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Understanding the health and nutritional status of children in Ghana

W.K. Asenso-Okyere [a,*], F.A. Asante [a], M. Nubé [b]

[a] Institute of Statistical, Social and Economic Research (ISSER), University of Ghana, P.O. Box 74, Legon, Ghana
[b] Center for World Food Studies, Free University of Amsterdam, Amsterdam, Netherlands

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Abstract

The data set of the Ghana Living Standards Survey (GLSS, round 1, 1987/1988) was utilized to analyse the principal determinants (publicly and privately) of health and nutrition of children under five in Ghana. While in most health and nutrition studies the emphasis is either on health-related factors such as occurrence of illness, immunization, accessibility to light (electricity), the role of breastfeeding, or on food availability and food-consumption-related factors, in the present study, an attempt has been made to incorporate both aspects simultaneously. On the basis of the GLSS, Ghanaian households spend at the average approximately 60% of total expenses on food. Changes in relative prices of the various food commodities differently affect household food availability. Lowering prices of relatively cheap foods (e.g., millet, cassava) tends to have a strong positive effect on total household kcal availability. At the level of the household, the absolute number of nondependents, presumed to represent the available labour force, is positively correlated with household food availability. There is also a positive correlation between the mothers' level of education (10 yrs of schooling and above) and the nutrition level of children. Occurrence of illness in children could be shown to negatively affect their health and nutrition status. Finally, a specific finding in the analysis was a rather strong negative effect of prolonged breastfeeding on the nutritional status of children. Among the policy recommendations emanating from the research are: (1) promotion of efficient production and marketing of cassava, (2) efforts to achieve slowing down of rural–urban migration to prevent labour shortages in rural households, (3) improving water and sanitation conditions, (4) expanding immunization programmes in particular in rural areas, and (5) promoting better weaning practices when children are no longer fully breastfed. © 1997 Elsevier Science B.V.

1. Introduction

1.1. Nutrition and health of Ghanaian children

The interconnections between the health and nutrition of a household is better understood by considering children in the early stages of their life. Children are more vulnerable to the consequences of under- and/or malnutrition than adults. It is in these formative years that good nutrition gets translated into visible signs on the body and can be measured by using anthropometric methods. Also, mortality rates tend to be high for this age group, and the risk of preventable mortality reduces considerably after the age of five. The nutrition and health status of a child may be linked to the poverty level of the household.

* Corresponding author. Fax: 00(233)21 500937; e-mail: isser@gha.healthnet.org.

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Issues of health and nutrition are very important in Ghana due to the low health and nutrition outcomes of a large cross-section of the population, most importantly children. Reutlinger and Selowsky (1978) pointed out that the nutritional status of an infant is the most important policy-induced determinant of the individual's initial physical condition, which, in turn determines the effectiveness of further investment in human capital. On the basis of anthropometry, about one-third of children in Ghana are malnourished (GSS, 1989b).

A study by Ewusi (1978) in the mid-seventies on the nutritional status of children in six villages in the coastal savanna plains and in the forest zone summarized the incidence of malnutrition in the study area. Using anthropometric measurements based on changes in the upper arm circumference, the survey showed that, for most of the villages, more than two-thirds of the children could be considered as being undernourished. Ewusi further concluded that on the average, 70.3% of the children were undernourished with 21.5% seriously undernourished. Orraca-Tetteh and Watson (1977), in another study of the nutritional situation in Bafi, a village in the Brong-Ahafo region, had a result which was similar to Ewusi (1978).

A nationwide nutrition survey of 14 000 children conducted jointly by the Nutrition Department of the Ministry of Health and UNICEF in 1986 found that 58.4% of preschool children fell below 80% of the US National Center for Health Statistic (NCHS) weight-for-age standards (World Bank, 1989). This was roughly twice the level obtained in the first national survey carried out in 1961–1962. About 8% of children in the country were clinically classified as suffering from marasmus or kwashiorkor. Malnutrition levels were highest in the northern zone (64%) and lowest in the coastal zone (48%).

The 1988 Demographic and Health Survey (GSS, 1989b) reports levels of malnutrition among 1841 children between the ages of 3–36 months. Chronic malnutrition constitutes 30% of the sample reported. The survey further indicated high levels of malnutrition in the north, and the two upper regions that were comparable to the savanna zone. It was also found that children who recently had diarrhoea had high rates of malnutrition. There were pronounced improvements in the rates of malnutrition of children whose mothers had more than a middle school level (10 yrs of schooling) of education. According to the survey, stunting and underweight occur among almost one in three children aged 3 to 36 months in rural areas, where over two thirds of the Ghanaian population lives. Nearly one in three urban children are stunted and nearly one in three urban children is underweight (GSS, 1989b).

Alderman (1990), using the first round of the Ghana Living Standards Survey (GLSS I) data, found that 31.4% of children fell below the weight-for-age standard (median-2 standard deviation). The GLSS data, which is the most recent national survey that groups the nutritional status of children in Ghana by age, gender and agro-ecological zone, revealed that the acute malnutrition for boys was appreciably higher than that for girls in the 6–24-month age bracket. The gap closes and reverses in the older age bracket that has less malnutrition. Malnutrition is observed to be severe in the savanna agro-ecological zone. This is consistent with earlier studies that reported higher levels of malnutrition in the northern regions (Levinson, 1988; 1961–1962 and 1986 National Nutrition Surveys). Greater-Accra has the lowest levels of both acute and chronic malnutrition. The remainder of the coastal agro-ecological zone has appreciably less chronic malnutrition than the forest or savannah regions.

In comparison with the national survey of 1986 (World Bank, 1989) the GLSS results (GSS, 1989a) indicate some improvement in nutritional conditions. Another indication of the changing pattern of malnutrition in the 1980s comes from data collected by the Catholic Relief Service (CRS) for children attending maternal child health centres (CRS, 1987). The data showed a slightly improving pattern over the period 1983–1987. However, the data also indicate that even in a 'good' agricultural and nutrition year such as 1980, 35% of children were below 80% of the weight-for-age standard; in the severe drought of 1983, the figure was 51%, and by 1986, after the recovery of agricultural production, it had decreased to 35%.

The overall poor health conditions in Ghana are illustrated by the fact that life expectancy at birth in 1990 was only 56.2 yrs (UNDP, 1996), which is identical to the average for all low-income countries, excluding India and China. In 1993, the Infant Mortality Rate was 83 deaths per 1000 live births, which is higher than the average for low-income economies (World Bank, 1993). With respect to health care, between 1985 and 1995, about 60% of the Ghanaian population had access to health services (UNDP, 1996). Due to the absence of modern facilities, many people in the rural areas get access to health care through herbalists and other unorthodox health care facilities. About 40% of all births are attended to by health personnel. In 1984, the number of persons per doctor was 14 890 and 640 per nurse. Through an intensive campaign (Expanded Programme on Immunization) the proportion of one-year-olds immunized has increased from 34% in 1981 to 64% between 1989 and 1991. This has drastically reduced the incidence of some childhood killer diseases and has therefore contributed to a reduction in infant mortality.

Infant mortality rate, estimated at around 100 deaths per 1000 births in 1973–1977, has declined by approximately 22% to 77 deaths per 1000 births between 1983–1987. Mortality during childhood has also declined during the period under consideration. The probability of a child dying between birth and age 5 has dropped from 0.187 in 1973–1977 to 0.155 in 1983–1988 (GSS, 1989b).

1.2. The research problem and objective

Past research has indicated the complex relationships between health and nutrition. The relative importance of the various factors that determine health and nutrition is affected by local conditions with respect to climate, food availability and accessibility, water and sanitation facilities, etc.

The present study aims to define and quantify some of the factors that determine the health and nutritional status of children in Ghana. The results will be useful for enacting pragmatic policies and designing effective intervention programmes to improve the health and nutrition of people, especially children who tend to be more vulnerable in many instances.

1.3. Source of data and method of analysis

The data for this study was based on the first round (1987/1988) of the GLSS I, which was conducted by the Ghana Statistical Service with assistance from the World Bank.

The GLSS I was carried out on a probability sample of 3200 households from 200 enumeration areas. There were a total of 15 648 individuals in the households selected. A two-stage sampling procedure was used in selecting the sample. In the first stage, 200 enumeration areas were selected with probability equal to size after they had been ordered according to agro-ecological zones and then rural/urban/semi-urban localities. Each work load contained 20 households with four of them used as replacements.

The GLSS provides data on various aspects of the Ghanaian households' economic and social activities, and the interaction between those activities. The data were collected using three questionnaires: (i) household questionnaire; (ii) community questionnaire; and (iii) price questionnaire (on food commodity prices).

Due to the absence of food intake data, household expenditures were used in the computation of food availability. This was done by converting food expenditure data to quantities through a price variable, and the quantities to calories through a conversion factor obtained from nutrition tables. A food intake survey technique would have been the best in estimating the quantity of food consumed (Bouis et al., 1992). Food quantity information obtained from expenditure surveys have measurement errors that are often systematically correlated with income, such that the responses of food intakes to increases in income are seriously overstated (Bouis et al., 1992). First, this may be because food quantities are not measured independently of income if total expenditures are the proxy used for income, and second, because food transfers in the form of guest and hired worker meals are underrecorded. Bouis et al. have concluded that the use of food expenditure surveys (typically used in economic analysis) has led to severely upward biased estimates, while using food intake survey techniques (developed by nutritionists) gives more accurate estimates of nutrient demand parameters.

The paper uses both bivariate and multivariate analysis in ascertaining the factors that affect the health and nutrition status of children under five in Ghana. Bivariate relationships are investigated through cross-tabulations. Multivariate analysis involved the specification and estimation of a nutrition and health status econometric model.

Section 2 presents some bivariate relationships between a composite health and nutrition variable and other variables.

2. Bivariate relations between health and nutrition and their determinants

2.1. Anthropometry

Table 1 gives the results on the prevalence of malnutrition in Ghana, by type and by region. The distribution of undernutrition among children, 0–59 months, reveals that 29.7% of children are chronically undernourished or stunted (height-for-age z-score below median-2 standard deviations). This shows that about 1 in 3 children aged 0–59 months are chronically undernourished. About 27% of children in Ghana are underweight (weight-for-age z-score (waz) below median-2 standard deviations). This implies that about 1 in 3 children in Ghana are underweight (see also Alderman, 1990).

Acute undernutrition, which is manifested by wasting (weight-for-height z-score (whz) that is below median-2 standard deviations of the reference population) can be found with 7% of children in Ghana aged 0–59 months. Thus, approximately 1 in 13 Ghanaian children are wasted. The distribution of undernutrition is consistent with results obtained from the Demographic and Health Survey carried out in 1987. The rural areas turn out to be more undernourished (higher percentages of chronically undernourished, underweight and acute undernutrition) than the urban areas. This confirms earlier findings (Boateng et al., 1990) that poverty in Ghana

Table 1
Distribution of undernutrition among children aged 0–59 months in Ghana, 1987–1988

	Chronically undernourished	Underweight	Acute undernutrition
Ghana	29.7	27.3	6.7
Locality			
Rural	33.9	30.4	7.1
Urban	20.0	20.0	5.9
Region			
Ashanti	32.3	32.6	9.5
Brong-Ahafo	34.9	30.9	6.3
Central	31.1	29.3	5.8
Eastern	26.0	18.7	4.1
Greater-Accra	20.8	17.3	7.5
Northern	38.9	40.5	11.5
Upper East	28.7	22.3	6.4
Upper West	37.8	37.0	8.4
Volta	28.2	25.7	5.8
Western	27.1	27.5	5.1
Zone			
North	35.8	34.3	9.0
South	28.7	26.0	6.3
Agro-ecology			
Coastal	23.1	21.8	6.2
Forest	32.6	29.9	6.1
Savannah	33.2	29.8	8.3

Source: Computed from the GLSS, 1987–1988 data.

Table 2
Household food availability and anthropometry of 'underfives'

Household per capita kcal quintile	Height-for-age z-score 'underfives'			Weight-for-height z-score 'underfives'		Household kcal capita^{-1} day^{-1}	
	N	Mean	Standard deviation	Mean	Standard deviation	N	Mean
1	380	−1.15	1.27	−0.45	0.89	634	596
2	359	−1.17	1.29	−0.44	0.97	635	1120
3	313	−1.04	1.47	−0.62	1.02	633	1658
4	262	−1.14	1.42	−0.55	0.94	630	2561
5	192	−1.32	1.50	−0.65	1.00	611	6051
all	1506	−1.15	1.37	−0.52	0.96	3143	2370

Source: computed from GLSS, 1987–1988 data.

is a rural phenomenon. When chronic and acute malnutrition are considered together, undernutrition is highest in the savannah area followed by the forest and coastal areas.

2.2. Food availability

Table 2 provides data on the household per capita kcal availability as obtained from the GLSS. For Ghana as a whole, the GLSS indicates an average higher figure than obtained from national data. For example, FAO reports for Ghana per capita mean kcal availabilities for 1987 and 1988 of 2205 and 2245 per day, respectively, (State of Food and Agriculture, FAO, 1992) as compared with an average of 2370 per day from the GLSS data.

The data show a very wide range of household per capita kcal availability figures when households are distributed over quintiles on the basis of kcal availability, with an average of 596 kcal capita^{-1} day^{-1} for the lowest quintile, and 6051 kcal capita^{-1} day^{-1} for the highest quintile. In a previous study by Alderman and Higgins (1992), such a disparity was observed, although on a smaller scale (2158–4815 kcal capita^{-1} day^{-1}) than in this study. Data differences may be partly due to the conversion of nonpurchased food items into expenditures at a given price. In this study, retail prices were used due to the absence of farm level prices. Clearly, the kcal availability figures obtained do not represent actual kcal intakes, as it would result in both extreme undernutrition and extreme overnutrition. Apart from data weaknesses, transfers between households may be partially responsible for the wide range in per capita kcal availability, and the range of actual household per capita kcal intakes must be, on physiological grounds, much smaller. However, for want of better instrument, we use household per capita kcal availability as a proxy for household food availability. Table 2 also provides mean height-for-age and mean weight-for-height z-scores for each quintile. It should be noted that the mean height-for-age or weight-for-height z-scores do not show a correlation with the household per capita food availability. Thus, the data suggest that the GLSS information on household food availability is a poor indicator for actual children's food intake, and the resulting children's nutritional status. Another limitation of the data is unavailability of information on intrahousehold kcal distribution.

2.3. Age of mother at birth

In Ghana, about 15% of all births are to women whose age is below 20 yrs (Ghana Fertility Survey, 1979/1980). It has been shown by various authors that when a woman gives birth to a baby at a very young age (teenage pregnancy) there is an increased risk for a low birth weight (ACC/SCN, 1990). There are a number of mechanisms through which the age of the mother at birth could affect birth outcome and also the child's height-for-age z-score in subsequent years. First, teenage girls are not yet fully grown up and when they become pregnant, the conditions for fetal growth may be suboptimal, resulting in a low birth weight (Kramer, 1987).

Table 3
Height-for-age z-scores of children at time of survey and age of mother when giving birth to the child

Age mother when giving birth	Age in months 'underfives'	Height-for-age z-score 0–60 months [a]			Height-for-age 0–36 months			Height-for-age 37–60 months			Household per capita expenditures	
	Mean	n	Mean	Std	n	Mean	Std	n	Mean	Std	Mean	Std
Below 17 yrs	29.26	74.00	−1.67	1.42	48.00	−1.37	1.43	26.00	−2.23	1.23	58454	42094
17 yrs	30.45	80.00	−1.47	1.46	49.00	−1.05	1.34	31.00	−2.14	1.40	64047	43215
18–19 yrs	26.23	175.00	−1.08	1.54	123.00	−0.92	1.41	52.00	−1.46	1.76	68038	38850
20–30 yrs	26.72	1096.0	−1.18	1.57	769.00	−0.99	1.60	327.00	−1.64	1.38	66824	56230
31–40 yrs	27.17	512.00	−1.00	1.58	347.00	−0.79	1.52	165.00	−1.43	1.61	64472	57470
41 and above	29.33	150.00	−1.03	1.54	95.00	−0.74	1.42	55.00	−1.53	1.62	51888	36254

[a] t-test on height-for-age z-scores of children 0–60 months, comparing children born when the mother is 17 yrs and below, $n=154$, average haz $= -1.57$, or 18 yrs and above, $n=1933$, average haz $= -1.11$, difference significant at $p=0.002$.
Source: computed from GLSS, 1987–1988 data.

Table 4
Illness and anthropometry

Number of days ill last month	Average age in months		HT for age z-score						WT for HT z-score					
			Children's age group						Children's age group					
			0–20 months		21–40 months		41–60 months		0–20 months		21–40 months		41–60 months	
	N	Mean	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
0	1295	28.63	−0.34	1.44	−1.37	1.57	−1.63	1.55	−0.38	1.24	−0.58	0.97	−0.42	0.93
1–7	752	28.16	−0.73	1.37	−1.47	1.53	−1.60	1.29	−0.70	1.16	−0.59	0.99	−0.42	0.80
8–31	225	25.69	−1.05	1.51	−1.36	1.64	−1.65	1.39	−1.02	1.09	−0.75	1.04	−0.69	0.86

Source: computed from GLSS, 1987–1988 data.

Second, when the child is born, breastfeeding by the teenage mother may be insufficient and negatively affect the child's growth after birth. Third, various socioeconomic factors, related to the age of the mother, and her experience in raising children, may affect the child's nutritional and health conditions, and thus the pattern of growth.

Table 3 gives, for the 'underfives' in the GLSS database, the relationship between the ages of mothers when the child was born and the height-for-age z-scores of the children at the time of the survey. The table reflects both the effect of the age of the mother during pregnancy and when giving birth, as well as the effect of the age of the mother during child rearing on the anthropometric z-scores of the child. The table shows that children in the age-group 0–60 months, whose mother was 17 yrs or younger when they were born, have significantly lower height-for-age z-scores when compared with children whose mother was 18 yrs or above.

If the children are divided over two age groups, 0–36 months and 37–60 months, for both groups, height-for-age z-scores are still lower for children born when their mother was 17 yrs or younger, in comparison with children born when their mother was 18 yrs or older.

2.4. Illness, vaccination and nutritional status of children

Infectious diseases are considered to play a major role in the causation of malnutrition. Illness may affect nutritional status through at least the following mechanisms: reduced food intake (through reduced appetite), reduced absorption or increased intestinal losses of nutrients (e.g., in diarrhoea), increased requirements because of higher metabolic rates (e.g., fever), and reduced requirements as a result of a lower level of physical activity. On the other hand, it has also been shown that malnutrition can increase susceptibility to disease; therefore, a higher incidence of illness can be expected in malnourished children (Tomkins and Watson, 1989). In Table 4 the relationships between illness and anthropometry of 'underfives' in the GLSS-data set are explored. Information was collected for how many days children were ill over the past 4 weeks. The table indicates, for children below 20 months of age, a negative correlation between occurrence of illness over the last month and their nutritional status, whether based on the height-for-age or the weight-for-height z-scores. For older children, there is still some negative correlation between illness and nutritional status when expressed on the basis of weight-for-height, but not on the basis of height-for-age.

These results give some support to the concept that recent illness has an effect on a short-term nutrition indicator such as weight-for-height, but much less on a long-term indicator such as height-for-age. This issue could, to some extent, further be explored by analysing the relationships between vaccination, illness occurrence and anthropometry. In Ghana, vaccination programmes against diphtheria, whooping cough, tetanus, poliomyelitis and measles are widely implemented. In the GLSS, mothers were requested to provide information on whether their youngest child was vaccinated against these diseases or not.

Table 5 indicates that for the 41–60-month age group, approximately 75% of the children had been vaccinated. Again, the absolute numbers of children are relatively low as information is only available for the youngest child in the household. With respect to the relationship between vaccination and nutritional status,

Table 5
Vaccination and child anthropometry

Child vaccinated	0–20 months				21–40 months				41–60 months			
	N	haz	whz	Days ill	N	haz	whz	Days ill	N	haz	whz	Days ill
		Mean	Mean	Mean		Mean	Mean	Mean		Mean	Mean	Mean
Yes	428	−0.56	−0.64	3.6	454	−1.39	−0.53	2.9	306	−1.54	−0.45	2.4
No	216	−0.44	−0.41	3.2	149	−1.64	−0.86	3.2	103	−2.16	−0.48	2.4
t-value [a]		−0.35	−0.92	0.76		0.15	3.11	−0.7		4.19	0.86	–

Source: computed from GLSS, 1987–1988.
[a] t-test for difference between means.

Table 6
Literacy of mother and child anthropometry

Mother literate/ illiterate	N	Children's height-for-age score		Children's weight-for-height score		Household per capita expenses
		Mean	Std	Mean	Std	
Mother literate	1459	−1.23	1.60	−0.57	1.07	58398
Mother illiterate	616	−0.97	1.42	−0.52	1.05	77204

Source: computed from GLSS, 1987/1988; household per capita expenses in cedis per year.

Table 5 indicates that for children in the 20–40-month age-group, and even more so for children in the 40–60-month age-group, vaccination is associated with better anthropometric z-scores. On the other hand, for the 0–20-month age-group, there is no difference in nutritional status between vaccinated and nonvaccinated children.

The mechanism through which vaccination is considered to have an effect on nutritional status is a reduction in the occurrence of infectious diseases. However, the GLSS data do not reveal a clear pattern in the occurrence of illness in vaccinated and nonvaccinated children (Table 5).

2.5. Education of parents and child anthropometry

The mothers' education has been found to be an asset to good household nutrition and health. It has been suggested that because education is usually positively correlated with the use of contraception (see, for example, Cochrane and Zachariah, 1983) maternal education tends to be positively correlated with birth interval that, in turn, tends to improve birth outcome. Further, mothers with more education may provide better health care to their children (Grossman, 1972). On the other hand, educated women may increasingly become involved in wage labour, away from home, and child care has to be provided by others (Schultz, 1984).

Table 6 shows for the GLSS data set a slightly better average height-for-age z-score for children whose mothers are literate. Clearly, also other factors including income, are likely to play a role in the positive correlation between education of the mother and the z-score of the child.

2.6. Expenditures and child anthropometry

The relationships between child anthropometry and household per capita expenditures provides conflicting results (Table 7). Whereas children from the lower quintiles have lower weight-for-height z-score, they tend to

Table 7
Household expenditures and child anthropometry

Household per capita total expenditures quintile	Number of households	Height-for-age z-score 'underfives'		Weight-for-height z-score 'underfives'		Household total per capita expenditures (cedis/yr)
		Mean	Standard deviation	Mean	Standard deviation	Mean
1	630	−1.30	1.31	−0.57	0.97	25541
2	630	−1.16	1.40	−0.51	0.93	45490
3	629	−1.15	1.41	−0.54	0.97	64754
4	630	−1.09	1.30	−0.50	0.99	95436
5	629	−0.78	1.48	−0.44	0.95	205090

Source: computed from GLSS, 1987–1988 data.

have better height-for-age z-scores than children in the higher quintiles. This is consistent with evidence from the anthropometric survey of Strauss and Mehra (1992).

3. Health and nutrition production functions

In the production of nutrition and health, the issue of the complementarity of the publicly provided inputs and those inputs provided by the household are crucial. Schiff and Valdes (1990a,b) disaggregated the nutrition and health status into a production function.

At the household level, a nutrition production function gives an indication of the nutrition status of the household. The nutrition status (N) is a function of (i) the inputs of nutrients r such as calories, protein, vitamins; (ii) input of nonnutrient food attributes q which affect nutrition, such as freshness of the foods purchased, their cleanliness, their storability; (iii) the privately provided inputs p, which affect nutrition, such as time and care to prepare food including cleaning, cooking, blanching and other inputs that ensure that the food does not get contaminated or spoiled; and (iv) the publicly provided inputs k which include potable water, sewerage, electricity, nutritional information, among many others.

The production of nutrition (N) is also partly determined by the individual's health status, as well as by age (A), sex (S) and locality (L), either rural or urban.

An important component of the household's welfare is the health status (H) of its members. This depends in part on their nutritional status (N). As with nutrition at the household level, a health production function is a function of N, p, k, and m, which represent current and lagged values of additional inputs affecting health. The variable m consists of both privately provided inputs such as amount and quality of child care and hygiene, and of publicly provided inputs such as medical services, information on hygiene and child care, among others. The health production function also depends on age (A), sex (S) and location (rural or urban) (L) of the individual.

The reduced-form equations for nutritional and health status can be derived for a household, the decisions on the consumption and production of health and nutrition are basically made by individuals or by the households in which they reside, given their assets, level of the community's infrastructure, the prices that they face, and technology for producing nutrition and health. In general, a household makes decisions on the quantity of a commodity that will be purchased based on commodity prices and income.

Empirical estimates of health status have been obtained by Behrman and Deolalikar (1988) through micro studies. Their specification involved (i) clinical measures of bodily attributes; (ii) anthropometric measures of height, weight, triceps skinfold thickness, arm circumference, among others; (iii) respondent-reported disease symptoms, mortality histories, and general health evaluation; and (iv) reports on capacity for undertaking normal respondent activities.

4. Specification of the health and nutrition model

The health and nutrition of children under five in Ghana will be characterized by an econometric model in this section. The food available in the household that is affected by income and prices is converted into health and nutritional status through a health and nutrition production function. Health and nutrition are measured as one composite variable using anthropometric data, but its short-term measure is distinguished from its long-term one. In the short term, health and nutrition is presumed to be reflected by the weight-for-height z-score and its long-term effect is proxied by the height-for-age z-score of the child.

4.1. Food availability

The food available in the household, which is measured in kilocalories, is obtained by converting food expenditure information to weight (in kg) using prices. The prices of food commodities included were obtained from the Price and Community Survey conducted alongside the GLSS. Food availability in the household is cast in the framework of a demand function, so it is specified as a function of income (total household expenditure) and composite price for food. Other explanatory variables are the number of nondependents in the household and a dummy for the location of the household (urban/rural).

Using a mixed logarithmic functional form, the food available in the household is specified as:

$$\text{Log}(\text{Food}_{\text{kh}}) = a_0 + a_1(D_{\text{urb}}) + a_2(N_{\text{dep}}) + \log(H_{\text{hexp}}) - \log(P_{\text{kcal}}) \quad (1)$$

where Food_{kh} is the total food available to a household per day in kcal, H_{hexp} is the total household expenditure in cedis per day, P_{kcal} is the price per kcal for the household (P_{kcal} = total household food expenditure/total household food availability in kcal), N_{dep} is the number of nondependents in household, and D_{urb} is the dummy for urban area, with $D_{\text{urb}} = 1$ for urban area (residential area of 5000 persons or more), $D_{\text{urb}} = 0$ otherwise.

It is expected that the larger the number of nondependents in a household, the larger the food available to the household per day.

4.2. Food price per kcal

The aggregate food price per kcal for each household is calculated by dividing total household food expenses by total food available in the household in kcal. The aggregate food price per kcal is hypothesized to be a function of the prices of the major food commodities consumed in Ghana. The equation is specified in a double-log (Cobb-Douglas) formulation, and the explanatory variables are deflated by the price of maize to ensure the reduction of inflationary tendencies in a data collected over a number of seasons in a period of one year.

The food price equation is as follows:

$$\begin{aligned}\text{Log}(P_{\text{kcal}}) &= b_0 + \log(P_{\text{maize}}) + b_1\log(P_{\text{millet}}/P_{\text{maize}}) + b_2\log(P_{\text{bread}}/P_{\text{maize}}) \\ &\quad + b_3\log(P_{\text{cassava}}/P_{\text{maize}}) + b_4\log(P_{\text{garri}}/P_{\text{maize}}) \\ &\quad + b_5\log(P_{\text{yam}}/P_{\text{maize}}) + b_6\log(P_{\text{plantain}}/P_{\text{maize}}) \\ &\quad + b_7\log(P_{\text{fish}}/P_{\text{maize}}) + b_8\log(P_{\text{chicken}}/P_{\text{maize}}) \\ &\quad + b_9\log(P_{\text{beef}}/P_{\text{maize}})\end{aligned} \quad (2)$$

This specification implies that the coefficient of $\log(P_{\text{maize}})$ equals $1 - b_i$.

P_{kcal} is the price of kcals (cedi/kcal), P_{maize}, P_{millet}, P_{cassava}, P_{garri}, P_{yam}, P_{plantain}, P_{fish}, P_{chicken}, and P_{beef} are the prices of maize, millet and guinea corn, raw cassava, garri, yam, plantain, fish and fish products, chicken, and beef in cedis per kilogram, respectively.

Individual food prices are expected to be positively related to the price of energy (P_{kcal}). However, since some of the food commodities are substitutes for others, it may be difficult to predict the signs of their prices in the equation on an a priori basis.

4.3. Individual food intake

The individual daily calorie intake (availability) is obtained from the household food availability using a conversion factor:

$$K_{\text{cali}} = (\text{Scale} * \text{Food}_{\text{kh}})/\text{size}_{\text{q}} \quad (3)$$

where K_{cali} is the individual daily food intake estimate in kilocalories, Scale is adult equivalent consumption unit, and Size_{q} is household size in adult equivalents.

4.4. Short-term health and nutrition

The weight-for-height z-score (whz), which is a measure of short-term health and nutritional status, is hypothesized to depend upon the genetic factors of the parents as denoted by their body mass indexes and heights, income of the household represented by total expenditures, the quality of care available to the child proxied by the state of literacy of the mother, experience of the mother proxied by her age, the health condition of the child as measured by days of illness in the last four weeks and whether the child has been vaccinated against the six childhood diseases, the quality of food served to the child proxied by the availability of light in the community, and the age of the child.

The weight-for-height equation, which relates short-term health and nutritional status of children to explanatory variables, is given in a mixed quadratic form as follows;

$$\begin{aligned}\text{Whz} \quad &= c_0 + c_1(\text{Ht}_\text{m}) + c_2(\text{Ht}_\text{f}) + c_3(B_\text{mim}) + c_4(B_\text{mif}) + c_5\log(\text{pcexp}) \\ &\quad + c_6[\log(\text{pcexp})]^2 + c_7(D_\text{chlvac}) + c_8(\text{literacy}) + c_9(\text{Age}_\text{moth}) \\ &\qquad + c_{10}(\text{Age}_\text{mnths}) + c_{11}(D_\text{light}) + c_{12}(\text{Days}_i)\end{aligned} \tag{4}$$

where Whz is the weight-for-height z-score, Ht_f is the height of the father, Ht_m is the height of the mother, B_mif and B_mim are the body mass index of the father and mother, respectively. D_chlvac is the dummy for child vaccination, with $D_\text{chlvac} = 1$ for child vaccination, and $D_\text{chlvac} = 0$ otherwise. Literacy is the dummy for literacy of the mother, with Literacy = 1 for literate mothers, and Literacy = 0 otherwise. Age_moth is the age of the mother, Age_mnths is the age of the child, D_light is the dummy for electricity, with $D_\text{light} = 1$ for electricity, and $D_\text{light} = 0$ otherwise, Days_i is the number of days the child had been ill in the last four weeks.

It is expected that all the explanatory variables will be positively related with short-term health and nutritional status.

4.5. Long-term health and nutrition

Similarly, the long-term health and nutrition variable, height-for-age z-score (haz) is hypothesized to be a function of characteristics of the child, the genetic factors of the parents, and some community endowments. The equation is specified in a linear form as follows:

$$\begin{aligned}\text{Haz} \quad &= d_0 + d_1(\text{Ht}_\text{f}) + d_2(\text{Ht}_\text{m}) + d_3(B_\text{mim}) + d_4(B_\text{mif}) + d_5(D_\text{sex}) + d_6(D_\text{chlvac}) \\ &\quad + d_7(\text{Sch}_\text{yrs}) + d_8(\text{Age}_\text{mnths}) + d_9(\text{Age}_\text{mnths})^2 + d_{10}(\text{Age}_\text{moth}) \\ &\qquad + d_{11}(D_\text{light}) + d_{12}(\text{days}_i)\end{aligned} \tag{5}$$

where Haz is height-for-age z-score, sch_yrs is years of schooling of mother and D_sex is gender of the child, with $D_\text{sex} = 1$ for female, $D_\text{sex} = 0$ otherwise. Other variables are as defined previously.

It should be noted that age of the mother is included in the regression and not age of the mother when giving birth, which is the analysed variable in Section 2 (Table 3). For the regression analysis, this has no consequences, as the variable age of the mother at birth is a linear combination of the age of the mother and the age of the child.

5. Estimated results and discussion

Using the Statistical Analysis System (SAS) an ordinary least squares (OLS) estimation procedure was used in the estimation of Eqs. (1), (2), (4) and (5). The estimated equations are presented in Tables 8–12.

Table 8
Dependent variable: household food availability in kcal/day

Variable	Coefficient	t-value	Probability
Constant	−0.47 [a]	−19.46	0.0001
Durb	−0.16 [a]	−8.38	0.0001
Ndep	0.015 [b]	1.80	0.072

Sample size = 934.
$R^2 = 0.81$.
Adjusted $R^2 = 0.81$.
[a] significant at < 0.01% level.
[b] significant at < 0.1% level.

Table 9
Dependent variable: relative food price per kcal

Variable	Coefficient/ elasticity	t-value	Probability
Constant	27.23 [a]	2.58	0.0100
$\text{Log}(P_{\text{millet}}/P_{\text{maize}})$	4.77 [a]	3.55	0.0004
$\text{Log}(P_{\text{bread}}/P_{\text{maize}})$	−9.83 [a]	−3.19	0.0015
$\text{Log}(P_{\text{cassava}}/P_{\text{maize}})$	7.55 [a]	3.72	0.0002
$\text{Log}(P_{\text{garri}}/P_{\text{maize}})$	5.98 [a]	2.72	0.0067
$\text{Log}(P_{\text{yam}}/P_{\text{maize}})$	1.89 [a]	5.41	0.0001
$\text{Log}(P_{\text{plantain}}/P_{\text{maize}})$	−3.34 [a]	−3.30	0.0010
$\text{Log}(P_{\text{fish}}/P_{\text{maize}})$	−5.43 [a]	−2.90	0.0038
$\text{Log}(P_{\text{chicken}}/P_{\text{maize}})$	−3.51 [a]	−3.86	0.0001
$\text{Log}(P_{\text{beef}}/P_{\text{maize}})$	−2.23 [a]	−2.60	0.0094

Sample size = 934.
$R^2 = 0.35$.
Adjusted $R^2 = 0.34$.
[a] Significant at < 0.01% level.

Table 10
Dependent variable: weight-for-height (whz)

Variable	Coefficient	t-value	Probability
Constant	−3.834	−0.51	0.6139
Ht_{m}	0.003	0.66	0.5077
Ht_{f}	0.006	1.33	0.1842
B_{mim}	0.049 [a]	4.73	0.0001
B_{mif}	0.046 [a]	3.42	0.0007
Log(pcexp)	0.032	0.02	0.9815
$[\text{Log(pcexp)}]^2$	−0.005	−0.08	0.9349
D_{chlvac}	−0.063	−0.83	0.4074
Literacy	0.041	0.55	0.5849
Age_{moth}	−0.0002	−0.45	0.6551
$\text{Age}_{\text{mnths}}$	0.001	0.51	0.6090
D_{light}	0.027	0.32	0.7515
Days_i	−0.021 [a]	−3.22	0.0014

Sample size = 925.
$R^2 = 0.06$.
Adjusted $R^2 = 0.05$.
[a] Significant at < 0.01% level.

Table 11
Dependent variable: height-for-age (haz)

Variable	Coefficient	t-value	Probability
Constant	−12.214 [a]	−7.89	0.0001
Ht_m	0.041 [a]	5.74	0.0001
Ht_f	0.028 [a]	4.06	0.0001
B_{mim}	0.033 [b]	2.27	0.0234
B_{mif}	0.024	1.29	0.1957
D_{sex}	0.015	0.17	0.8637
D_{chlvac}	0.073	0.69	0.4886
Sch_{yrs}	0.0005	0.05	0.9609
Age_{mnths}	−0.097 [a]	−9.25	0.0001
$[Age_{mnths}]^2$	0.001 [a]	6.24	0.0001
Age_{moth}	0.0005	0.88	0.3817
D_{light}	0.281 [b]	2.48	0.0132
$Days_i$	−0.010	−1.09	0.2723

Sample size = 933.
$R^2 = 0.23$.
Adjusted $R^2 = 0.22$.
[a] Significant at < 0.01% level.
[b] Significant at < 0.05% level.

5.1. Food availability

The food availability equation had an R^2 of 0.81 (Table 8). The average share of food expenses as percentage of total expenses is 0.61 ($\exp[-0.47 - 0.16 \times 0.33 + 0.015 \times 2.5]$). The urban/rural dummy

Table 12
Dependent variable: height-for-age (haz) with length of breastfeeding as explanatory variable

Variable	Coefficient	t-value	Probability
Constant	−17.5231 [a]	−9.38	0.0001
Ht_f	0.0229 [a]	3.10	0.0020
Ht_m	0.0354 [a]	4.60	0.0001
B_{mim}	0.0225	1.49	0.1381
B_{mif}	0.0253	1.27	0.2053
D_{sex}	0.1198	1.26	0.2080
D_{chlvac}	0.1717	1.51	0.1326
Sch_{yrs}	−0.0047	−0.41	0.6787
Age_{mnths}	−0.1197 [a]	−5.83	0.0001
$(Age_{mnths})^2$	0.0015 [a]	4.54	0.0001
Age_{moth}	−0.0001 [b]	−2.22	0.0267
D_{wat}	−0.0099	−0.07	0.9435
D_{light}	0.0890	0.61	0.5399
Ht	0.1717 [a]	10.28	0.0001
$(Ht)^2$	−0.0007 [a]	−9.85	0.0001
$Days_i$	−0.0138	−1.46	0.1449
M_{lcbf}	−0.0712 [a]	−6.10	0.0001

Sample size = 596.
$R^2 = 0.418$.
Adjusted $R^2 = 0.402$.
[a] Significant at < 0.01% level.
[b] Significant at < 0.05% level.

variable is significant at the 0.0001 level, with a lower share of food expenses as percentage of total expenses in the urban situation. The number of nondependents has a weak positive effect on the food share.

5.2. Food price per kcal

All the price ratios turned out to be significant at least at the 0.01 level. Of the nine food commodities included in the equation, relative prices of millet, cassava, garri, and yam have a positive effect on the kcal price, while the more expensive foods bread, plantain, fish, chicken and beef affect the composite food price negatively. The food price kcal had an R^2 of 0.35. (Table 9).

5.3. Weight-for-height z-score

Results for the estimation of the short-term health and nutrition measure (whz) are given in Table 10. The coefficients of the body mass index of the mother (b_{mim}) and father (b_{mif}) and the number of days the child had been ill over the last month (days_{i}) are all significant at less than 0.01% level. Thus, genetic and health factors are one of the most important variables that determine the short-term health and nutritional status of children. The number of days of illness (days_{i}) has a negative relationship with the whz.

Food security is exacerbated by poor health when the child cannot efficiently utilise the available food. This stresses the importance of good health as food security strategy.

The results confirm other findings that literate mothers tend to have a positive impact on the health and nutrition of their children. Availability of electricity in the community also tends to improve the health and nutrition of the children.

5.4. Height-for-age z-score

One of the most significant variables that determine the health and nutritional status of children in the long run are the genetic composition of the parents, and the availability of social amenities in the community (proxied by availability of electricity). The heights of the mother and father and mother's BMI which were positively related to the height-for-age *z*-score were significant at less than 0.05 level.

Finally, in the multivariate analyses of haz and whz as presented in Tables 10 and 11, the variable on the length of the period of breastfeeding of 'underfives' is not included. The reason is that the information on the length of breastfeeding was only available for the last child in each household, and including the variable would have reduced the sample size significantly. To make a cursory investigation of this effect, a separate regression was run for long-term health and nutrition (haz) with length of breastfeeding of the child (M_{lcbf}) as one of the explanatory variables (Table 12). Results showed a negative and significant relationship with the dependent variable. These startling results suggest that children who continue to be breastfed into their second and third year do not receive, or do not consume adequate amounts of supplementary food. Perhaps children who continue to be breastfed receive as supplementary food only maize, sorghum or millet porridge of low nutritional value.

6. Conclusion

To date, most health and nutrition studies undertaken in Ghana have focused on either nutrition and calorie consumption aspects or health and illness aspects of nutrition without linking nutrition and health simultaneously. To bridge this gap, this study has tried to find out the factors which are the principal determinants of health and nutrition of children under five in a simultaneous context.

In assessing the relative merits of various public policies to deal with malnutrition among the poor, a better understanding of the household behaviour is the starting point. It is in this context that public policies must be designed; that is, they must consider the fact that households make the ultimate decisions concerning the family's expenditure on nutrition and health. The following are a few policy implications that can be considered to promote the health and nutrition of Ghanaian children.

(1) The calorie availability can increase if the prices of commodities such as cassava and millet are reduced. While millet and sorghum are the main staple crops in the North, maize, cassava and plantains are the major crops for many Ghanaians in other parts of the country. Cassava is a good source of energy, so its promotion on a large scale to reduce the price can lead to an increase in the caloric availability in many households. Fortunately, cassava grows on many Ghanaian soils, but if its cultivation is carried out with the application of fertilizer and improved practices, it is possible to raise its average yield from the present 7 ton/ha to more than 20 ton/ha. While there is little likelihood that the government would like to directly influence the price of food stuffs through subsidies and/or price support, programmes that tend to reduce the cost of transport, or post-harvest losses which may be implemented by public agencies, would have significant effects on the food supplies and, therefore, food availability to the child.

(2) For children in the 0–59-month age group both the short-term health and nutrition indicator weight-for-height, as well as the long-term health and nutrition indicator height-for-age are negatively correlated with recent illness. This is significant only for the short-term. Improved source of light (electricity) and further expansion of vaccination programmes are likely to contribute to reduced occurrence of illness and a better health and nutrition status of the 'underfives' in the short- to long run.

(3) Prolonged breastfeeding appears to be negatively correlated with the child's long-term nutritional status. This is likely to be related with inadequate weaning practices in Ghana. Formulation of better weaning foods and more information to women on the importance of adequate supplementary feeding after the age of 6 months may contribute to better child health and nutrition.

(4) There is the need to improve the nutritional status of children as measured by anthropometric indicators (weight-for-height, weight-for-age and height-for-age). Food production policies must be complemented with nutritional and health policies that promote physiological access (utilization) to food which concern the conversion of food into nutrients that the body needs. On the average 29.7%, 27.3% and 6.7% of children are chronically undernourished, underweight and acutely undernourished, respectively. A national nutrition strategy and related programmes (including a surveillance system) must be put in place in order to address the serious nutritional deficiencies that have been identified.

(5) The multivariate analysis showed the positive impact of good source of light (electricity) on the nutrition of children. The absence of this publicly-provided input may cause food products to become spoiled or contaminated. This may lead to a reduction in the absorption of nutrients, or worse, to gastrointestinal and other diseases accompanied by a drastic reduction in the degree of nutrient absorption, and thus a reduction in the nutritional status. Therefore, it is important to emphasize the provision of electricity in the development programme of the country, especially in the rural areas. A rural electrification scheme can be sustained if the people have the capacity to maintain the equipment once it has been put into place. However, rural electrification should be taken as part of an integrated rural development scheme so that benefits from the linkages can be maximized.

(6) The positive impact of vaccination was made apparent in this study. Results showed that children in the 20–40-month age group and, even more so, children in the 40–60-month age group had better anthropometric z-scores when they were vaccinated, but lower scores for 0–20 months which emphasizes the long-term effects of vaccination. It is therefore important for the government to step up its campaign to fully immunize most children. The programme can be more successful if both public and private health care centres participate in it and the outreach services are expanded.

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