Does Economic Growth Improve Child Health? Understanding Discordant Trends in Malnutrition Indicators during the Economic Growth in Ghana

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Abstract

Policymakers have long argued that economic growth in developing countries will positively impact child health. We examine child nutrition in Ghana during the economic growth of the 1980s and 1990s. Data show that stunting declined from 30% in 1988 to 21% in 1998, but sharply increased to 27% in 2003. Wasting followed an entire opposite path, while underweight progressively fell from 30% to 24% during this period. These different responses to growth reflect differences in the underlying factors generating these outcomes. Improvement in underweight was consistent with the positive household effects of macroeconomic growth, but increase in stunting after 1998 responded to the decline in health care utilization following the reform of the health care system. The fraction of children presenting any the three forms of malnutrition remained stable at around 40% during the period of growth, indicating that macro-level economic growth does not necessary translate into better child health.

Introduction

Following the severe economic reversals experienced by many African countries in the 1980s and 1990s (Easterly and Levine, 1997), a major public policy goal has been to promote growth with the intent of restoring macroeconomic stability and improving social and individual well-being. At the country level, higher income has been found to be associated with better child health by most measures (Haddad et al., 2003; Behrman and Rosenzweig, 2004; Smith and Haddad, 2002; Prichett and Summers, 1996), leading to the conclusion that economic growth will improve health status (Smith and Haddad, 2002; Prichett and Summers, 1996). However, the mechanism linking macro level economic improvement to child health has not been fully explored, especially at the household level. Researchers have emphasized the role of increases in household income and investment in public infrastructure (Smith and Haddad, 2002), but several other socioeconomic and demographic effects of growth that may positively or negatively affect health have received little attention. In this paper, we study the determinants of child nutritional status in Ghana during a period of economic growth. Using the three classical measures of malnutrition (stunting, wasting and underweight), we also examine the extent to which trends in these outcomes were driven by changes over time in the distributions of their determinants, affected by growth.

There are several reasons for focusing on child nutrition as an indicator of health. Maternal and childhood undernutrition is currently the single leading cause of the global burden of disease (Lopez et al., 2006; Ezzati et al., 2002). Childhood malnutrition also has been identified as the underlying factor in more than 50% of deaths of children under 5 years of age in developing countries (Black et al 2003), and still constitutes a major public health crisis in these settings (de

Onis et al., 2000; de Onis et al., 2004). At the national and sub-national levels, higher child mortality rates have been found to be associated with low weight-for-age (Pelletier and Frongillo, 2003). The consequences of malnutrition span beyond compromise in physical health, and have been found to be associated with instability in mental health, internalization of behavioral problems, delays in primary school enrollments, and lower educational attainment (Glewwe and Jacoby, 1993; Weinreb et al., 2002; Chang et al., 2002). The commitment of the international community to reducing childhood malnutrition and mortality has been recently renewed through the Millennium Development Goals, but achieving this goal requires further studies on how nutritional status responds to changing economic contexts, which has been the case in many developing countries experiencing high burden of malnutrition.

In developing countries, studies on the impact of macro level economic changes on child health have mainly focused on the effects of economic downturns (see Paxson and Schady, 2005 on Peru; Hill et al., 1993 on sub-Sahara Africa; Pongou et al., 2006 on Cameroon). Little attention has been paid to the health effects of economic recovery or upturns, especially using household level data. Haddad et al. (2003) separately analyzed household and country level data, and others have used only country level data (Smith and Haddad, 2002, Pritchett and Summers, 1996), but none have tracked changes in child health during a period of sustained growth in any of the countries included in their analysis. Edmonds (2004) uses multiple household surveys conducted during the economic growth of the 1990s in Vietnam, and finds that improvement in household income during this period positively impacted child linear growth. Despite the importance of this study to our work, it should be noted that it did not examine the role of other effects of growth, such as child and household demographics. Also, comparable studies are scanty in Africa. This gap in the literature could be understood in the context of paucity of household level data during the period of growth that characterized many countries after independence. Most data have been collected only in the late 1970s and 1980s when most economies were experiencing severe declines. After a profound economic crisis, Ghana experienced a sustained increase in per capita GDP after 1983 (see Figure 1), setting it apart from the experience of many countries in the region. In this study, we use the Ghana Demographic and Health Surveys (DHS) collected in this country in the year 1988, 1993, 1998 and 2003 to examine the determinants of child nutrition (as measured by stunting, wasting and underweight), and the extent to which changes over time in the distributions of these factors impacted these outcomes.

Data show that the prevalence of stunting declined from 30% in 1988 to 21% in 1998, but sharply increased to 27% in 2003. Wasting followed an opposite path, increasing from 8% in 1988 to 13% in 1998, and then declining to 10% in 2003. Underweight progressively declined from 30% to 24% during this period. These different responses to growth reflect differences in the underlying factors generating these outcomes as evidenced by our sub-region fixed-effects estimates. Factors such as child gender, male household headship, and age of household head significantly impact stunting, while their effects on both wasting and underweight are not significant. Birth order, maternal age at childbirth, marital status, and mother's height are common factors to both stunting and underweight. Finally, preceding birth interval, prolonged breastfeeding, birth size, mother's weight, household economic status, and health care utilization are correlated with the three outcomes, although with differing magnitude. While trends in stunting and underweight are consistent with the positive effects of economic growth on household socioeconomic conditions and other demographic factors such as birth interval, birth order and maternal age at childbirth, increase in stunting after 1998 is associated with prolonged breastfeeding and decline in health care utilization following the reform of the health care system. Our study illustrates that macro-level economic growth that may lead to improvement in household economics may not necessary translate into better child health.

Background on the determinants of childhood malnutrition

Determinants of child health and nutrition have been a subject of considerable scholarship. The analytical framework proposed by Mosley and Chen (1984) hypothesizes that these determinants occur at multiple levels, ranging from individual to community characteristics, as also confirmed by a number of empirical studies (Behrman, 1988; Behrman and Wolfe, 1984, 1987; Thomas and Strauss, 1992; Lavy et al., 1996; Lee et al., 1997; Pongou et al., 2006; Choudhury and Bhuiya, 1993). In what follows, we assess the potential role of child, parental and household characteristics in determining child nutritional status in a context of economic growth.

Child Characteristics

Many child factors resulting from parental choice or not have significant effects on health. Studies have shown that biological factors such as gender and age are associated with nutritional status (Haddad et al., 2003; Pongou et al., 2006). It is generally argued that girls have a stronger immunity system in early ages, resulting in relatively better health status as compared to boys. However, Mozumder et al. (2000) found that being a female child is associated with malnutrition, motivating further research on the relationship between gender and health. In developing countries, the role of child age in determining nutritional status is also well documented (Pongou et al., 2006). As children age, demand for quality supplementation and contact with the external environment increases; generally resulting in lower nutritional status in older children. In many studies however, the effect of age remains significant even after controlling for household and environmental factors, suggesting that some biological unobservable might work against children's health as they grow older.

Birth weight is another determinant of nutritional status in developing countries (Madzingira, 1995; Ukwuani and Suchindran, 2003; Maleta et al., 2003). Low birth weight children have low health endowment, making them more vulnerable to infectious diseases and malnutrition in the short and the long run. Similar to birth weight, birth spacing, which is related to parental choice, might influence nutritional status. Shorter birth spacing results in many younger children in the household, which might decrease the quantity and quality of parental investment per child. This might therefore result in lower health and nutritional status, as demonstrated in some studies (Mozumder et al., 2000; Thuida et al., 2005). Nutritional status might also be related to birth order. The cost of child rearing implies that as the number of children increases, fewer resources are left to be invested in higher rank children (Birdsall, 1991), implying a negative relationship between birth order and child nutritional status as found in the Philippines (Horton, 1986, 1988).

Another potential determinant of nutritional status mainly documented in the medical literature is duration of breastfeeding. However, the results for its effects are mixed. Breastfeeding after 12 months has been linked to improved survival rates and anthropometric status in many settings (Onyango et al., 1999; Molbak et al., 1997; Molbak et al., 1994). Alvarado et al. (2005) found that breastfeeding mitigates the effects of poor social conditions on growth for children who have breastfed for longer than 6 months after birth. However, longer periods of breastfeeding have also been found to be related to higher mortality and substandard anthropometric (Martin, 2001; Villalpando, 2000; Caulfield et al., 1996). Ukwuani and Suchindran (2003) reported that shorter periods of breastfeeding increased wasting, while prolonged breastfeeding increased stunting. Along the same line, improper weaning was found to be a significant risk factor for malnutrition for children less than five years of age (Kumar et al., 2006).

Maternal Characteristics

Associations between maternal characteristics such as education, marital status, employment status, weight and height, and parity on one hand and childhood malnutrition on the other hand are documented in several studies (Behrman, 1988; Behrman and Wolfe, 1984, 1987; Thomas and Strauss, 1992; Madise et al., 1999; Lavy et al., 1996). Higher levels of maternal education are associated with better knowledge of nutritious foods and proper nutrition. Education is also associated with positive utilization of health care services, and better hygiene practices. Consequently, education is expected to have positive impact on child nutrition, as demonstrated in several studies (Appoh and Krekling, 2005; Ruel et al., 1992; Glewwe, 1999; Thomas, 1994).

While maternal education has been consistently found to have positive impact on child health, a study conducted in Nigeria was unable to find any positive effect of mothers who earn cash from their work on childhood malnutrition (Ukwuani and Suchindran, 2003). Other maternal demographic factors such as age and marital status have been found to be significantly associated with severe malnutrition in children (Islam et al., 1994; Delpeuch et al., 2000). Older mothers have richer experience of childcare, and children born to married mothers benefit from care from both parents, which may improve their nutritional health. Consistent with this theory, mother's age at birth has been found to be associated with malnutrition in studies conducted in Brazil and Ghana (Lima et al., 1990; Rikimaru et al., 1998). Also, children born to married mothers were found to fare better than their counterparts born to unmarried mothers in Cameroon (Pongou et al., 2006).

Household Characteristics

Household characteristics ranging from household size (Pleto et al., 1991; Horton, 1988), number of children under 5 years of age, economic status, and utilization of health care (Thomas and Strauss, 1992; Lavy et al., 1996; Pongou et al., 2006) has been identified as predictors of childhood malnutrition. However, the effect of household size might not be obvious. Pleto et al. (1991) found that Mexican children from larger households tended to be shorter and consumed food of poorer quality. However, in a context where presence of adults in the same household is likely to increase total income and other inputs to child health, a larger number of adults would result in better health status.

Gender of household head may also be an important factor in childhood malnutrition. Female headship has been found to be associated with better child nutrition in many studies (Kennedy and Peters, 1992; Staten et al., 1998; Johnson and Rogers, 1993). Female headship is generally associated with increased power over household resources, and higher investment in child health. However, female headship may also be associated with higher poverty, especially in the context of developing countries such as in Nigeria (Mberu, 2006), implying lower investment in child health. Assessing the impact of the gender of head of household is of particular interest especially in a context of economic upturns, which might imply higher participation of females in productive activities, as in the case of Ghana (Derose, 2006), as well as changes in household structure.

Hypothetical mechanism linking economic growth and child health

Growth can affect child health either positively or negatively through the factors reviewed above in several ways. Economic growth is generally associated with increase in education and participation in the labor force, implying less unemployment and less poverty at the household and community levels. Economic growth also implies increased investments in public infrastructure (water, sanitation, electricity etc.) and the health care sector, resulting in healthier environments and increased access to health care services. As previously argued, these factors positively affect child health and nutrition, implying that nutritional status is expected to improve because of economic upturns.

A positive economic shock that increases job opportunities would also raise the value of time and consequently increase its cost (Becker, 1981; Becker and Lewis, 1973), a situation that might have a mixed effect on child heath by affecting women reproductive role. Increase in the cost of time might cause women to desire fewer children, as they are forced by time constraints to make a trade off between employment outside the home and childcare. Mothers' participation in the labor force is therefore likely to be associated with larger birth spacing, which could result in improvements in child quality. Also, as birth interval increases, we expect fewer children under five in the household, which has the potential to reduce competition for resources, resulting in lower malnutrition. However, the absence of mothers in the home could also have an effect on breastfeeding duration. Women who work for cash outside the home are more likely to shorten breastfeeding duration, which can negatively affect child nutritional status. While breastfeeding duration would be shorter for children born to these mothers, we expect that economic gains from employment will make it possible for these children to have access to more nutritious foods.

As educational and employment opportunities increase for women during economic growth, their health status also is expected to improve. Positive changes in health status would be a result of increased access to health care and intake of more nutritious foods. This would result in larger weight and better intrauterine growth, implying improvement in birth weight, which is known to positively impact child physiological growth. In addition, entry of younger men and women into the labor force as a consequence of growth might also impact union formation and household structures (household size, gender and age of head). To the extent that these factors promote or conflict with child well-being as demonstrated in the previous section, health will be affected.

Considering the potential effects of the economic growth during the period 1988–2003 on factors that may influence child malnutrition in Ghana allows us to assess whether improvements in the economy at the macro level had any impact at the household level. It is however important to note that growth is endogenous to productivity and productivity might be endogenous to child health. In fact, good initial child health will free mothers and will allow them to invest more in productive activities. It is therefore important to understand the origins and consequences of growth in Ghana, to completely rule out the possibility of reverse causality in this context.

Sources and Consequences of Economic Growth in Ghana

Ghana experienced increase in GDP per capita in the early 1960s, but plunged into a severe economic reversal in the 1970s and the early 1980s (Figure 1). This crisis was driven by policies and changes in government regimes (Danquah, 2006). In 1982-1983, the country witnessed its worst drought in 50 years, which caused bush fires and crops destruction, resulting in weak levels of consumption and minimum wages and social services (USAID, 1992). The economy stabilized in 1984 and has maintained growth with little variance over recent years (Figure 1).

Studies examining the sources of economic growth in Ghana report that improvements in macroeconomic policy and reforms played a significant role (Christiaensen et al., 2003; Aryeetey and Fosu, 2002). Total factor productivity (TFP), an aspect of total output that is unrelated to inputs or productivity, has been identified as the most important factor in explaining economic growth in Ghana (McKay and Aryeetey, 2004). This factor has been linked to the positive effects of political regimes, liberal administrations and economic liberalization (Aryeetey and Fosu, 2003**;** McKay and Aryeetey, 2004; Danquah, 2006). In recent years, Ghana took advantage of the *Heavily Indebted Poor Country* (HIPC) initiative and reached its decision point in 2002.

Macroeconomic reforms underlying growth in Ghana had positive impact on the industrial and agricultural sector. Between 1988 and 1991, the contribution of industry to GDP doubled and represented nearly 16% (World Bank, 1992). Inflation dropped from 122% before reform to about 10% in 1992 (Figure 2). The agricultural sector, the largest segment of the economy, which makes up 60% of total employment and half of total GDP, also has been identified as the major contributor of the recent economic growth (Food Security Assessment, 2005). Government policies such as the Cocoa and Pests Control Program, Agricultural Rehabilitation

Project, Presidential Special Initiatives and Vaccination of Livestock programs have significantly aided the agricultural and livestock sectors. Also, the effects of higher producer prices, access to credit and other favorable incentives to these sectors have had an impact on efficiencies in production of output (African Economic Outlook, 2005-2006). However, growth has not been consistent across sectors, with sectors such as manufacturing, mining, quarry and services not faring so well (O'Connell and Ndulu, 2000; Aryeetey and Fosu, 2002; Teal, 1995).

The improvements in the macroeconomy allowed the government to implement its reform agenda for the Ghana Poverty Reduction Strategy (GPRS). GPRS emphasized wealth creation, improved governance and reductions in income inequalities (World Bank, 2004). Benefits from the growth have not been uniform across households. Farmers (mainly export) in Ghana have experienced the largest drop in poverty with a significant reduction in income poverty for "food farmers". Coulombe and McKay (2003) in their analysis found that the reduction in poverty among food crop farmers was mainly due to incentives to the group. Nationally, reductions in poverty among those who worked in industrial and service sectors (public service, communication, manufacturing, commerce and trading) were not significant and did not play a major role in overall poverty reduction (McKay and Aryeetey, 2004).

As previously argued, these macro level economic transformations had an impact at the micro level (household consumptions) and at the community level (health care sector, public infrastructure, access to water and sanitation). There is also some indication that individuals who come from poor or underprivileged backgrounds have at times gained disproportionately from rural infrastructure development. Examples of such gains include access to better quality water that positively influences health, and benefits from electricity and production activities. These improvements in household and community economic and environmental conditions are expected to have positively affected child health. However, there is no evidence in the literature to support this hypothesis. We use household level data from Demographic and Health Surveys to study the determinants of child nutritional status during the period of economic growth in Ghana and to examine how change in the distributions of these determinants affected child outcomes.

Methods

Data

Demographic and Health Surveys (DHS) were conducted in Ghana in 1988, 1993, 1998 and 2003. Designed to be representative at the national, urban-rural and regional levels, each survey used a two-stage probabilistic sample technique to select clusters at the first level and households at the second level. In each household, information was collected on household socio-economic characteristics. The survey also included a questionnaire administered to women aged 15 to 49 years old, comprising a birth history, information on individual characteristics and health behaviors, and details on their children.

For children alive at survey (those aged 2-35 months in 1988, 0-35 months in 1993, 0-59 months in 1998, and 0-59 months in 2003), weight and height were measured and used to calculate anthropometric indicators: height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) z scores using the United States National Center for Health Statistics/World Health

Organization (NCHS/WHO) international reference. For comparability across years, we restrict our study to children aged 2-35 months at each survey.

Variables

Malnutrition is measured using anthropometric indicators. Stunting is defined as height-for-age (HAZ) 2 standard deviations (SDs) below the median of the NCHS/WHO international reference. Underweight and wasting are similarly defined, using weight-for-age (WAZ) and weight-for-height (WHZ) z-scores, respectively. HAZ is a measure of linear growth and reflects cumulated and chronic health insults. WHZ measures the nutritional effects of short-term shocks, while WAZ is though of as a composite index of HAZ and WHZ, and has been used in many epidemiological studies on the impact of child nutrition on mortality (Pelletier et al., 2003). While many studies have used each of these three indicators in isolation, we consider them altogether to assess their different and common underlying factors.

Control variables include a set of child characteristics (age, sex, breastfeeding status, birth order, preceding birth interval and birth size), maternal characteristics (educational attainment, employment status, marital status, age at child birth, husband education if married, weight and height), and household characteristics (economic status, access to or utilization of health care services, household size, number of children under 5 in the household, and age and gender of household head). Household economic status (HES) is measured by an index constructed using principal component analysis (Filmer and Pritchett, 2001). Nine items reflecting household wealth and environmental conditions were utilized (car or truck, motorcycle, refrigerator, electricity, radio, television, finished floor, flush toilet, and piped water in the household) The indicator for use of health care services is constructed similarly, with indicator variables including prenatal visits, tetanus injection during pregnancy, medical assistance at delivery, knowledge of oral rehydration solutions (ORS) and possession of a health card for the child. These analyses were performed using pooled data from the four years (1988, 1993, 1998 and 2003) to ensure cross-year comparability.

Details on the distributions of all variables are presented in Table 1. We note that the distributions of child gender and age did not significantly change during the period 1988-2003, but average child age significantly increased from 17.4 to 18.1 in 1998-2003. The proportion of first-born children was the highest in 1998 (24%), and as expected, there was a significant increase in birth interval from 30.8 months in 1988 to 36.1 months in 2003. Average birth order declined during this period, consistent with the slight increase in the proportion of first-born children. Contrary to our expectations, breastfeeding rose, as also observed by DeRose (2006), and the proportion of children with small birth size increased. Maternal characteristics were also affected during the period of growth. Maternal age at childbirth slightly rose, and the proportion of children born to married mothers decreased, in favor of those whose parents were living together without being formally married. As expected, the proportion of mothers working for cash sharply increased along with education, but education sharply declined after 1998. There was also a general increase in maternal weight, but height stabilized at the same level in 1993-1998, and declined afterwards. Consistent with trends in maternal education, husband education generally increased in 1988-1998, but declined afterwards. The positive economic performance of the country during this period is reflected in the significant increase in household economic status. Health care utilization also increased, but significantly deteriorated after 1998. This decline may be attributable to the decentralization of the health care system in 1996 (MOH, 1998; Bossert and Beauvais, 2002; Nyonator and Kutzia, 1999), increasing user fees as found in other settings (Mbugua et al., 1995; Blas and Limbambala, 2001; Palmer et al., 2004; Manzi et al,, 2005), and general decline in financing of health care sector, as evidenced by drop in per capita health care expenditure between 1998 and 2003 (Figure 3). Household size and number of children under 5 declined in general, but slightly increased after 1998. We also note a decline in the proportion of children living in household headed by male in 1988-1998, but this proportion sharply increased in 2003. The same pattern was observed in the average age of household head, indicating that growth impacted on household structures. As we have noticed, the year 1998 was a turning point for many factors, despite the growth, and this is expected to have affected trends in the prevalence of malnutrition in the country.

Prevalence of malnutrition in Ghana, 1988-2003

Prevalence of all forms of malnutrition during the period 1988-2003 in Ghana is reported in Table 2 and further illustrated in Figure 4. The proportion of stunted children declined from 30% in 1988 to 27% in 1993 and to 21% in 1998, but significantly increased to 27% in 2003. Wasting had an opposite trend, increasing from almost 8% in 1988 to 12% in 1993 and 13% in 1998, but declining to almost 10% in 2003. These opposite trends in stunting and wasting raise questions about the determinants of chronic and acute malnutrition, and how the responses of these determinants to macroeconomic changes may have different impacts on different indicators of child health. Underweight progressively declined from 30% in 1988 to 24% in 2003, while the fraction of children presenting any of the three forms of malnutrition previously mentioned remained stable at around 40%, with little variance during this period.

Determinants of childhood malnutrition during the economic upturns

To assess the determinants of malnutrition, we estimated a linear probability model of the form:

$$(1) \qquad y_{ir} = \beta_0 + \sum_{t=1988,1993,2003} \beta_t \, year_t + X\alpha + \mu_r + \varepsilon_{ir}$$

where y_{ir} is a dichotomous outcome variable (stunting, wasting or underweight) for a child *i* in a community *r*, and β_t the coefficient on the dummy indicator for the year *t* (*t* = 1988, 1993, 2003), capturing year *t* effects. Note the year 1998 is omitted and serves as the reference year. *X* is an array of variables including child bio-demographics, and maternal and household characteristics, which effects α are a vector of parameters to be estimated. μ_r and ε_{ir} capture unobserved community and individual heterogeneity, respectively. Since outcomes and some variables might be jointly determined, ε_{ir} is likely correlated with some elements of the vector *X*, implying that some of elements of the vector α only measure associations that are not necessary causal. Because community health-related unobserved factors such as prices and environmental conditions are likely to vary across regions and across urban and rural areas within the same region, we split each of the eight regions surveyed in 1988 into urban and rural areas, creating 16 sub-regions, and we estimate equation (1) using sub-region fixed-effects, therefore netting out μ_r. We also correct for heterokedasticity and clustering of observations within sub-regions in the estimated standard errors. The results of this exercise are reported in Table 3 for stunting, Table 4 for wasting and Table 5 for underweight.

Results

We comment on results presented in Tables 3-5 using a comparative approach, which consists of examining the effect of each independent variable on the three outcomes simultaneously. This approach has the potential to further our understanding of the mechanism driving trends in different indicators of child nutrition during a period of economic change. In each table, Column (I) estimates the effects of child bio-demographic factors after adjusting for the years effects. Column (II) adds maternal characteristics to variables in Column (I), and Column (III) further adjusts for household characteristics. Column (IV) adds three variables (child birth size and mother's weight and height) that were not collected in 1988, but were collected in the subsequent surveys. Therefore Columns I-III are estimated using the pooled 1988, 1993, 1998 and 2003 surveys, while Column IV is estimated using only the three last surveys. We mainly comment on results of Column (III) since it is the full model and refer to Column (IV) when necessary.

Child bio-demographics

Tables 3-5 show that the prevalence of all forms of malnutrition was consistently higher in male as compared to female children during the period of economic growth in Ghana. We note from Columns (III) that stunting, wasting and underweight were respectively 3.2, 1.3 and 1.0 percentage points greater among boys than girls, but the results for wasting and underweight are not statistically significant at the 10% level. Studies have found that during childhood, male experience higher incidence of health conditions resulting in growth failure as compared to female (Rudy et al, 2002). This is attributed to the immune system, which is thought to be weaker for the former.

As expected, age had a curvilinear relationship with each indicator of malnutrition. Increase in the probability of malnutrition associated with a one-month increase in child age is 3.2 percentage points for stunting, 1.7 percentage points for wasting, and 4.3 percentage points for underweight. The association of age with nutritional status is classical, especially in developing countries where the prevalence of malnutrition generally rises after 6 months of age to reach its maximum between 12-23 months, and then declines afterwards (Pongou et al., 2006; Lamontagne et al., 1998; Engle and Zeitlin, 1996).

Larger birth interval was associated with lower prevalence of malnutrition. Column (III) of each table shows that a one-month increase in preceding birth interval was associated with a 0.1 pp decrease in the probability of each form of malnutrition. This result confirms the positive effect of birth spacing on child nutritional status (Thuita et al., 2005; Mozumder et al., 2000). Greater birth spacing positively affects child health by limiting the number of children to look after within a limited period, enabling mothers to fully recover from preceding childbearing and allowing them to engage in revenues generating activities that reduce poverty within the household (Miller and Xiao, 1999).

We also find that extended breastfeeding was associated with worsening child nutritional status. Conditional on age, the prevalence of stunting was on average 13.0 percentage points greater among children who were still breastfeeding at the time of the survey as compared to those who had already been weaned. This difference was 4.2 percentage points for wasting, and 15.7 percentage points for underweight. Similar findings were obtained in Cameroon (Pongou et al., 2006) and other developing countries (Caulfield et al., 1996). However, given that malnutrition is generally not prevalent among children under 6 months of age, this finding raises question about the quality and quantity of supplementation given to breastfeeding children beyond 6 months of age. It is also possible that breastfeeding in these ages is used as substitutes for less calories, especially in poor households. We tested this hypothesis and found that the difference in prevalence of stunting between breastfeeding children and weaned children is the largest among children from the poorest households (19.2 percentage points, $p<0.001$) and not significant at all among the richest children (6.7 percentage points, $p=0.207$) (results not shown). This finding is consistent with studies in Sudan (Fawzi et al., 1998). Therefore, the relationship between breastfeeding and nutritional status in our study should not be necessary regarded as causal. It is possible that children of perceived small stature are breastfed for longer periods to compensate for their slow growth as illustrated in Simondon et al. (2001), and further discussed in Kramer (2003). Studies in Mexico have found a positive relationship between breastfeeding and child growth (2005).

We found a curvilinear relationship between birth order and stunting. A unit increase in birth rank was associated with increase in the probability of being stunted with a diminishing marginal effect. The results were qualitatively similar for wasting and underweight, although the effect was smaller and not statistically significant at the 10% level for wasting. Birth order has been generally found to be associated with worsening child health and nutrition (Horton, 1988). The cost of child rearing implies that as the number of children increases, fewer resources are left to be invested in higher rank children. In the context of sub-Saharan Africa where kinship networks constitute a major form of insurance, the diminishing marginal effect may reflect the fact that younger children are supported by older ones, especially when the age gap between the oldest and the youngest is huge.

Birth size was only available in 1993, 1998 and 2003. The effect of this variable is estimated in Column (IV). As expected, larger birth size was associated with lower prevalence of malnutrition. Large size at birth was associated with a 9.4, 4.7 and 14.4 percentage points decrease in the probability of being stunted, wasted and underweight, respectively. This finding implies that birth size is a determinant of both chronic and acute malnutrition.

Maternal characteristics

Maternal age at childbirth is a significant determinant of child nutritional status (Lima et al., 1990; Rikimaru et al., 1998; Deodhar and Jarad, 1999). Tables 3 and 5 (Column (III)) shows that one year increase in mother's age at childbirth was associated with a 1.5 percentage points decrease in the probability of stunting, and a 1.5 percentage points decrease in the probability of underweight. Very young mothers are not generally biologically mature, which do not allow normal development of the fetus, resulting in low birth size and other biological deficiencies, which are reflected in child growth after birth. They also may lack the resources and the adequate knowledge and experience necessary for child rearing, implying inappropriate feeding and treatment of infectious diseases (Appoh and Krekling, 2005; Ruel et al., 1992; Islam et al., 1994; Rahman et al., 1993).

Marital status also is an indicator of exposure to factors that protect health. Children born to married mothers attract the attention of both parents and in most cases enjoy the emotional and financial stability of their family. We find that these children fared better than children born to divorced mothers and mothers not living with their partners. This was especially true for stunting (Table 3, Columns II & III) and underweight (Table 5, Columns II & III).

Parental education has been found to be a significant determinant of child health in many studies (Barrera, 1990; Lavy et al., 1996; Handa, 1999). Our study shows that children born to mothers with more education were less likely to be malnourished (Tables 3-5). However this effect was very weak, and generally lost statistical power when other variables were controlled, implying that the role of higher maternal education was explained by better economic status and better health care utilization associated with this class. Similarly, husband education did not have a significant independent effect on stunting and underweight. Its effect on wasting was positive (Table 5, Column (IV)).

Children born to mothers working for cash had lower prevalence of wasting and underweight, but the effect of "working for cash" was not significant on wasting. Revenues generating activities may reduce food and monetary poverty, which is reflected in child nutritional status.

The effects of mothers' biological factors such as weight and height are also tested in Column (IV) of Tables 3-5. Mother's height may capture genetic endowment as well as family background while weight after netting out the effect of height may capture a dimension of permanent household economic status. These variables were associated with lower prevalence of malnutrition by all measures, but the effect of height on wasting was not significant. These findings are consistent with the literature on the determinants of child health (Frongillo et al., 1997; Islam et al., 1994; Rahman et al., 1993).

Household characteristics

Numerous studies have documented the positive effects of household characteristics (e.g. income, health care utilization, etc.) on child health and nutrition (Thomas and Strauss, 1992; Thomas, 1994; Pleto et al., 1991; Adekunle, 2005). Our constructed index of household economic status was associated with lower prevalence of malnutrition. A unit increase in the economic status index resulted in a 1.2 percentage points decrease in the probability of stunting (Table 3, Column (III)). After controlling for mother's weight and height, the effect of this variable diminished to non-significance, maybe reflecting the fact that adult anthropometric measures capture to a certain extent the resources available to households. The effect of economic status on wasting was not statistically significant, but became meaningful after controlling for maternal biological factors (Table 4, Columns III-IV) (note that the effect of health care utilization which was significant in Column III became non-significant in Column IV, maybe indicating that the roles of economic status and health care utilization are joint, and cannot be separate from each other). We also note that better economic status was associated with a lower prevalence of underweight, even after controlling for mother's weight and height (Table 5, Columns III-IV).

Health care utilization was also associated with lower prevalence of all forms of malnutrition (Tables 3-5). Better use of health care implies adequate prenatal and postnatal treatments, appropriate feeding practices and better management of infectious diseases, all resulting in improved child nutritional status. It is however important to note that this variable is constructed mainly using prenatal and postnatal health care use indicators and its effect is highest on stunting; therefore implying that early childhood conditions have a long-term impact on child health.

Household size and number of children under five have been found to affect child nutrition (Horton, 1988; Pleto et al., 1991; Waters et al., 2004). These variables also capture the level of household resources available to each household member. In general, we find no significant effects of these variables on any form of malnutrition during the Ghana economic upturns. But the number of children under the age of 5 was found to be associated with increase probability of stunting after controlling for all factors. It has been argued that increase in the number of children generally increases food competition within the household, resulting in lower quantity of food for each child (LeGrand and Phillips, 1996; Delpeuch et al., 2000). But it is important to note that when the effect of birth interval is significant, the effect of number of children is not significant and vice-versa (Table 3, Columns III-IV), therefore implying that these variables are correlated and have joint significant effects.

Other household factors also found to have an effect on child nutritional status during the economic upturns in Ghana were the gender and age of household head. The prevalence of stunting was on average 2.6 percentage points lower in male-headed households as compared to female-headed households. The results are in the same direction for wasting and underweight, although they are not statistically significant. In developing countries, male household headship generally implies the presence of a female (generally the mother) in the household while the converse is not true. This implies that children living in such households generally benefit from the presence of both parents, which positively impacts on their health. Also, male headship is generally associated with greater resources and less poverty (Mberu, 2006), implying a greater investment in child health. Our result for head of household is different from other studies (Kennedy & Peters 1992; Staten et al. 1998). Older household heads were associated with lower prevalence of stunting (Table 3, Columns III-IV) and higher prevalence of wasting (Table 4 Column III).

We note that the three forms of malnutrition examined had some common determinants during the 1980s and 1990s economic upturns in Ghana. Child bio-demographics prominently featured among these factors as well as some maternal and household characteristics. It should however be noted that the effects of many of these variables varied across outcomes in magnitude and statistical significance. Stunting and underweight essentially had the same determinants, but household factors like gender and age of household head were significantly associated with stunting, but not with underweight. Age of household head had an opposite effect on stunting and wasting, implying that some factors may yield mixed effects on child health. These findings may help understand why different trends in different indicators of malnutrition were observed during the period of growth experienced by the country.

Understanding trends in the prevalence of malnutrition

In this section, we assess the extent to which trends in different measures of child nutritional status during the period of economic growth in Ghana were driven by trends or changes in the distributions of their determinants as studied in the previous section. We hypothesize that if a factor is associated with lower prevalence of malnutrition (e.g. economic status) and is positively affected by an economic upturn (e.g. increase in economic status during economic growth in Ghana), then the level of malnutrition will decrease. So in general, trends in malnutrition are determined both by trends in its underlying determinants and the direction in which malnutrition is affected by these determinants. Table 6 summarizes our assumption about the expected trend in malnutrition as a result of the combination of both factors. However, this approach to estimating the contribution of changes in the distributions of determinants to trends in malnutrition raises an important issue that should be addressed. Changes in the level of malnutrition might also result from changes in the effects of its determinants over time. For instance, if the effect of economic status increases during a positive macro economic shock because the benefits of this shock accrued only to the richest class, we might still observe change in the level of malnutrition even if there is little change in average income. To address this issue in our study, we estimate a model in which variables are interacted with year's dummies to assess changes across years in the coefficient on each independent variable (results not shown). We note that the effect of sex and birth interval changed across years, but these changes were not statistically significant. We can therefore attempt to explain trends in different indicators of malnutrition only based on the assumption highlighted in Table 6.

We explain trends in different measures of malnutrition in Ghana based on equation (1), but with a different order of inclusion of independent variables. For each outcome, we first estimate equation (1) only with years dummies, with the year 1998 being our reference year (this year was a turning point in the trends of stunting and wasting, and change in the level of underweight between 1998 and 2003 was not statistically significant) (Tables 7-10, Columns (I)). We additionally adjust for child sex and age (Tables 7-10, Columns (II)). Based on the determinants of malnutrition (Tables 3-5) and their trends (Table 1), variables that are expected to have driven trends in the observed direction (Figure 4) are first added and those that are expected to have acted in the opposite direction are included afterwards. This also implies that the order of inclusion of these variables should change across outcomes. The rationale underlying this order of inclusion is based on Table 6 and the observed trends pictured in Figure 4. If a variable is associated with lower prevalence of malnutrition and if this variable increased between 1988 and 1998 while the level of malnutrition decreased, then the inclusion of this variable in the model is expected to decrease the coefficient on the year 1988. That is, if the distribution of the variable in 1988 were the same as in 1998, the prevalence of malnutrition would have been lower in 1988 than it actually was. This would also mean that increase in the level of this variable mediated some part of the decrease in malnutrition.

Because the year 1998 was a turning point in trends in stunting and wasting and because change between 1998 and 2003 was not statistically significant for underweight, we mainly seek to understand these trends for the periods 1988-1998 and 1998-2003 for the first two indicators and only for the period 1988-1998 for the latter. Results are presented in Tables 7-10.

Stunting

Period 1988-1998

The results for the period 1988-1998 are presented in Table 7. We are only interested in how the coefficient on the year 1988 responds to inclusion of additional factors. After adjusting for sub-region effects, we note that the proportion of stunted children decreased by 10.5 percentage points between 1988 and 1998 (Column (I)). Further adjustment for child sex and age changes little in the coefficient on the year 1988 (Column (II)). This is not surprising since the age and sex distributions of children did not change during the period of interest (Table 1). After controlling for child preceding birth interval and birth order and their quadratic terms, this coefficient dropped to 0.098 (Column (III)). This drop is explained by the fact that birth interval for instance was associated with lower level of stunting and its level in general rose between 1988 and 1998 (for birth order, it is just the opposite). Column (IV) additionally controls for maternal education, age at childbirth and its quadratic term, husband education, economic status, household size and number of children under five in the household. A close look at these variables show that the direction in which each of them is associated with stunting and their trends during 1988-1998 imply that they mediated decrease in this form of malnutrition during this period. This resulted in a drop in the coefficient on the year 1988 to 0.069. Note that this coefficient is significantly different from the first coefficient 0.105 at the 5% level. Control of the remaining determinants in Column (V) did not show any mediating effects of these factors. We therefore conclude that 34% of the total decrease in stunting between 1988 and 1998 could be explained by changes in the distributions of variables included in Columns (III-IV).

Period 1998-2003

The proportion of stunted children increased by 6.4 percentage points between 1998 and 2003 in Ghana. This is reflected in the robust coefficient on the year 2003 in Table 8, Column (I). Controlling for child sex and age decreases this coefficient to 0.055 (Column (II)). This could be explained by the small increase in average child age between 1998 and 2003 (Table 1). After further controls for breastfeeding status, birth order and its quadratic term and health care use index in Column (III), this coefficient diminishes to 0.043. This finding implies that rise in the prevalence of stunting after 1998 was associated with higher birth rank probably due to declines in the level of fertility of women with fewer children, extended breastfeeding and declines in the use of primary health care services. Ghana decentralized its health care system in 1996 (Nyonator and Kutzin, 1999). This reform was associated with increase in user fees, leading to a decline in health care utilization. Our results suggest that this situation contributed to deteriorating child linear growth after 1998. When controlling for the remaining variables in Columns IV-V, we note little mediating effects due to these factors.

Wasting

Wasting increased by 4.8 percentage points between 1988 and 1998 and then declined by 3.1 percentage points between 1998 and 2003 (Table 9, Columns (I)). Controlling for child sex and age has no effects on the coefficients on the years 1988 and 2003 (Column (II)). After controlling for breastfeeding status (Column (III)), we observe a slight change in the effect of year 1988, indicating that increase in wasting during the period 1988-1998 was correlated with extended breastfeeding. The effect of year 2003 on the contrary increases. Columns IV-V lead to the conclusion that the factors included in our analysis had little mediating effects on the trend in wasting during the period of interest.

Underweight

The proportion of underweight children significantly decreased by 5.5 percentage points between 1988 and 1998 and further decreased by 2.1 percentage points in 2003 (Table 10, Column (I)). Controlling for child age and sex explains little in the trends observed in 1988-1998 (Column

(II)). Controls in Column (III) show that part of the decrease in underweight could be explained by declines in birth order and increase in preceding birth interval. After adding economic status index, health care use index, maternal age at child birth and its quadratic term and employment status, household size and number of children under five in the household, the coefficient of the year 1988 drops to 0.023 and becomes statistically non different from zero. Trends in the variables included in Column (IV) explained nearly 50% of the total decrease in underweight between 1988 and 1998 in Ghana.

Trends in different measures of childhood malnutrition in Ghana during the period of economic growth were partly explained by child, maternal and household factors included in our analysis. However, that only part of these trends could be explained suggests that there was a country factor affecting the health of all social classes. We also note that the explanatory factors for changes in the level of malnutrition differed across measures, as well as the share explained by these factors, reflecting the fact that determinants of malnutrition differ in magnitude and statistical significance across outcomes.

Conclusion

We examine child nutrition in Ghana during the economic recovery of the 1980s and 1990s. Our analysis indicates that the three indicators of malnutrition analyzed in our study had different responses to growth. Stunting declined between 1988 and 1998, but significantly increased afterwards. Wasting followed an opposite path increasing from 8 to 13% in 1988-1998, and then decreasing to 10% in 2003. Underweight progressively fell from 30% in 1998 to 24% in 2003. These different trends also demonstrate differences in the sets of factors generating these outcomes, as confirmed by our analysis. We note that factors such as child gender, male household headship, and age of household head significantly impacted stunting, while their effects on both wasting and underweight were not significant. Birth order, maternal age at childbirth, marital status, and mother's height were common factors to both stunting and underweight. Finally, preceding birth interval, prolonged breastfeeding, birth size, mother's weight, household economic status, and health care utilization were associated with the three outcomes.

We note that the distributions of these determinants changed during economic growth. Household economic status increased, as well as health care utilization, but this latter factor declined after 1998, following the health care system reform in the country in 1996. We showed that these factors partly explained trends in stunting and underweight during the 1990s growth. Even though household income increased in Ghana during the period 1988 – 2003, user fees and competing demands for services (i.e. water, food etc.) might have decreased the demand for care for children, especially after the 1996 decentralization, explaining increase in stunting after 1998. Changes in the distributions of other bio-demographic factors also explained changes in child nutritional status. Most notable is the increase in birth interval that partly mediated decrease in stunting and underweight in 1988-1998. Prolonged breastfeeding surprisingly increased, and was associated with increase in malnutrition.

Although household income responded positively to macro level economic upturns in Ghana during the 1990s, we show that possible explanations for the mixed results in the three measures of malnutrition could be associated with other child, maternal, and household level factors. As the place of women in Ghanaian society and the labor force changed due to economic growth, women modified their decision-making on marriage, childbirth, education, and other factors to mirror the macroeconomic change.

The findings from the study are significant to policy development as well as intervention approaches. Most of the factors associated with childhood malnutrition can be prevented through intervention and educational programs. Increase in stunting after 1998 implies that macro-level economic growth that may lead to improvement in household economic factors may not necessarily translate into improvement in child health and nutrition. The approach to eliminating childhood malnutrition must be comprehensive approach and pointed, underscoring the importance of interventions that address characteristics associated with specific populations within communities. Policy and interventions should emphasis individual, community and governmental level approaches. Empowering parents with necessary tools and information concerning the importance of proper nutrition could potentially overcome differences in social groups, and mechanisms of decision-making that negatively impacts child malnutrition. Further research into this topic would be instrumental to effectively addressing the malnutrition crisis in Ghana in particular and developing countries in general.

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Table 1: Summary Statistics. Standard deviations are in parentheses

Variables	All sample	1988	1993	1998	2003
N	7043	1836	1751	1602	1854
Year 1988	0.30 (0.46)	1.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Year 1993	0.22 (0.42)	0.00 (0.00)	1.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Year 1998	0.23 (0.42)	0.00 (0.00)	0.00 (0.00)	1.00 (0.00)	0.00 (0.00)
Year 2003	0.24 (0.43)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.00 (0.00)
Child bio-demographics					
Male	0.50 (0.50)	0.50 (0.50)	0.50 (0.50)	0.50 (0.50)	0.49 (0.50)
Female	0.50 (0.50)	0.50 (0.50)	0.50 (0.50)	0.50 (0.50)	0.51 (0.50)
Age	17.60 (9.75)	17.49 (9.69)	17.40 (9.95)	17.44 (9.67)	18.08 (9.69)
First born	0.22 (0.41)	0.20 (0.40)	0.21 (0.41)	0.24 (0.43)	0.22 (0.41)
Preceding birth interval	33.66 (27.37)	30.79 (22.78)	34.65 (27.00)	33.90 (28.24)	36.09 (31.49)
Still breastfeeding	0.64 (0.48)	0.61 (0.49)	0.65 (0.48)	0.64 (0.48)	0.66 (0.47)
Breastfeeding is missing	0.00 (.07)	0.00 (0.07)	0.00 (0.05)	0.01 (0.09)	0.00 (0.07)
Birth order	3.59 (2.35)	3.80 (2.44)	3.48 (2.20)	3.47 (2.39)	3.53 (2.31)
Birth size was small	0.15 (0.35)	NA	0.12 (0.32)	0.13 (0.34)	0.18 (0.38)
Birth size was average	0.39 (0.49)	NA	0.46 (0.50)	0.29 (0.45)	0.41 (0.49)
Birth size was large	0.46 (0.50)	NA	0.42 (0.49)	0.57 (0.49)	0.40 (0.49)
Maternal characteristics					
Age at child birth	27.40 (6.82)	27.11 (6.84)	27.22 (6.67)	27.32 (6.84)	28.00 (6.90)
Married	0.79 (0.41)	0.85 (0.36)	0.77 (0.42)	0.72 (0.45)	0.81 (0.39)
Never married	0.03 (0.16)	0.03 (0.17)	0.02 (0.15)	0.02 (0.15)	0.03 (0.18)
Widowed	0.01 (0.08)	0.01 (0.08)	0.00 (0.071)	0.01 (0.08)	0.01 (0.10)
Divorced	0.03 (0.16)	0.03 (0.17)	0.03 (0.18)	0.027 (0.16)	0.016 (0.12)
Living together	0.12 (0.32)	0.06 (0.23)	0.15 (0.35)	0.18 (0.39)	0.10 (0.30)
Not living together	0.03 (0.17)	0.03 (0.16)	0.02 (0.15)	0.04 (0.19)	0.03 (0.18)
Works for cash	0.67 (0.47)	0.51 (0.50)	0.66 (0.47)	0.76 (0.43)	0.78 (0.41)
"Works for cash" is missing	0.11 (0.32)	0.03 (0.17)	0.20 (0.40)	0.14 (0.35)	0.00 (0.00)
education	4.79 (4.52)	4.75 (4.50)	4.86 (4.50)	4.96 (4.61)	4.63 (4.47)
Weight	559.37 (119.14)	NA	547.42 (98.33)	555.96 (117.75)	573.44 (135.28)
Weight is missing	0.00 (0.07)	NA	0.00 (0.05)	0.00 (0.05)	0.01 (0.10)
Height	1573.99 (170.67)	NA	1579.46 (111.77)	1580.31 (176.39)	1563.08 (205.54)
Height is missing	0.01 (0.09)	NA	0.00 (0.06)	0.00 (0.06)	0.01 (0.12)
Household characteristics					
Husband education	4.94 (5.42)	6.28 (5.28)	6.25 (5.05)	7.15 (5.63)	5.39 (5.60)
Husband education is missing	0.37 (.48)	0.10 (0.30)	0.36 (0.48)	0.08 (0.28)	0.12 (0.32)
Economic status index	0.04 (1.83)	-0.30 (1.62)	-0.05 (1.78)	0.14 (1.83)	0.47 (2.03)
Health care use index	0.24 (1.31)	-0.01 (1.38)	0.27 (1.34)	0.53 (1.16)	0.26 (1.25)
Household size	6.14 (3.10)	7.21 (3.60)	5.58 (2.84)	5.54 (2.67)	5.90 (2.66)
# children under 5 in the household	1.92 (1.01)	2.18 (1.22)	1.86 (0.90)	1.77 (0.88)	1.80 (0.84)
Household head is male	0.67 (0.47)	0.67 (0.47)	0.64 (0.48)	0.65 (0.48)	0.74 (0.44)

Age of household head	40.36 (14.09)	43.18 (15.11)	37.70 (12.78)	38.97 (13.53)	40.57 (13.79)

NA=Non available

Table 2: Trends in prevalence of malnutrition in Ghana, 1988-2003

	1988	1993	1998	2003
Stunting (% HAZ < -2 SDs)	30.0 (1.1)	26.8 (1.1)	20.6 (1.0)	27.4 (1.0)
Underweight (% WAZ < -2 SDs)	30.3 (1.1)	28.2 (1.1)	25.7 (1.1)	24.1 (1.0)
Wasting (% WHZ < -2 SDs)	7.7 (0.6)	12.0 (0.8)	13.2 (0.8)	9.7 (0.7)

Standard errors are in parentheses.

Table 3: Sub-region fixed-effects estimates of stunting in Ghana, 1988-2003

Variables	I	II	III	IV
Year 1988	0.101***	0.101***	0.079***	-
	[0.016]	[0.017]	[0.017]	-
Year 1993	0.062***	0.060***	0.049***	0.046***
	[0.012]	[0.012]	[0.012]	[0.011]
Year 2003	0.051***	0.053***	0.050***	0.044***
	[0.012]	[0.011]	[0.012]	[0.010]
Child bio-demographics				
Child is male	0.030***	0.031***	0.032***	0.047***
	[0.008]	[0.008]	[0.008]	[0.007]
Child age	0.031***	0.031***	0.032***	0.031***
	[0.004]	[0.004]	[0.004]	[0.005]
(Child age) ^{2}	-0.000***	-0.000***	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]
Child is first born	-0.027	-0.029	-0.013	0.012
	[0.020]	[0.019]	[0.021]	[0.024]
Preceding birth interval	-0.002***	-0.001**	-0.001**	-0.001
	[0.000]	[0.000]	[0.000]	[0.001]
(Preceding birth interval) ^{2}	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]
Still breastfeeding	0.136***	0.130***	0.130***	0.125***
	[0.025]	[0.025]	[0.026]	[0.032]
Breastfeeding is missing	0.006	0.006	-0.011	0.01
	[0.043]	[0.046]	[0.046]	[0.047]
Birth order	0.017*	0.037***	0.032***	0.038***
	[0.009]	[0.007]	[0.008]	[0.011]
(Birth order) ^{2}	-0.001	-0.003***	-0.002***	-0.002**
	[0.001]	[0.001]	[0.001]	[0.001]
Birth size was average				-0.053**
				[0.021]
Birth size was large				-0.094***
				[0.019]
Maternal characteristics				
Age at child birth		-0.018***	-0.015**	-0.009
		[0.005]	[0.005]	[0.006]
(Age at child birth) ^{2}		0.000**	0.000**	0.000
		[0.000]	[0.000]	[0.000]
Never married		0.05	0.026	0.037
		[0.048]	[0.050]	[0.040]
Widowed		-0.002	-0.025	-0.022
		[0.057]	[0.060]	[0.047]
Divorced		0.081*	0.057	0.019
		[0.040]	[0.041]	[0.036]
Living together		0.016	0.005	0.012
		[0.019]	[0.019]	[0.012]

Not living together		0.054*	0.038*	0.017
		[0.025]	[0.022]	[0.034]
Education		-0.003**	-0.001	0.000
		[0.001]	[0.001]	[0.001]
Works for cash		0.000	0.006	-0.006
		[0.011]	[0.011]	[0.014]
Work for cash is missing		0.028	0.031*	0.008
		[0.017]	[0.017]	[0.015]
Husband education			-0.001	-0.001
			[0.001]	[0.001]
Husband education is missing			0.001	-0.01
			[0.018]	[0.014]
Weight				-0.000***
				[0.000]
Weight is missing				-0.137
				[0.079]
Height				-0.000*
				[0.000]
Height is missing				-0.343*
				[0.182]
Household characteristics				
Economic status index			-0.012***	-0.005
			[0.003]	[0.005]
Health care use index			-0.021***	-0.022***
			[0.005]	[0.003]
Household size			0.003	0.000
			[0.002]	[0.002]
# Children under 5 yrs			0.009	0.024***
			[0.005]	[0.005]
Household head is male			-0.026*	-0.024*
			[0.014]	[0.011]
Age of household head			-0.003*	-0.004*
			[0.002]	[0.002]
(Age of household head) ^{2}			0.000	0.000*
Constant	-0.255***	-0.001	-0.014	0.515**
	[0.051]	[0.098]	[0.100]	[0.200]
Observations	7043	7043	7043	5207
Number of sub-regions	16	16	16	16
Overall R-squared	0.10	0.11	0.12	0.13

* significant at 10%; ** significant at 5%; *** significant at 1%

Robust standard errors are in brackets. Regressions I-III were estimated using the 1988, 1993, 1998 and 2003 Demographic and Health Surveys (DHS) and regression IV only used the three last surveys.

Table 4: Sub-region fixed-effects estimates of wasting in Ghana, 1988-2003

Variables	I	II	III	IV
Year 1988	-0.050***	-0.051***	-0.056***	-
	[0.014]	[0.013]	[0.015]	-
Year 1993	-0.007	-0.007	-0.014	-0.019
	[0.016]	[0.016]	[0.014]	[0.015]
Year 2003	-0.033***	-0.033***	-0.034***	-0.034***
	[0.009]	[0.009]	[0.010]	[0.010]
Child bio-demographics				
Child is male	0.013	0.013	0.013	0.013
	[0.008]	[0.008]	[0.008]	[0.010]
Child age	0.017***	0.017***	0.017***	0.017***
	[0.002]	[0.002]	[0.002]	[0.003]
$(\text{Child age})^2$	-0.000***	-0.000***	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]
Child is first born	-0.011	-0.015	-0.01	-0.033
	[0.016]	[0.014]	[0.017]	[0.025]
Preceding birth interval	-0.001*	-0.001**	-0.001	-0.001**
	[0.000]	[0.000]	[0.001]	[0.001]
$(\text{Preceding birth interval})^2$	0.000*	0.000*	0.000	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]
Still breastfeeding	0.042***	0.042***	0.042***	0.040***
	[0.009]	[0.010]	[0.009]	[0.011]
Breastfeeding is missing	-0.013	-0.014	-0.019	-0.028
	[0.022]	[0.023]	[0.024]	[0.027]
Birth order	0.018**	0.015	0.015	0.016
	[0.007]	[0.008]	[0.009]	[0.012]
$(\text{Birth order})^2$	-0.001**	-0.001	-0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]
Birth size was average				-0.028
				[0.017]
Birth size was large				-0.047**
				[0.018]
Maternal characteristics				
Age at child birth		0.001	0.000	0.002
		[0.005]	[0.005]	[0.007]
$(\text{Age at child birth})^2$		0.000	0.000	0.000
		[0.000]	[0.000]	[0.000]
Never married		0.016	-0.009	-0.017
		[0.026]	[0.039]	[0.033]
Widowed		-0.033	-0.038	-0.048
		[0.034]	[0.033]	[0.033]
Divorced		0.014	0.006	-0.021
		[0.021]	[0.020]	[0.029]
Living together		0.000	-0.002	0.001
		[0.014]	[0.014]	[0.014]
Not living together		-0.004	-0.014	-0.018

		[0.023]	[0.026]	[0.033]
Education		-0.001	-0.001	-0.002*
		[0.001]	[0.001]	[0.001]
Works for cash		-0.004	-0.002	-0.005
		[0.008]	[0.009]	[0.010]
Work for cash is missing		0.004	0.004	-0.005
		[0.014]	[0.015]	[0.017]
Husband education			0.001	0.002**
			[0.001]	[0.001]
Husband education is missing			0.021	0.027*
			[0.014]	[0.014]
Weight				-0.000***
				[0.000]
Weight is missing				-0.197***
				[0.028]
Height				0.000
				[0.000]
Height is missing				-0.003
				[0.049]
Household characteristics				
Economic status index			0.001	-0.008**
			[0.002]	[0.002]
Health care use index			-0.005*	0.003
			[0.003]	[0.004]
Household size			0.000	-0.001
			[0.002]	[0.002]
# Children under 5 yrs			0.004	0.003
			[0.005]	[0.006]
Household head is male			-0.012	-0.012
			[0.008]	[0.009]
Age of household head			0.002**	0.002
			[0.001]	[0.001]
(Age of household head)^2			0.000	0.000
			[0.000]	[0.000]
Constant	-0.031	-0.041	-0.088	0.032
	[0.029]	[0.061]	[0.065]	[0.112]
Observations	7297	7297	7297	5330
Number of sub-regions	16	16	16	16
Overall R-squared	0.03	0.03	0.03	0.04

* significant at 10%; ** significant at 5%; *** significant at 1%

Robust standard errors are in brackets. Regressions I-III were estimated using the 1988, 1993, 1998 and 2003 Demographic and Health Surveys (DHS) and regression IV only used the three last surveys.

Table 5: Sub-region fixed-effects estimates of underweight in Ghana, 1988-2003

Variables	I	II	III	IV
Year 1988	0.053***	0.045**	0.031*	-
	[0.014]	[0.016]	[0.017]	-
Year 1993	0.027*	0.024*	0.017	0.01
	[0.013]	[0.013]	[0.013]	[0.016]
Year 2003	-0.034**	-0.032**	-0.035**	-0.041**
	[0.014]	[0.014]	[0.015]	[0.016]
Child bio-demographics				
Child is male	0.008	0.009	0.01	0.022
	[0.011]	[0.012]	[0.012]	[0.013]
Child age	0.042***	0.042***	0.043***	0.040***
	[0.004]	[0.004]	[0.004]	[0.005]
$(\text{Child age})^2$	-0.001***	-0.001***	-0.001***	-0.001***
	[0.000]	[0.000]	[0.000]	[0.000]
Child is first born	-0.026	-0.026	-0.023	-0.037
	[0.028]	[0.030]	[0.031]	[0.033]
Preceding birth interval	-0.002**	-0.001**	-0.001**	-0.002***
	[0.001]	[0.001]	[0.001]	[0.000]
$(\text{Preceding birth interval})^2$	0.000*	0.000*	0.000*	0.000***
	[0.000]	[0.000]	[0.000]	[0.000]
Still breastfeeding	0.161***	0.156***	0.157***	0.144***
	[0.021]	[0.021]	[0.021]	[0.025]
Breastfeeding is missing	0.009	0.007	-0.004	0.014
	[0.052]	[0.055]	[0.055]	[0.057]
Birth order	0.016*	0.035***	0.030***	0.032**
	[0.008]	[0.008]	[0.009]	[0.013]
$(\text{Birth order})^2$	-0.001	-0.002*	-0.002	-0.002
	[0.001]	[0.001]	[0.001]	[0.001]
Birth size was average				-0.097***
				[0.018]
Birth size was large				-0.141***
				[0.017]
Maternal characteristics				
Age at child birth		-0.014**	-0.013**	-0.007
		[0.006]	[0.006]	[0.008]
$(\text{Age at child birth})^2$		0.000	0.000	0.000
		[0.000]	[0.000]	[0.000]
Never married		0.052	0.04	0.023
		[0.039]	[0.046]	[0.050]
Widowed		0.012	-0.01	-0.027
		[0.043]	[0.044]	[0.050]
Divorced		0.007	-0.007	-0.034
		[0.031]	[0.032]	[0.035]
Living together		0.021	0.014	0.009
		[0.017]	[0.017]	[0.021]

Not living together		0.053**	0.044*	0.042
		[0.025]	[0.022]	[0.028]
Education		-0.002	0.000	-0.001
		[0.002]	[0.002]	[0.002]
Works for cash		-0.025*	-0.021	-0.022*
		[0.014]	[0.013]	[0.013]
Work for cash is missing		0.003	0.005	-0.01
		[0.021]	[0.021]	[0.019]
Husband education			-0.001	0.000
			[0.001]	[0.001]
Husband education is missing			-0.005	-0.008
			[0.014]	[0.017]
Weight				-0.001***
				[0.000]
Weight is missing				-0.327***
				[0.097]
Height				0.000
				[0.000]
Height is missing				-0.227
				[0.138]
Household characteristics				
Economic status index			-0.008**	-0.019***
			[0.003]	[0.003]
Health care use index			-0.019***	-0.001
			[0.005]	[0.006]
Household size			0.003	0.000
			[0.002]	[0.003]
# Children under 5 yrs			-0.001	0.007
			[0.004]	[0.009]
Household head is male			-0.022	-0.013
			[0.018]	[0.013]
Age of household head			0.000	-0.002
			[0.002]	[0.001]
(Age of household head)^2			0.000	0.000
			[0.000]	[0.000]
Constant	-0.246***	-0.037	-0.037	0.467**
	[0.068]	[0.098]	[0.101]	[0.211]
Observations	7043	7043	7043	5207
Number of sub-regions	16	16	16	16
Overall R-squared	0.08	0.08	0.09	0.11

* significant at 10%; ** significant at 5%; *** significant at 1%

Robust standard errors are in brackets. Regressions I-III were estimated using the 1988, 1993, 1998 and 2003 Demographic and Health Surveys (DHS) and regression IV only used the three last surveys.

Table 6: Expected trends in malnutrition as a result of both the direction of association of malnutrition with and trends in determinants

	Direction of association between determinants and malnutrition		
Trends in determinants	**-**	**+**	**0**
-	+	-	0
+	-	+	0
0	0	0	0

Notes: (-), (+) or (0) for direction means that a determinant is either associated with lower malnutrition, higher malnutrition, or that there is no association at all. (-), (+) or (0) for trends means that that determinant either decreased, increased, or did not change during a time interval. (-), (+), or (0) for each cell as the result of multiplying the signs of the direction and the trend of this determinant means that malnutrition either declined, rose, or was not affected during this time interval.

Table 7: Explaining change in prevalence of stunting in Ghana, 1988-1998

Year	I	II	III	IV	V
1988	**0.105*** **	**0.105*** **	**0.098*** **	**0.069*** **	**0.079*** **
	[0.016]	[0.015]	[0.016]	[0.016]	[0.017]
1993	0.061***	0.063***	0.063***	0.050***	0.049***
	[0.011]	[0.012]	[0.012]	[0.012]	[0.011]
2003	0.064***	0.055***	0.056***	0.051***	0.050***
	[0.014]	[0.013]	[0.013]	[0.014]	[0.012]

-All models are estimated using sub-regions fixed-effects. Model I includes the dummy indicators for the years 1988, 1993 and 2003, the year 1998 being the reference. Model II additionally adjusts for child age and sex. Model III adds child birth order and preceding birth interval and their quadratic terms. Model IV further adds maternal education, age at child birth and its quadratic term, husband education, economic status index, health care use index, household size, and number of children under five in the households. Model V includes all the variables in Model IV and adds breastfeeding status, mother's marital status and employment status, sex of household head, and age of household head and its quadratic term.
-* significant at 10%; ** significant at 5%; *** significant at 1%.
-Robust standard errors in brackets.

Table 8: Explaining change in prevalence of stunting in Ghana, 1998-2003

Year	I	II	III	IV	V
1988	0.105***	0.105***	0.093***	0.086***	0.081***
	[0.016]	[0.015]	[0.016]	[0.016]	[0.017]
1993	0.061***	0.063***	0.056***	0.053***	0.050***
	[0.011]	[0.012]	[0.012]	[0.011]	[0.012]
2003	**0.064*** **	**0.055*** **	**0.043*** **	**0.042*** **	**0.050*** **
	[0.014]	[0.013]	[0.013]	[0.014]	[0.013]

-All models are estimated using sub-regions fixed-effects. Model I includes the dummy indicators for the years 1988, 1993 and 2003, the year 1998 being the reference. Model II additionally adjusts for child age and sex. Model III adds breastfeeding status, birth order and its quadratic term, and health care use index. Model IV further adds maternal education, husband education, household size and number of children under five in the household. Model V includes all the variables in Model IV and adds preceding birth interval and its quadratic term, mother's marital status and employment status, economic status index, sex of household head, and age of household head and its quadratic term.

-* significant at 10%; ** significant at 5%; *** significant at 1%.

-Robust standard errors in brackets.

Table 9: Explaining change in prevalence of wasting in Ghana, 1988-1998

Year	I	II	III	IV	V
1988	**-0.048*** **	**-0.048*** **	**-0.047*** **	**-0.047*** **	**-0.054*** **
	[0.015]	[0.015]	[0.014]	[0.014]	[0.015]
1993	-0.014	-0.012	-0.012	-0.012	-0.017
	[0.014]	[0.015]	[0.015]	[0.015]	[0.013]
2003	**-0.031*** **	**-0.031*** **	**-0.033*** **	**-0.032*** **	**-0.035*** **
	[0.010]	[0.010]	[0.010]	[0.009]	[0.010]

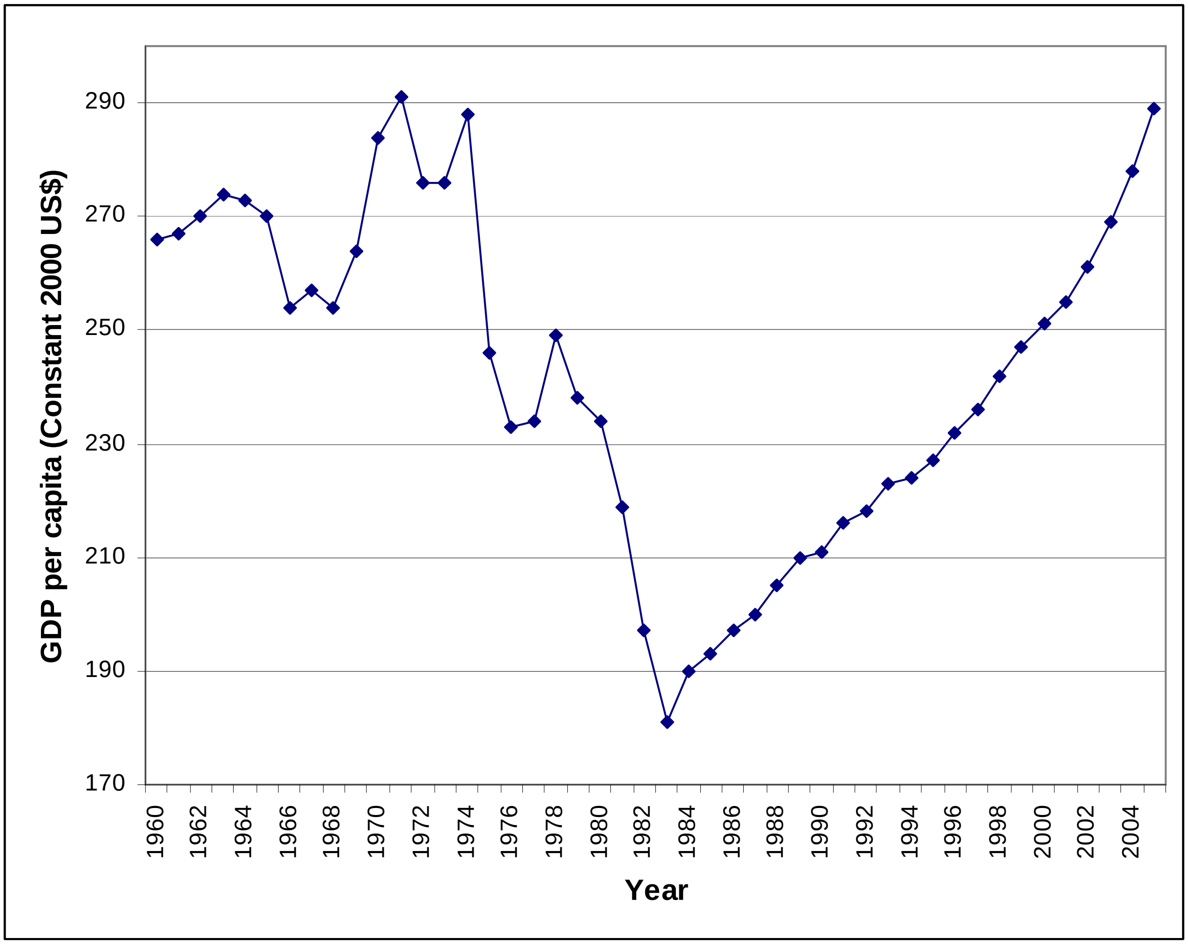
-All models are estimated using sub-regions fixed-effects. Model I includes the dummy indicators for the years 1988, 1993 and 2003, the year 1998 being the reference. Model II additionally adjusts for child age and sex. Model III adds breastfeeding status, . Model IV further adjusts for sex of household head. Model V adds child birth order and preceding birth interval and their quadratic terms, maternal education, husband education, economic status index, health care use index, age of household head and its quadratic term.
-* significant at 10%; ** significant at 5%; *** significant at 1%.
-Robust standard errors in brackets.

Table 10: Explaining change in prevalence of underweight in Ghana, 1988-1998

Year	I	II	III	IV	V
1988	**0.055*** **	**0.056*** **	**0.050*** **	**0.023**	**0.032***
	[0.013]	[0.014]	[0.013]	[0.014]	[0.017]
1993	0.023*	0.027*	0.027*	0.017	0.017
	[0.012]	[0.013]	[0.014]	[0.013]	[0.013]
2003	**-0.021**	-0.028*	-0.028*	-0.030*	-0.034**
	[0.015]	[0.014]	[0.015]	[0.015]	[0.015]

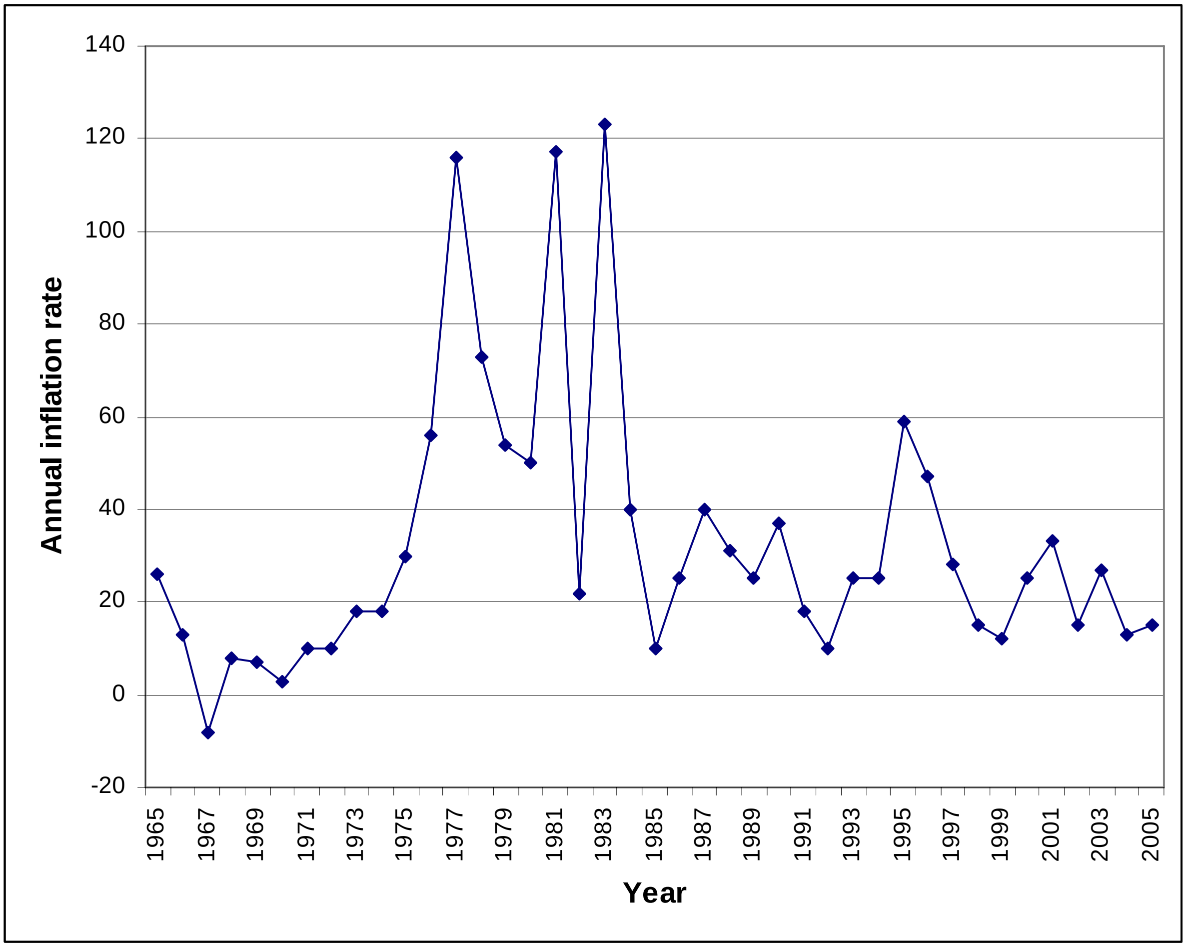
-All models are estimated using sub-regions fixed-effects. Model I includes the dummy indicators for the years 1988, 1993 and 2003, the year 1998 being the reference. Model II additionally adjusts for child age and sex. Model III adds child birth order and preceding birth interval and their quadratic terms. Model IV further adds economic status index health care use index, maternal age at child birth and its quadratic term and employment status, household size and number of children under five in the household. Model V includes all the variables in Model IV and adds breastfeeding status, maternal education and marital status, sex of household head, and age of household head and its quadratic term.
-* significant at 10%; ** significant at 5%; *** significant at 1%.
-Robust standard errors in brackets.

Figure 1: GDP per capita (constant 2000 US$) in Ghana, 1960-2005



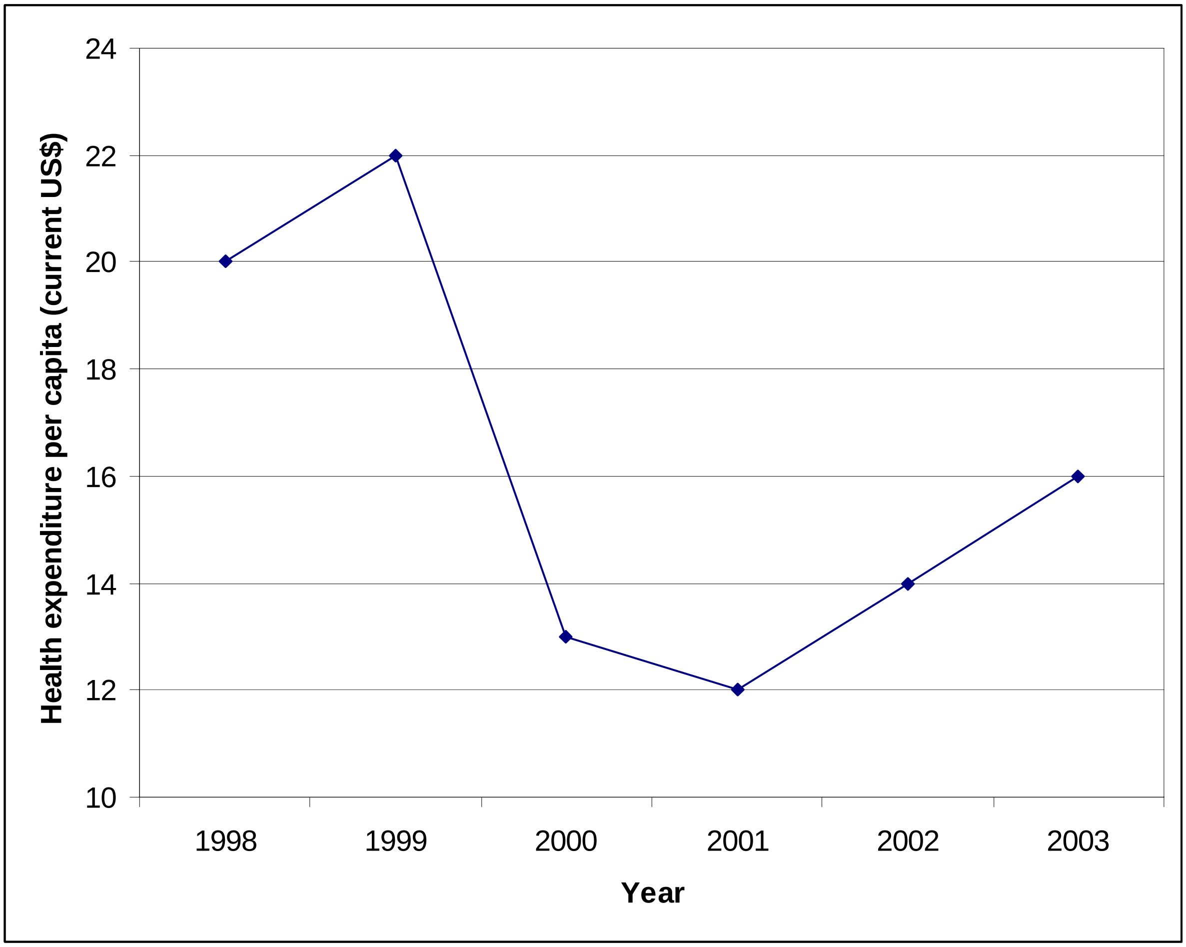
Source: World Bank databases.

Figure 2: Annual inflation rate (consumer prices) in Ghana, 1965-2005



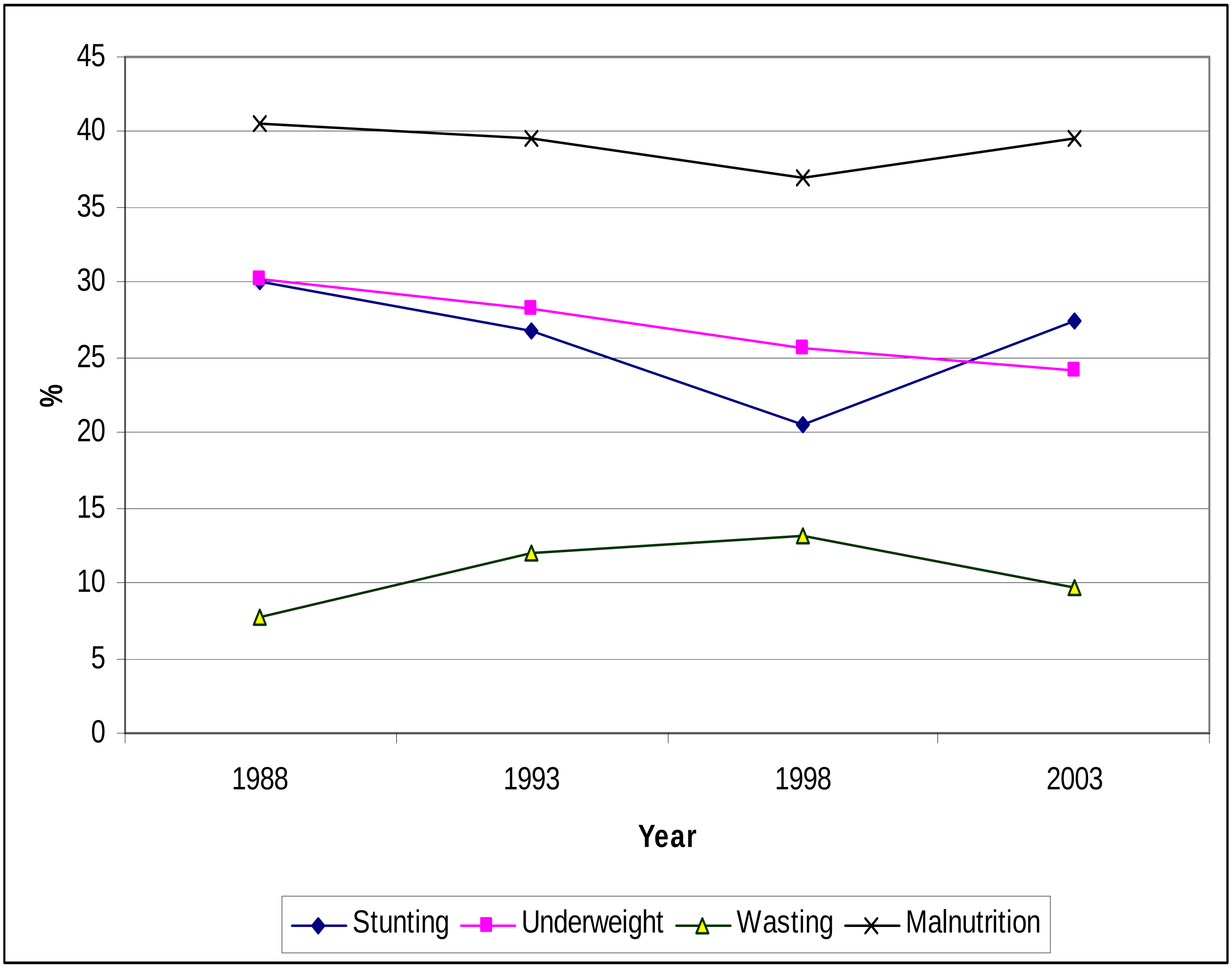
Source: World Bank databases.

Figure 3: Health expenditure per capita (current US$)



Source: World Bank databases.

Figure 4: Prevalence (%) of childhood malnutrition in Ghana, 1988-2003



Sources: Based on the 1988, 1993, 1998 and 2003 Demographic and Health Surveys in Ghana.