child.

BMI increases significantly with education, particularly post-secondary education. This is in addition to the effect of education that works through income. Education not only influences the wage rate of an individual but also the type of work. If physical intensity decreases with education, as is most plausible, the education variable would capture the effect of reduced energy expenditure. This hypothesis is supported by the coefficient of land. Although land is an indicator of wealth, the coefficient is negative and significant, albeit small in magnitude. Given the relatively limited use of hired labor in Ghana, the size of a household's landholding likely correlates with the labor effort of women within the household. Furthermore, women who live in urban areas, with a higher density of markets and services as well as greater access to public transportation, have significantly higher BMI at the same income levels or levels of food expenditures.

The probability of illness is not significantly correlated with BMI. While a negative coefficient is expected, a predictor based on self-reported illness may not be a good proxy for an objective measure of illness. As is often also observed in both developed and developing countries, in the GLSS

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[19] Horton interpreted her results in terms of competition for resources within the family. This interpretation is plausible as birth weights in developed countries generally increase with birth order. There is less evidence on this relationship from low-income countries.

Table 9 - Body Mass Indices Equations - Pooled Urban and Rural Sample
(standard errors in parentheses)

Variable	(1)	(2)	(3)	(4)	(5)	Probit (6)
Intercept	2.530 (1.962)	1.733 (1.996)	2.804 (2.627)	-0.182 (2.252)	2.149 (2.201)	3.399 (0.788)
Height in centimeters	0.019 (0.009)	0.019 (0.009)	0.019 (0.009)	0.018 (0.009)	0.021 (0.010)	-0.008 (0.004)
Age in years	0.364 (0.042)	0.357 (0.043)	0.355 (0.043)	0.362 (0.043)	0.370 (0.043)	-0.070 (0.017)
Age squared	-0.003 (0.0004)	-0.003 (0.0004)	-0.003 (0.0004)	-0.003 (0.0004)	-0.004 (0.0004)	0.001 (0.0001)
Parity*	-0.279 (0.093)	-0.281 (0.094)	-0.280 (0.094)	-0.295 (0.095)	-0.310 (0.095)	0.040 (0.038)
Lactating dummy	0.049 (0.167)	0.034 (0.168)	0.023 (0.169)	0.076 (0.169)	0.066 (0.169)	-0.299 (0.073)
Primary education	0.415 (0.215)	0.384 (0.220)	0.378 (0.221)	0.416 (0.221)	0.433 (0.221)	0.033 (0.087)
Secondary education	0.307 (0.171)	0.338 (0.172)	0.342 (0.172)	0.320 (0.173)	0.367 (0.173)	-0.139 (0.073)
Post-secondary education	0.844 (0.432)	0.807 (0.432)	0.814 (0.432)	0.750 (0.433)	0.891 (0.433)	-0.068 (0.199)
Log per capita expenditure	0.789 (0.113)	0.738 (0.115)	0.785 (0.137)	0.607 (0.131)	--- (0.046)	-0.167
Predicted illness probability*	---	0.001 (0.040)	0.005 (0.040)	-0.015 (0.041)	-0.014 (0.041)	---
Log expenditure per illness	---	0.293 (0.087)	0.296 (0.087)	0.299 (0.089)	0.324 (0.089)	---
Log food expenditure per capita*	---	---	-0.145 (0.232)	---	---	---
Log cereal expenditure per capita*	---	---	---	0.275 (0.124)	0.353 (0.123)	---
Log root crop expenditure per capita*	---	---	---	0.013 (0.086)	0.056 (0.086)	---

(continued)

Table 9 (continued)

Variable	(1)	(2)	(3)	(4)	(5)	Probit (6)
Log meat, fish, and poultry expenditure per capita*	---	---	---	0.247 (0.133)	0.309 (0.133)	---
Log other food expenditure per capita*	---	---	---	-0.157 (0.228)	0.070 (0.223)	---
Urban dummy	1.139 (0.157)	1.012 (0.161)	1.019 (0.162)	0.915 (0.166)	0.944 (0.166)	-0.135 (0.065)
Land owned	-0.002 (0.0009)	-0.003 (0.0009)	-0.003 (0.0009)	-0.003 (0.0009)	-0.003 (0.0009)	0.001 (0.0003)
Forest dummy	-0.732 (0.145)	-0.756 (0.145)	-0.764 (0.146)	-0.629 (0.154)	-0.676 (0.154)	0.129 (0.060)
Savannah dummy	-1.261 (0.187)	-1.155 (0.194)	-1.162 (0.194)	-1.051 (0.231)	-1.072 (0.232)	0.333 (0.075)
April-June	-0.264 (0.170)	-0.289 (0.170)	-0.281 (0.171)	-0.335 (0.175)	-0.337 (0.175)	0.095 (0.070)
July-September	0.464 (0.167)	0.464 (0.168)	0.454 (0.169)	0.457 (0.172)	0.471 (0.172)	-0.061 (0.070)
October-December	0.169 (0.182)	0.153 (0.183)	0.140 (0.184)	0.120 (0.190)	0.089 (0.190)	0.002 (0.074)
Household Size	0.143 (0.020)	0.136 (0.020)	0.127 (0.024)	0.155 (0.023)	0.152 (0.023)	-0.039 (0.008)
R^2	0.153	0.156	0.156	0.158	0.153	---
Number	3,692	3,673	3,673	3,673	3,673	3,692

* Predicted variable.

data self-reported illness increases with income or education or both. This reflects both differences in the concept of illness and the possibility that the poor cannot afford to be ill--in the sense of labor foregone. Since the instrument used here correlates self-reported illness with education and income, it does not purge the potential bias.

On the other hand, the significant and positive coefficient of expenditure per disease incident is expected. Note that the fixed-effect instrumenting equations explained little of the intracluster variance. Consequently, the variance of this regressor comes almost entirely from the between cluster effects. These stem from differences in the availability of medical care as well as the expected quality per unit price. Predicted expenditures per illness, then, likely proxies for the quality of local health infrastructure.

As discussed above, only specification (5) in Table 9 is a nutrition production function and, hence, preferred on conceptual grounds. Nevertheless, it is instructive to compare the coefficient of total per capita expenditures in the alternatives presented in the table.[20] The coefficient of expenditures declines as more information is included, although the standard error increases only slightly. The coefficient is, therefore, significant in all specifications. This raises a question that remains unanswered: by what pathway does income influence BMI that is distinct from disease incidence, health expenditures and food expenditures? It is not through investment in sanitation; that should work through the illness variable, which in any case is not apparently a function of the presence of piped water or flush toilets. A plausible explanation is that energy expenditure per unit of time worked decreases with assets that correlate with expenditures per capita. Moreover, if leisure is a normal good and, furthermore, less energy intensive than work, the effect would be enhanced through the demand for leisure.[21] The unexplained total expenditure effect is particularly large relative to other variables.

The food purchases variable has no apparent effect in specification (3) which includes the income effect. The four subgroups of food expenditure instrumental variables are, however, jointly significant when they are included without the total expenditure variable. Although there is some independent variation in the four variables due to the implicit price effects

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[20] While there is a strong a priori case for using instrumental variables for inputs as well as for total expenditures when a subset of expenditures is the dependent variable, there is not a strong case for using an instrumented variable when BMI is the dependent variable. Unlike height, there are few studies that indicate reverse causality from BMI to income, and the labor leisure choice is unlikely to strongly affect the model. A Hausman test rejected the endogeneity of expenditures at the 5 percent level. In the interest of efficiency of estimates, therefore, observed rather than predicted expenditures are used in these regressions.

[21] The total expenditure variable includes the effect of work effort on expenditures and is, therefore, not ideally suited to test this hypothesis.

modeled in the fixed-effect approach, it is nevertheless difficult to estimate the effect of the different components of food expenditures with precision. They are likely fairly correlated with each other. Nevertheless, it is plausible that expenditures on root crops have a smaller impact than expenditures on cereals or meats.

Even with a fair amount of regional variation contained within the instruments for health and food expenditure, there is a highly significant difference between BMI status of residents of the coastal agroecological zone and the other two zones. This parallels the effect observed for children. While there is no direct policy conclusion that can be derived from this regional pattern (which is also observed in the equations explaining total expenditures) it does reflect a degree of heterogeneity in the country that may exceed the preferences of planners.

Unlike the population of children, there are many women in the sample who have BMI that are high enough to warrant some concern. Although difficult to quantify, there is likely a loss function where low and high levels decrease productivity and quality of life. Accordingly, equation 6 presents a probit analysis that indicates the probability of a women having a low BMI as an alternative to the functional forms that imply "more is better." The cutoff used, admittedly somewhat arbitrary, for low levels of BMI is a level below 18.5 (James et al. 1988). As can be seen in the table, the signs of most of the coefficients are the opposite of the corresponding coefficient in the other regressions as is consistent with the dependent variable being a measure of nutritional risk. Higher parity increases the probability of a low BMI while higher income reduces the probability. The former coefficient is, however, no longer statistically significant. The urban dummy variable and other regional patterns remain important.

4. FOOD EXPENDITURE PATTERNS

The regressions presented above consider food expenditures only insofar as they explain nutritional status. Food policy, however, has a wider scope than nutrition policy (Timmer et al. 1983). Food is a substantial component of real income and its price and availability is a major indicator of the health of the economy. Thus, policymakers have an additional concern for levels of consumption of food in general and for specific food commodities.

Two types of descriptive statistics are particularly useful for food policy analysis: budget shares to various commodities and the percentage of major food items that are purchased in the market as opposed to produced at home. While more complete food policy analysis requires a knowledge of price and cross-price elasticities, as well as information on marketable surplus, the type of information in Tables 10 and 11 assists in approximating real income changes attendant to food price movements and, hence, indicate relative vulnerability. Such vulnerability is of particular concern in Ghana, as well as most other African countries, due to relatively high food budget shares and the comparatively high intra- and inter-year variability of prices.

The average Ghanaian household spends between 61 and 76 percent of its budget on food commodities depending on the area of residence (Tables 10a and 10b). The differences among agroecological zones and between urban and rural areas reflects, in part, differences in average incomes. It is, however, often observed that an urban resident will spend less on food than a rural counterpart with the same income, as the price of food in terms of nonfood is relatively higher in urban areas. This includes the cost of housing, transport and fuel, which generally claim more of the budget of urban dwellers than of rural residents.

Roots, tubers, and plantains dominate the budget in the forest zone as well as the rural coastal zone, while in the savannah families spend more on grains than on roots. Even within the broader categories, strong regional patterns are obvious. Millet and sorghum are virtually confined to the savannah zone, although that region also devotes a larger share of its income to maize than do the coastal and forest zones where maize is mainly produced. The savannah region also spends more in proportion to its total expenditures on rice, although in this case this is in keeping with the distribution of cultivation. Neither rice nor wheat, however, has a major share in the food budget even in urban areas where they are more heavily consumed.

While this study cannot devote sufficient attention to the complex issue of price policy and market interventions for food commodities, it should be noted that price stabilization is easier for commodities that are traded.

Table 10a - Rural Food Budget Share Means by Agroecological Zone

Commodity	Agroecological Zone Coastal	Forest	Savannah	Pooled Rural Sample
Cereals	0.152	0.118	0.351	0.180
Maize/Kenkey	0.114	0.083	0.117	0.098
Rice	0.015	0.019	0.024	0.019
Millet/Sorghum	0.000	0.000	0.202	0.047
Wheat bread/Pasta	0.023	0.015	0.009	0.016
Roots/Tubers	0.195	0.262	0.141	0.217
Cassava/Gari/Fufu	0.148	0.117	0.061	0.113
Yams	0.010	0.025	0.066	0.031
Sweet potato/potato	0.002	0.000	0.001	0.001
Cocoyam	0.013	0.047	0.007	0.028
Plantain	0.022	0.073	0.006	0.044
Meats/Fish/Dairy	0.165	0.164	0.082	0.145
Beef	0.005	0.006	0.009	0.006
Poultry	0.011	0.013	0.008	0.011
Other meats	0.009	0.020	0.014	0.016
Fish/shellfish	0.135	0.121	0.049	0.108
Milk/cheese	0.005	0.004	0.002	0.004
Other Foods	0.189	0.187	0.191	0.188
Oilpalm Oil/Nuts	0.031	0.026	0.012	0.024
Other oils/fats	0.006	0.003	0.002	0.004
Groundnuts	0.008	0.011	0.020	0.012
Fruits	0.016	0.019	0.007	0.016
Vegetables	0.076	0.088	0.095	0.086
Alcoholic beverages	0.015	0.016	0.026	0.018
All Foods	0.700	0.730	0.765	0.730
Mean Hhold Per Capita Expenditures	85,313	72,289	56,315	72,500
No. of observations	524	949	444	1,917

Source: GLSS data.

Note: Cassava budget shares include purchases of prepared fufu. As this product may be made from other rootcrops as well, the cassava shares may overestimate actual cassava consumption slightly.

Table 10b - Urban Food Budget Share Means by Agroecological Zone

Commodity	Agroecological Zone Coastal	Forest	Savannah	Pooled Rural Sample
Cereals	0.162	0.135	0.258	0.162
Maize/Kenkey	0.096	0.089	0.116	0.094
Rice	0.029	0.024	0.032	0.028
Millet/Sorghum	0.001	0.001	0.091	0.010
Wheat bread/Pasta	0.037	0.022	0.019	0.030
Roots/Tubers	0.115	0.177	0.102	0.135
Cassava/Gari/Fufu	0.075	0.080	0.056	0.075
Yams	0.014	0.021	0.036	0.019
Sweet potato/potato	0.001	0.000	0.000	0.001
Cocoyam	0.006	0.031	0.003	0.014
Plantain	0.019	0.045	0.007	0.026
Meats/Fish/Dairy	0.163	0.150	0.100	0.152
Beef	0.009	0.014	0.020	0.012
Poultry	0.018	0.014	0.009	0.015
Other meats	0.012	0.021	0.017	0.015
Fish/shellfish	0.111	0.095	0.045	0.099
Milk/cheese	0.013	0.007	0.007	0.010
Other Foods	0.173	0.191	0.193	0.181
Oilpalm Oil/Nuts	0.025	0.022	0.014	0.023
Other oils/fats	0.009	0.007	0.006	0.008
Groundnuts	0.008	0.010	0.017	0.009
Fruits	0.019	0.018	0.010	0.018
Vegetables	0.064	0.086	0.090	0.074
Alcoholic beverages	0.014	0.014	0.013	0.014
All Foods	0.613	0.653	0.651	0.630
Mean Hhold Per Capita Expenditures	122,619	93,342	79,663	108,446
No. of observations	681	397	127	1,205

Source: GLSS data.

Note: Cassava budget shares include purchases of prepared fufu. As this product may be made from other rootcrops as well, the cassava shares may overestimate actual cassava consumption slightly.

Root crops, due to their bulk, are rarely traded in international markets in a form suitable for human consumption. Both maize and sorghum are traded commodities, but generally of grades that are used for animal feed. This should indicate the relative difficulty Ghana will have in using international markets to assist in keeping food prices low and in stabilizing the real incomes of the majority of its population.

On a more positive note, the diversity of the diet is indicative of substitution possibilities. As indicated by Pitt (1983), increases in the price of a commodity may reduce consumption of that food; even though total nutrient consumption may not change, indeed, it may increase due to substitutions into other foods. Alderman (1986) argues that this inherent stability of nutrient consumption with respect to price changes is less likely in cultures where a single staple dominates the diet. Such concentration is, however, not the case in Ghana. If prices for foods are not highly correlated, substitution between food commodities can contribute to maintaining food security. In this respect, the savannah regions with the relatively higher concentration in coarse grains (less diversified diet) are most likely vulnerable to fluctuations in prices, as well as to fluctuations in real incomes around their low averages.

In theory, the income elasticities for food expenditures in Table 12 should convey roughly the same information as is reported in the breakdown of budgets by expenditure quintile in Tables 11a and 11b. Arc elasticities may be derived from changes in budget shares. For example, a constant budget share across expenditure quintiles implies an elasticity of 1 while an increasing budget share implies an elasticity greater than 1. Note, however, that the elasticities are estimated using an instrumental variable for expenditures in order to remove some of the correlation of errors that may influence patterns in Table 11. Moreover, the elasticities are estimated using cluster fixed effects to remove any missing variable bias stemming from the absence of explicit price information. Consequently, the elasticities reported in Table 12 differ somewhat from a straightforward derivation of arc elasticities using the means reported in Tables 11a and 11b. All equations include variables for family size, percentage of children under five years, number of members with primary and with secondary schooling or above by gender, landholding, and a dummy variable for female-headed households.

Note that a few of the elasticities are not robust with respect to functional form. The alternative estimates are presented to illustrate the potential shortcoming of the widely used double log functional form; elasticities derived from budget shares are preferred for theoretical reasons.[22] Moreover, whenever the two estimates differ appreciably, the elasticities derived from budget share equations are closer to arc elasticities calculated from cell means.

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22 The advantages include the fact that budget share equations aggregate across commodities and are less prone to heteroscedasticity. Moreover, they allow elasticities to vary over expenditure levels.

Table 11a - Rural Food Commodity Budget Share Means by Quintile

Commodity	Per Capita Expenditure Quintile 1	2	3	4	5	Pooled Rural Sample
Cereals	0.206	0.193	0.187	0.165	0.150	0.180
Maize/Kenkey	0.098	0.100	0.107	0.101	0.087	0.098
Rice	0.018	0.018	0.017	0.020	0.021	0.019
Millet/Sorghum	0.077	0.063	0.047	0.028	0.020	0.047
Wheat bread/Pasta	0.014	0.012	0.015	0.017	0.023	0.016
Roots/Tubers	0.187	0.226	0.228	0.221	0.220	0.217
Cassava/Gari/Fufu	0.099	0.123	0.112	0.109	0.120	0.113
Yams	0.032	0.028	0.034	0.029	0.031	0.031
Sweet potato/potato	0.001	0.001	0.001	0.000	0.001	0.001
Cocoyam	0.021	0.029	0.033	0.033	0.026	0.028
Plantain	0.034	0.045	0.048	0.050	0.042	0.044
Meats/Fish/Dairy	0.138	0.135	0.148	0.145	0.160	0.145
Beef	0.004	0.005	0.006	0.006	0.008	0.006
Poultry	0.008	0.009	0.012	0.012	0.014	0.011
Other meats	0.015	0.011	0.016	0.015	0.022	0.016
Fish/shellfish	0.108	0.106	0.110	0.107	0.110	0.108
Milk/cheese	0.002	0.003	0.003	0.005	0.007	0.004
Other Foods	0.191	0.179	0.182	0.182	0.207	0.188
Oilpalm Oil/Nuts	0.023	0.021	0.026	0.025	0.025	0.024
Other oils/fats	0.003	0.003	0.004	0.004	0.005	0.004
Groundnuts	0.013	0.012	0.012	0.012	0.014	0.012
Fruits	0.011	0.014	0.014	0.017	0.021	0.016
Vegetables	0.097	0.089	0.082	0.078	0.086	0.086
Alcoholic beverages	0.016	0.015	0.016	0.018	0.024	0.018
All Foods	0.722	0.733	0.744	0.713	0.737	0.730
Mean Hhold Per Capita Expenditures ('000)	230.1	390.5	550.3	780.9	1630.9	720.1
No. of observations	383	384	383	384	383	1,917

Source: GLSS data.

Note: Cassava budget shares include purchases of prepared fufu. As this product may contain other rootcrops as well, the cassava shares may overestimate actual cassava consumption slightly.

Table 11b - Urban Food Commodity Budget Share Means by Quintile

Commodity	Per Capita Expenditure Quintile 1	2	3	4	5	Pooled Rural Sample
Cereals	0.187	0.162	0.161	0.161	0.147	0.162
Maize/Kenkey	0.119	0.100	0.093	0.088	0.080	0.094
Rice	0.027	0.027	0.026	0.032	0.026	0.028
Millet/Sorghum	0.020	0.012	0.015	0.003	0.001	0.010
Bread/Pasta	0.021	0.023	0.027	0.038	0.039	0.030
Roots/Tubers	0.156	0.152	0.130	0.118	0.113	0.135
Cassava/Gari	0.089	0.081	0.071	0.064	0.068	0.075
Yams	0.017	0.019	0.020	0.020	0.017	0.019
Sweet potato/potato	0.001	0.001	0.001	0.001	0.001	0.001
Cocoyam	0.019	0.021	0.014	0.009	0.007	0.014
Plantain	0.030	0.030	0.024	0.024	0.020	0.026
Meats/Fish/Dairy	0.129	0.142	0.153	0.160	0.175	0.152
Beef	0.010	0.010	0.013	0.013	0.013	0.012
Poultry	0.009	0.012	0.016	0.019	0.021	0.015
Other meats	0.011	0.014	0.014	0.016	0.021	0.015
Fish/shellfish	0.096	0.098	0.102	0.097	0.101	0.099
Milk/cheese	0.004	0.007	0.008	0.014	0.018	0.010
Other Foods	0.187	0.181	0.178	0.170	0.190	0.181
Oilpalm Oil/Nuts	0.025	0.025	0.024	0.019	0.021	0.023
Other oils/fats	0.006	0.008	0.008	0.009	0.010	0.008
Groundnuts	0.011	0.010	0.009	0.008	0.008	0.009
Fruits	0.014	0.016	0.015	0.022	0.023	0.018
Vegetables	0.090	0.080	0.075	0.062	0.064	0.074
Alcoholic beverages	0.008	0.012	0.014	0.013	0.022	0.014
All Foods	0.660	0.637	0.621	0.608	0.625	0.630
Mean Hhold Per Capita Expenditures ('000)	360.2	600.0	840.2	1,240.7	2,360.8	1,080.4
No. of observations	241	241	241	241	241	1,205

Source: GLSS data.

Note: Cassava budget shares include purchases of prepared fufu. As this product may contain other rootcrops as well, the cassava shares may overestimate actual cassava consumption slightly.

Table 12 - Expenditure Elasticities of Various Food Estimates from Log-Log and Budget Share Models[a]

Commodity	Log-Log Model Rural	Log-Log Model Urban	Budget Share Model Rural	Budget Share Model Urban
Cereals	0.9180	1.0637	0.6904	0.9139
Maize/Kenkey	0.8390	0.8285	0.6049	0.7875
Rice	0.9984	1.5026	1.2669	1.2017
Millet/Sorghum[b]	1.2234	-1.1010	0.7041	0.5789
Wheat bread/Pasta	1.8053	1.9076	1.3488	1.4772
Rootcrops/Plantains	0.9346	1.2027	0.8974	1.0929
Cassava/Gari/Fufu	0.7255	1.4567	0.8795	1.0284
Plantain	0.1265	1.0979	0.4854	1.0983
Meats/Fish/Poultry/Dairy	0.8995	0.9493	0.9665	0.9047
Beef	1.5232	0.2296	2.6154	1.3069
Poultry	2.0698	2.5224	2.6154	1.3069
Other meats	2.0475	0.9459	1.7592	1.2827
Fish	0.3838	0.5103	0.6580	0.6041
Dairy Products	1.7009	2.7676	1.8563	1.7433
Other Foods	1.1503	0.7814	1.0861	0.8569
Oilpalm Oil/Nuts	0.9577	-0.8326	0.9094	0.3105
Other oils/fats	0.6946	1.3475	0.9885	1.1754
Fruits	1.7006	2.0705	1.3975	1.9454
Vegetables	1.0612	-0.4389	1.0946	0.4557
Groundnuts	1.1992	1.4404	0.9869	1.0289
Alcoholic beverages	0.1122	1.2328	1.4986	1.9379
Total Food	0.9097	0.9274	0.9115	0.9390
No. of Observations	1,914	1,188	1,914	1,188

Source: GLSS data.

Notes: The dependent variable in the log-log model is the natural logarithm of per capita expenditures on the food commodity; in the budget share model, it is the proportion of total household expenditures going toward the food commodity. In both models, the income instrument is the predicted natural log of total per capita household expenditures.

[a] Insofar as the standard errors of the estimates for the two models are in different units and are thus not strictly comparable, they are not reported here. They are available from the author upon request.

[b] Millet/sorghum elasticities were estimated using the subset of households in the Savannah zone (n=441 for rural, n=111 for urban).

The elasticities for expenditures on food items are quite large. While elasticities for expenditures on a commodity are greater than for the physical quantity consumed of that commodity due to quality effects, it is unlikely that the difference is large.[23] This implies that the demand for food commodities in Ghana is likely to grow in the near future as incomes increase. This is consistent with the comparatively low food consumption for the country as well as data from other parts of West Africa (see, for example, Strauss 1982). This, however, differs from the comparatively low estimates derived from time-series data by Asante et al. (1989). While there are no obvious errors in the Asante et al. study, the difference from the results here is larger than generally observed when time series and cross sections are compared. The Asante results imply a slow growth of demand for agricultural commodities and, hence, a potential for surplus production in the short run. The present study implies higher levels of food consumption (and possible nutrition) with income growth and a need for agriculture to strive to keep pace with demand. The difference has major policy implications. It would, therefore, be useful to use combined time-series and cross-sectional estimates from a combination of GLSS rounds when they become available to verify the present results.

Tables 13a and 13b indicate the reliance of households on markets for food consumption. The ratios reported differ from the more common self-sufficiency or marketed surplus ratio in that they only report the share of consumption that comes from own production; data on the portion of production that was marketed were reported in a different section of the survey and are not analyzed here. While there are substantial differences across agro-ecological zones, differences across expenditure groups are relatively small in the rural area. Exceptions to this generalization are for relatively minor commodities. There is a pronounced difference between expenditure groups, however, in the urban area. Consistent with the wider range of income-earning opportunities available to them, upper income groups are far less reliant on their own agriculture for their food consumption. One exception is the relatively high reliance on own production for root crops among the few well-off forest and savannah urban dwellers.

Even in rural areas, households in the coastal and forest zones purchase more cereals than they consume from their own production. A similar pattern is observed for meats and other foods. The share of root crops obtained from the market in the rural coastal zone, while less than half of total consumption, is nevertheless larger than the comparable share in the other two zones. To a degree, the high reliance on marketed foods for rural areas reflects the allocation of land to cocoa production and other export crops in the forest region. This, however, is only part of the story. In addition, many maize and rice producers sell the bulk of their production and purchase cassava and yams. Moreover, as the ratio is calculated here, a household that sells some of their production at harvest season and purchases some of the same commodity later in the year using wage or other earnings would

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23 Deaton (1987) found only a small difference for Côte d'Ivoire.

Table 13a - Share of Home Production in Rural Food Expenditure - Top and Bottom Quintiles by Agroecological Zone

Commodity	Coastal		Forest		Savannah	
	Lower	Upper	Lower	Upper	Lower	Upper
Total Food	0.266	0.281	0.486	0.415	0.663	0.650
Cereals	0.279	0.199	0.479	0.452	0.876	0.849
Maize/Kenkey	0.356	0.303	0.615	0.658	0.906	0.887
Rice	0.000	0.048	0.126	0.129	0.521	0.570
Millet/Sorghum	..	..	..	..	0.932	0.973
Roots/Tubers	0.592	0.589	0.824	0.738	0.868	0.831
Cassava/Gari/Fufu	0.650	0.606	0.817	0.726	0.813	0.861
Yams	0.572	0.597	0.746	0.563	0.935	0.819
Sweet potato/potato	0.683	0.122	0.667	0.112	0.754	0.481
Cocoyam	0.808	0.775	0.944	0.927	0.977	0.884
Plantain	0.404	0.576	0.887	0.836	0.936	0.848
Meats/Fish/Dairy	0.059	0.129	0.066	0.119	0.218	0.345
Beef	0.000	0.055	0.000	0.000	0.000	0.000
Poultry	0.429	0.335	0.638	0.554	0.828	0.730
Other meats	0.474	0.296	0.284	0.334	0.498	0.262
Fish/shellfish	0.027	0.082	0.001	0.011	0.059	0.416
Milk/cheese	0.000	0.000	0.000	0.008	0.089	0.000
Other Foods	0.227	0.241	0.412	0.414	0.430	0.579
Oilpalm Oil/Nuts	0.250	0.274	0.537	0.501	0.302	0.297
Other oils/fats	0.091	0.152	0.025	0.179	0.009	0.221
Groundnuts	0.000	0.110	0.196	0.161	0.639	0.927
Fruits	0.337	0.442	0.848	0.820	0.444	0.230
Vegetables	0.297	0.313	0.482	0.422	0.633	0.790
Alcoholic beverages	0.000	0.000	0.106	0.247	0.019	0.009
No. of observations	67	144	179	182	137	57

Source: GLSS data.

Notes: Calculations are ratios of consumption from home production to total consumption. These differ from self-sufficiency ratios, which are ratios of total production to total consumption. Ratios for Millet/Sorghum consumption are calculated only for the Savannah zone, since only small amounts are consumed in the other regions of the country.

Table 13b - Share of Home Production in Urban Food Expenditure - Upper and Lower Quintiles by Agroecological Zone

Commodity	Coastal		Forest		Savannah	
	Lower	Upper	Lower	Upper	Lower	Upper
Total Food	0.067	0.039	0.252	0.097	0.454	0.105
Cereals	0.066	0.067	0.174	0.065	0.679	0.092
Maize/Kenkey	0.103	0.142	0.269	0.142	0.707	0.131
Rice	0.001	0.000	0.021	0.000	0.204	0.090
Millet/Sorghum	0.000	0.000	0.000	0.000	0.872	0.030
Roots/Tubers	0.113	0.081	0.520	0.214	0.546	0.233
Cassava/Gari/Fufu	0.135	0.117	0.483	0.163	0.717	0.251
Yams	0.000	0.018	0.432	0.326	0.352	0.069
Sweet potato/potato	0.341	0.000	0.000	0.025	0.000	0.000
Cocoyam	0.407	0.196	0.827	0.575	0.951	0.195
Plantain	0.078	0.078	0.560	0.267	0.369	0.538
Meats/Fish/Dairy	0.042	0.028	0.047	0.062	0.188	0.006
Beef	0.000	0.000	0.000	0.000	0.321	0.000
Poultry	0.149	0.067	0.404	0.253	0.613	0.046
Other meats	0.000	0.043	0.134	0.177	0.313	0.014
Fish/shellfish	0.041	0.024	0.000	0.000	0.032	0.000
Milk/cheese	0.000	0.000	0.000	0.000	0.000	0.000
Other Foods	0.020	0.029	0.144	0.088	0.307	0.101
Oilpalm Oil/Nuts	0.026	0.008	0.171	0.061	0.075	0.038
Other oils/fats	0.002	0.000	0.041	0.000	0.029	0.000
Groundnuts	0.014	0.000	0.051	0.007	0.479	0.021
Fruits	0.049	0.133	0.287	0.243	0.135	0.009
Vegetables	0.024	0.030	0.186	0.147	0.483	0.214
Alcoholic beverages	0.000	0.000	0.026	0.014	0.000	0.000
No. of observations	92	175	101	54	48	12

Source: GLSS data.

Notes: Calculations are ratios of consumption from home production to total consumption. These differ from self-sufficiency ratios, which are ratios of total production to total consumption. Ratios for Millet/Sorghum consumption are calculated only for the Savannah zone, since only small amounts are consumed in the other regions of the country.

indicate a comparatively low share of own production in total consumption. Nevertheless, the data indicate a larger reliance on traded foods than commonly assumed for small farmers in Africa. These farmers, then, would be affected by changes in marketing margins both as producers and consumers.

5. CONCLUSION

This study indicates a positive relationship between income and nutritional levels. While this may be deemed obvious, it is surprisingly difficult to demonstrate and often contradicted (Behrman et al. 1988). The results here confirm a similar study based on Côte d'Ivoire data (Sahn 1989). Many of the long term impacts of current economic policies, although introduced for reasons other than nutrition, will likely affect nutrition through this income relationship. A revival of Ghana's once noteworthy educational system may also affect nutrition via income, rather than directly shifting the effectiveness of input utilization. We are not, however, able to investigate the impact of any particular existing government program. This is, in part, due to the absence of infrastructure variables, although there is some indirect evidence of the role of health infrastructure through the probability of disease. Moreover, the Government of Ghana is still in the process of restoring the overall economy as well as social infrastructure and does not currently have nationwide programs aimed at improving nutrition, the impacts of which might be investigated in a similar analysis of nutritional status. Similarly, the GLSS was not designed to investigate the impact of those types of supplementary feeding programs that are being undertaken. One can, however, extrapolate a bit from the evidence in these data as well as from other programs to consider potential interventions.

For example, the regional patterns verified here confirm the persistence of a nutritional disadvantage for children born in the savannah and also provide a basis for determining priorities. The higher levels of malnutrition in the north is not a new disparity--it was observed in nationwide surveys nearly 30 years ago. The legacy represents a vicious circle; the effect which is referred to above as the womb environment or phenotype pathway carries the effects of malnutrition to subsequent generations. Regional differences may also reflect ecological constraints as well as the relatively high costs of health infrastructure and utilization in a region with difficult transportation and, in places, relatively low population densities. Nevertheless, targeted programs may counteract some of these handicaps.

For example, the nutrition of children can be affected in the short run through improved prenatal nutrition. There is ample evidence that medical care and intervention programs, especially those targeted to mothers exhibiting less than normal growth during pregnancy, can reduce the probability of a low birth weight child. While food supplementation programs designed for children often fail to indicate measurable impacts on nutrition, partially due to imprecise targeting, programs aimed at women in the later stages of pregnancy are more likely to have significant results (Kennedy and Alderman 1987, Anderson 1989). For example, one of the most noted studies of maternal supplementation indicated a major reduction of low birth weight children in the Gambia, although little effect on lactation was observed (Prentice et al. 1983).

This discussion has touched upon two forms of targeting. A priority for women in the later stages of pregnancy is a form of life cycle targeting, while the regional pattern implies geographic targeting.[24] Another type of targeting that is often considered, targeting by income or other measures of economic status, often requires more data and trained administrators than is currently available in Ghana.

The suggestion of a focus on pregnant women is a divergence from the main form of nutritional intervention that was included in the PAMSCAD package. To be sure, no one wants to argue, in an either/or manner, against providing extra food to underweight children. Nevertheless, it is often difficult to design supplementary feeding programs that are sharply focused on children in the vulnerable 6- to 24-month bracket. Such programs work best when coupled with health care centers. They have their main impact through the incentives for monitoring and preventative care. The potential for an impact of the food distributed is enhanced if the quantity increases when a child indicates failure to thrive. This has been attempted by voluntary agencies in Ghana with mixed results. The success of such programs is dependent on increased utilization of health care outlets, which in turn is dependent on availability and quality.

Like child-oriented programs, interventions targeted to pregnant women can be subtargeted by other criteria, including low weight gain. Moreover, they share a feature in that a portion of the benefits comes from the increased incentives to obtain prenatal care.[25] Although the number of women in the later stages of pregnancy is lower than the number of preschool children or the number of children in the more narrow band of maximum vulnerability, universal coverage is likely infeasible for the short or medium term.

This, then, returns the discussion to geographic targeting. Such targeting is administratively simple and virtually free of incentives to alter behavior or conceal information that influences the efficiency of some targeting schemes. It, however, has the potential to add to interregional political tensions. Moreover, geographic targeting often assumes away major differences in the costs of delivering a service. When the cost of delivering services is greater in remote regions, the most effective means of achieving national objectives are not necessarily indicated by poverty lines or similar targeting aids. With semiurban areas exhibiting comparatively

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24 For a review of targeting methods and results, see Alderman (forthcoming) as well as Pinstrup-Andersen (1988).

25 The GLSS data indicate that 88 percent of all mothers (84 percent in rural areas) reported prenatal care. This is surprisingly, even suspiciously, high and does not indicate the type or the quality of care obtained.

high levels of chronic malnutrition, these areas may be a convenient entry point for programs, particularly in the savannah regions, to be augmented if or when experience and infrastructure permit in high priority rural regions.

While the GLSS data collection is not designed for program evaluation, the data may assist in targeting criteria. In particular, the increased sample size that will be possible when the second (and subsequent) years of the survey are available can conveniently provide statistics on nutrition at greater levels of geographic disaggregation than currently advisable.

The analysis above points to a few additional generalities that can augment the planning of health and nutrition strategies. For example, given the effect of parity on the mother's nutrition and the sibling effect observed in the children's regression, programs that influence both the number and spacing of births will likely improve nutrition.[26] If, furthermore, education or specific family planning programs influence the age at which a mother begins her family, an effect on children's nutrition should be observed as indicated by the maternal age variable in the regressions. Similarly, any program that reduces the probability of childhood disease will have an additional effect on health. Preventative health programs, then, may be a more direct pathway to improving nutrition than supplementary feeding programs.

It is not possible, however, to say much about the potential for food pricing policy to improve nutrition. Not only are there few cost-effective instruments that can influence marginal prices for vulnerable groups in Ghana, it is hard to interpret the available food expenditure variables in a policy context. They are not strong predictors for children's nutritional status, although they are for adult women. Even in this case, however, one would be foolish to venture that an increase in the price of foods that are inelastic--implying increased expenditures following such a price increase--is a sound nutritional policy. More conclusive results and more useful policy levers might be uncovered if the nutrients for which food expenditures are believed to proxy can be calculated. This may be possible when the full set of prices that were collected are linked with the household data.

While the strength and types of conclusions that can be drawn from the GLSS data are limited by data problems referred to above, the surveys are designed for monitoring as well as for research that elucidates pathways. Repeated surveys as envisioned by the GLSS project can provide such a monitor for overall economic progress as well as specific progress in improving social welfare. Repeated surveys may, furthermore, provide increased information to isolate effects only weakly illuminated with the current data.

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26 For a recent review, see Haaga (1989).

APPENDIX: ESTIMATION OF INSTRUMENTS

While the estimating of instrumental variables is undertaken primarily to obtain regressors for the main estimates, there are a number of points of note in these equations. These are discussed briefly below.

Total Expenditures (Appendix Table 1) are used as a proxy for unobserved permanent income. In preliminary estimates (not shown), it was observed that expenditure equations were more plausible than income predictors. While most coefficients in the expenditure functions are quite consistent with a permanent income interpretation, the same cannot be said with the income equations. For example, urban household expenditures increase 100,000 cedis for every university degree in the household (male) and 30,000 cedis for primary completers, with rural results being surprisingly similar. In the urban income equations, the corresponding numbers are 9,000 and -2,000, and in the rural, they are not significant at -17,000 and 8,000, respectively. The problem is also indicated looking at the average level of income for the entire sample, which is roughly only half of average expenditures. It is more disturbing that the underreporting of income (for a number of fairly obvious reasons, it is unlikely that expenditures are overreported) is clearly not uniform. If one looks at regional means (urban/nonurban) or at means by agroecological zones, one sees that Accra has the highest expenditures and the lowest incomes while the situation is roughly reverse for the rural savannah. Perhaps, government employees are more likely to underreport incomes.

While the comparison between expenditure and income regressions was done in total cedis terms, it was noted that these regressions were heteroscedastic. This problem was reduced when dependent variable was transformed into natural logarithms. The results reported in Appendix Table 1 are, furthermore, transformed into per capita terms.

The equations indicate that, in general, education had the expected positive impact on total family expenditures, with the coefficient in the rural equations being often higher than in the urban. Note also that an additional woman with post-primary education has a larger impact on the logarithm of expenditures per capita (or total family expenditures) than does an additional male with a similar education. Nonland assets have small but positive impacts (in an expenditure equation this should measure the long-run net returns). Land, which is allowed to vary by ecological zone due to quality factors, also has a small but positive impact. The coefficient of land in cocoa, while positive, is also surprisingly small and not significant. Dummy variables for agroecological zones and type of urban setting indicate that locale has a significant effect, even controlling for different

Appendix Table 1 - Expenditures Equations (standard errors in parentheses)

Variable	Log Total Expenditures Per Capita		
	Rural	Urban	Pooled
	00.000	00.000	00.000
Intercept	11.501 (0.063)	11.859 (0.074)	11.177 (0.045)
Males 0-5 yrs	-0.157 (0.018)	-0.188 (0.022)	-0.086 (0.011)
Males 5-10 yrs	-0.112 (0.020)	-0.182 (0.023)	-0.086 (0.012)
Males 10-20 yrs	-0.091 (0.016)	-0.155 (0.020)	-0.078 (0.009)
Males 20-65 yrs	-0.041 (0.028)	-0.086 (0.037)	-0.023 (0.017)
Males 65+ yrs	-0.039 (0.058)	-0.212 (0.085)	-0.074 (0.037)
Females 0-5 yrs	-0.142 (0.018)	-0.207 (0.023)	-0.089 (0.011)
Females 5-10 yrs	-0.117 (0.021)	-0.154 (0.024)	-0.092 (0.013)
Females 10-20 yrs	-0.077 (0.017)	-0.093 (0.021)	-0.054 (0.009)
Females 20-65 yrs	-0.111 (0.023)	-0.093 (0.028)	-0.035 (0.013)
Females 65+ yrs	-0.220 (0.049)	-0.102 (0.063)	-0.116 (0.026)
Males with primary education (only)	0.075 (0.025)	0.068 (0.027)	0.051 (0.015)
Males with secondary education	0.144 (0.083)	0.197 (0.062)	0.133 (0.042)
Males with university education	0.697 (0.288)	-0.013 (0.156)	-0.017 (0.131)
Females with primary education (only)	0.013 (0.025)	0.103 (0.026)	0.055 (0.013)
Females with secondary education	0.220 (0.167)	0.291 (0.092)	0.265 (0.065)
Land in Coastal Zone	1.187[a] (0.446)	0.784[a] (1.097)	0.445[a] (0.313)
Land in Forest Zone	0.767[a] (0.255)	0.712[a] (1.313)	0.912[a] (0.216)
Land in Savannah Zone	2.919[a] (0.460)	7.000[a] (3.905)	3.035[a] (0.395)
Cocoa Acreage	0.413[a] (0.479)	3.213[a] (3.868)	0.479[a] (0.413)

(continued)

Appendix Table 1 (continued)

Variable	Log Total Expenditures Per Capita		
	Rural	Urban	Pooled
Value of Livestock	5.737[b] (1.654)	3.107[b] (5.813)	3.701[b] (1.029)
Value of Vehicles	2.983[b] (1.548)	3.396[b] (1.702)	3.643[b] (0.727)
Value of Other Capital	6.623[b] (1.786)	1.176[b] (0.577)	1.610[b] (0.439)
Semi Urban dummy	0.071 (0.029)	...	0.062 (0.024)
Urban dummy	...	...	0.213 (0.023)
Forest Zone dummy	-0.119 (0.033)	-0.089 (0.041)	-0.112 (0.023)
Savannah Zone dummy	-0.352 (0.043)	-0.178 (0.062)	-0.350 (0.030)
Female head of household dummy	-0.119 (0.040)	-0.203 (0.046)	-0.071 (0.024)
Age of head of household	-0.003 (0.001)	-0.003 (0.001)	-0.003 (0.0008)
Interview month trend	0.025 (0.004)	0.018 (0.005)	0.025 (0.003)
Accra dummy	...	0.200 (0.042)	0.247 (0.037)
Tema dummy	...	0.020 (0.064)	0.068 (0.055)
R^2	0.335	0.466	0.346
Number	1,914	1,188	3,673

[a] Times 10^{-3}.

[b] Times 10^{-7}.

levels of assets. Finally, female headed households have significantly smaller expenditures in both rural and urban areas.

Parity Regressions were estimated using OLS (Appendix Table 2). While the dependent variable is a count variable (integer) rather than a continuous variable and is, furthermore, truncated at zero, Ainsworth (1989) has indicated that techniques to correct for the departure from OLS assumptions that these conditions entail do not have a noteworthy influence on the results. The dependent variable is the number of children ever born, regardless of survival.

While the age variables are both highly significant in the two equations, this merely confirms the cumulative pattern of the dependent variable.

The main concern, however, is with the income variables that indicate increasing parity at a given age and education as incomes increase. A similar pattern was observed by Ainsworth for Côte d'Voire, although it is not commonly observed in developed countries. Unlike Ainsworth, however, the specification here includes a quadratic term. The turning point at which the marginal impact of income becomes negative occurs when the logarithm of total expenditures is roughly one-and-a-half standard deviations above the mean, which is well within the sample.

Post-primary education has a strong effect on parity at a given age.[27] The coefficients for post-secondary education are higher than for secondary education. In contrast to Côte d'Ivoire, education has a significant influence on parity even in rural areas.

[27] The study did not determine the impact on completed births--that is, the total number of children after a woman has completed her childbearing. More educated women generally start their childbearing later, but may not necessarily have less children over their lifetime.

Appendix Table 2 - Parity Estimates (Cluster Fixed Effects)

	Rural	Urban
Intercept	-144.912 (31.315)	-155.427 (36.909)
Age	0.393 (0.034)	0.385 (0.044)
Age Squared	-0.002 (0.0005)	-0.003 (0.0007)
Highest Schooling = primary	0.042 (0.158)	-0.069 (0.197)
Highest Schooling = secondary	-0.275 (0.118)	-0.873 (0.151)
Highest Schooling = post secondary	-1.629 (0.474)	-1.604 (0.271)
Log Total Expenditure	20.980 (4.947)	22.356 (5.718)
(Log Total Expenditure)^2	-0.795 (0.197)	-0.835 (0.221)
Land Ownership	-0.0005 (0.0006)	-0.001 (0.004)
Cluster Mean Parity	0.460 (0.054)	0.560 (0.064)
R^2 of Equation	0.663	0.584
Number	1,248	782

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