Longitudinal analysis of child malnutrition trends in Ghana

Kara Ross*, Aleksan Shanoyan*, and Yacob Zereyesus*

***Department of Agricultural Economics, Kansas State University, Manhattan, KS, USA**
Contact Author: kross02@ksu.edu

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's
2014 AAEA Annual Meeting, Minneapolis, MN, July 27-29, 2014.

Longitudinal analysis of child malnutrition trends in Ghana

Introduction

Child malnutrition continues to be an issue of growing interest for the international development community in general and African governments and policy makers in particular. Over 6.5 million children in developing countries under the age of five die every year because of malnutrition and hunger-related diseases (UNICEF, 2006). For many countries, implementation of effective malnutrition prevention initiatives is becoming a priority. These initiatives typically focus on promoting proper feeding practices, improving maternal health, and providing access to adequate sanitary conditions. Among specific examples of such initiatives are three of the eight Millennium Development Goals focused on reducing hunger and child mortality and improving maternal health, and the World Health Organization and United Nations Children's Fund's (UNICEF) Global Strategy on Infant and Young Child Feeding, a program focused on improving the health, growth and development of infants and young children. These initiatives along with many others are aimed at reducing the prevalence rates of child malnutrition, which will not only impact children's well-being in a short-run, but also will promote human development needed for long-run economic growth.

Ghana is one of the countries where child malnutrition continues to be an important issue. Although Ghana has evolved into a middle income country with a stable and mature democracy, there are still areas in Ghana experiencing extreme poverty and food insecurity. These impoverished and food insecure areas are predominately found in rural parts of northern Ghana. There is a large disparity in the health and well-being of people living in rural areas in northern Ghana compared to those living in the Greater Accra Region. Thus, many of intervention programs have shifted their focus and are targeting areas in northern Ghana. The main goal of Ghana's national health programs is improving the health and nutrition status of children (ICF Macro, 2010). The majority of child malnutrition programs have been initiated by development partners such as United States Agency of International Development (USAID), UNICEF, and World Food Programme.

Child malnutrition is a result of inadequate food intake and improper treatment of illness. It is commonly measured by using three anthropometric indicators of stunting, wasting, and underweight. A child is considered stunted if their height-for-age is more than two standard deviations below the median of an international reference population. Stunting is an indicator of chronic deficiency, and this malnutrition affects cognitive and physical development and its effects are usually permanent. A child is considered to be wasted if their weight-for-height is more than two standard deviations below the median of the international reference population. Wasting is an indicator of acute undernutrition, and its affect can be fatal. Underweight is a composite measure of both chronic and acute undernutrition (Gillespie and McNeill, 1994; Arnold et al., 2003). Malnourished children face a higher risk of mortality than well-nourished children (ICF Macro, 2010).

The purpose of this paper is to improve the understanding of the complexity and the magnitude of the issue of child malnutrition in northern Ghana by examining the changes in prevalence of child malnutrition over time. Assessing trends in child malnutrition levels will provide insights into the effectiveness of the implemented programs and will assist policy makers and program managers in the design and implementation of new programs that target most vulnerable groups. Even though most individual programs have impact evaluation component as part of their respective projects, these evaluations can only provide a snapshot over the duration of their project or focus area and do not provide a complete view of the changes in child malnutrition over a longer period of time. Thus, the objective of this paper is to conduct a comprehensive longitudinal analysis of child malnutrition trends in Ghana using nationally representative data from Ghana Demographic and Health Surveys (DHS) 1988-2008. More specifically, this study will investigate the factors that influence child malnutrition in Ghana and how these determinants have changed over twenty year period.

The paper is divided into five sections. The second section provides a description of the econometric method and the DHS 1988-2008 data. Following this, section three presents the results from the analyses, and section four provides a discussion of the notable findings and their implications for policy choices and assistance programs aimed to combat child malnutrition. Final section presents conclusions and unresolved issues.

Methods

Conceptual framework

To measure the trends in child malnutrition, a series of discreet choice models is estimated controlling for important socioeconomic, demographic, and behavioral factors. The models for each of the three nutritional states (underweight, wasted, and stunted) are developed using a forward selection like approach. A child's *(i)* nutritional status *(H)* is assumed to be a function of two dimensions associated with the child and his care giver: socio-economic *(SE)* and behavioral *(B)*. The socio-economic dimension includes exogenous factors *(θ)* like child's gender and socio-economic factors *(σ)* like mother's education. The behavioral dimension is determined by the birth mother's and care givers behaviors *(α)* that include prenatal care and delivery care and health promoting behaviors and progressive household characteristics *(δ)*, such as breastfeeding and access to clean drinking water. Nutritional status *(H)* is measured by three independent antrhroprometic measures: weight-for-age (underweight), height-for-age (stunted) and weight-for-height (wasted).

$$H_i = f(SE(\theta, \sigma), B(\alpha, \delta)) \qquad (1)$$

Suppose that the health status, H_i, is a linear function of K factors whose values, for child i, are X_{ik}, $k = 1, \ldots, K$, then the structural model is as follows:

$$\begin{aligned} H_i &= \sum_{k=1}^{K} \beta_k X_{ik} + \varepsilon_i \\ &= Z_i + \varepsilon_i \end{aligned} \qquad (2)$$

Where β_k is the coefficient associated with the k^{th} variable, $Z_i = \sum_{k=1}^{K} \beta_k X_{ik}$, and ε_i is the error term. The error term, ε_i , is assumed to have a standard logistic distribution with a mean of zero and a variance of $\pi^2/3$. H_i is the latent variable or the unobserved dependent variable. The observed binary Y_i is related to the unobserved dependent variable, H_i, based on the following measurement model:

$$\begin{aligned} Y_i &= 1, \ if \ H_i > 0 \\ Y_i &= 0, \ if \ H_i \le 0 \end{aligned} \qquad (3)$$

If y_i =1, then child *i* is malnourished , i.e., wasted, stunted, underweight; and is y_i =0 if he is not. The probability of observing an outcome is:

$$\Pr\left[y_i = 1 | x\right] = \frac{\exp(\alpha + \beta x)}{1 + \exp(\alpha + \beta x)} \quad (4)$$

The analysis is conducted for each of the three nutritional states: underweight, stunted, and wasted. The same model for each of the nutritional states is estimated using data from the five DHS surveys to determine if the factors affecting a child's nutritional status are consistent over the 20 years covered by the DHS surveys or if they have changed. A comparison analysis using t-tests is conducted to determine if prevalence rates for the three nutritional states have changed over the 20 years.

Data

The study uses data gathered from the five rounds of the Ghana Demographic and Health Surveys (DHS). DHS is a nationally representative, large scale survey. These surveys are part of the DHS program that was established in 1984 by the USAID. Surveys are conducted in overlapping five-year phases and have been implemented in approximately 70 countries. The objective of the multiple DHS surveys is to establish trend data that enable decision makers to measure the progress of programs in their programs being implemented in their respective areas. In Ghana, the first DHS survey was conducted in 1988, followed by subsequent surveys in 1993, 1998, 2003, and most recently in 2008. The Ghana Statistical Services provides the support for the implementation of the DHS in Ghana. Each survey is conducted using a stratified and self-weighting sample of households in which all eligible women 15 to 49 years are interviewed.

In the 1998 survey, interviews were completed for 4,406 households with 4,488 women interviewed. In the 1993 Ghana DHS survey, the number of households and women interviewed increased to 5,822 and 4,562 respectively. Compared to the previous surveys, the 1998 DHS survey had some slight changes to its design. The population in the three northern regions (Northern, Upper East, and Upper West) is relatively smaller compared to the other seven regions. Oversampling of these three northern regions occurred to obtain adequate precise estimates associated with those regions. Sampling weights were developed to adjust for the unequal probability of selection of households in different regions. Also in the 1998 survey, men aged 15 to 59 in every third household sampled were eligible for interview. The total number of households interviewed was 6,003 with 4,843 women and 1,546 men interviewed. In the fourth survey of the series (2003), all men aged 15-59 were eligible for interview. Oversampling occurred in Brong Ahafo, Northern, Upper East, and Upper West to obtain adequate precision for estimates of indicators in those regions. Appropriate sampling weights were developed to adjust for oversampling. Overall, interviews were completed for 6,251 households and a total of 5,691 women aged 15-49 and 5,015 men were interviewed. In the 2008 survey, no oversampling in the northern region occurred. Similar to the 2003 survey, all women aged 15-49 and all men aged 15-59 were eligible for interview. In total, 12,323 households were interviewed and 4,916 women and 4,568 men were interviewed.

Variables

Nutritional status is used as an objective indicator of children's overall health and well-being (ICF Macro, 2010). Following previous literature, a range of socio-demographic characteristics are used as control variables in the analysis. These variables include: sex of child, age of child, birth order, breastfeeding status, mother's age at birth, maternal and paternal education, ante-natal care, household size, particularly the number of young dependents present in the household, and household characteristics such as electricity and availability of clean drinking water.

The nutritional status of children is assessed using anthropometric measures of weight-for-age (underweight), weight-for-height (wasted), and height-for-age (stunted). These measures are determined using the new World Health Organization (WHO) child growth reference standards. The 1988, 1993 and 1998 surveys restricted the anthropometric measurements to only the children born to the women interviewed in the survey, and thus do not provide representation of all the children in the households. The women interviewed in the surveys are aged 15 to 50 years old, and the anthropometric measurements are for children aged zero to 59 months. In the 2003 and 2008 surveys, height and weight measurements are collected from all of the children aged 59 months or younger living in the household, regardless of their mother's presence or age. The 1988, 1993 and 1998 surveys restricted the anthropometric measurements to only the children born to the women interviewed in the survey, and thus do not provide representation of all the children in the households. The women interviewed in the surveys are aged 15 to 50 years old, and the anthropometric measurements are for children aged zero to 59 months. In the 2003 and 2008 surveys, height and weight measurements are collected from all of the children aged 59 months or younger living in the household, regardless of their mother's presence or age.

Two other important control variables are breastfeeding and education. The WHO recommends that a child been exclusively breastfed for the first six months of life and recommends that breastfeeding continues up to two years of age with nutritional adequate and safe complementary foods. Exclusive breastfeeding for the first six months is an integral part for a child to achieve optimal growth, development, and health (WHO, 2001).

The research has shown that education is one of the most important factors affecting woman's health status and the health status of her children. Education, especially for women, is closely associated with fertility, use of contraception, and the health status of children (ICF Macro, 2010). There have been marked improvements in educational levels obtained by Ghana's overall population. Since Ghana's independence in 1957, more women and children have taken advantage of the opportunities to attend school than before independence. By 2008, the proportion of men who attended school had reached 78 percent, while the proportion of women attending school had reached the highest level ever reported of 69 percent. The percentage of women age 15–49 with no education has significantly reduced, from 40 percent in 1988 to 21 percent in 2008; however, there has only been a slight increase in the proportion with primary schooling over the same time period, from 16 to 20 percent. Women has experienced substantial increases in education obtainment at the Junior Secondary School (JSS) or middle school level and at the secondary school or higher levels. The proportion of women with JSS or middle school education has increased from 37 percent in 1988 to 45 percent in 2008, and the proportion of women with a secondary school or higher education level increased from 8 to 14 percent during the same time period (ICF Macro, 2010).

The analysis will allow examining the effect of these changes in education on health and nutritional status of children. Education has positive correlation with antenatal care and the care provided by medically trained professionals. A mother with some education is more likely to receive some type of antenatal care, and she is more likely to have a doctor provide the care she receives. In 2008, half of women with secondary education or higher received antenatal care from a nurse or midwife, and 48 percent received the care from a doctor. Between 1988 and 2008, there has been a general shift towards the use of nurse or midwife to provide antenatal care services instead of a doctor (ICF Macro, 2010).

The ability of mothers to use maternity care services, such as antenatal and delivery care, is another important factor affecting the overall survival chances of children (WHO, 2005). Not only are there health benefits for the child, but the mother also receives significant health benefits from the use of health services professional medical treatment (Shah and Say, 2007). Another example is access to timely vaccination such as tetanus vaccination given to a mother during pregnancy to prevent tetanus infection for her and her unborn child. The antibodies in the vaccination are passively transferred to the unborn child via the mother, and can protect the child even after birth for a few months. The tetanus vaccination has also been found to help prevent premature delivery (CDC, 2013).

Lastly, a set of household characteristics is used to control for the effect of a household's standard of living, which can have implications for maternal and child health. Such characteristics include access to sanitary toilet facilities, access to electricity and access to clean drinking water (ICF Macro, 2010).

Analysis

The analysis consists of two main parts. First part involves estimation of three separate models to assess the effects of socio-economic and behavioral factors on the likelihood of a child being underweight, wasted, and stunted respectively. The effect of each variable is estimated separately for each of the five points of observation over twenty year period (1988, 1993, 1998, 2003, and 2008). In the second part of the analysis, these effects are compared both across measures of malnutrition and across time. Appropriate sample weights are used to adjust for the survey design and oversampling for each survey data. It is expected that the direction and the magnitude of the effect of different variables will vary across three measures of nutrition.

The socio-economic variables included in the underweight models are child's age in months, gender of the child, number of children living in the household under the age of five, whether the child is a member of a multiple birth or not, i.e., a twin, the preceding birth interval, which is the difference in the months between the child and the closet sibling older than him, and mother's age in years. The behavioral variables included in the model are whether the mother received a tetanus injection during her pregnancy, whether the mother received prenatal care from a medically trained care giver, e.g., doctor, nurse or midwife, prior to the birth of the child, whether the mother received assistance from a medically trained care giver during delivery of the child, and the number of months the child is breastfed.

The socio-economic variables included in the wasted models are child's age represented in six age groups (0-5 months, 6-11 months, 12-23 months, 24-35 months, 36-47 months and 48-60 months), gender of the child, number of children living in the household under the age of 5, whether the child is a member of a multiple birth or not, i.e., a twin, and mother's education level. The behavioral variables included in the model are whether the mother received a tetanus injection during her pregnancy, whether the mother received prenatal care from a medically trained care giver, e.g., doctor, nurse or midwife, prior to the birth of the child, and the number of months the child is breastfed.

The socio-economic variables included in the stunted model for each survey are child's age in months, gender of the child, mother's educational level, father's highest education level, and mother's age at birth in years. The behavioral variables included in the model are whether the mother received prenatal care from a medically trained care giver, e.g., doctor, nurse or midwife, prior to the birth of the child, whether the mother received assistance from a medically trained care giver during delivery of the child, and the number of months the child is breastfed. Access to drinking water from a man-made source, e.g., piped in water, protected well, or water from a tanker, is also included in the model.

Results

The results from the logistic regressions assessing the likelihood of underweight children, wasted children, and stunted children are presented in Table 1, Table 2, and Table 3 respectively. Estimates of effects on the likelihood of underweight children indicate that the duration of breastfeeding n the model applied to 1988 data, the duration of breastfeeding and mother's age were variables that influenced the underweight status of children under five years. These variables are significant at the 10 percent level.

Table 1: Estimates from Underweight Logit Model for the Five Survey Rounds

Children Malnutrition: Underweight	DHS Survey Round				
	1988	1993	1998	2003	2008
Independent Variables					
Child Gender	0.2880	-0.3418*	-0.1036	-0.2909	-0.6769**
	(0.2911)	(0.1834)	(0.2111)	(0.1895)	(0.3262)
Child Age (months)	-0.0031	-0.1009***	-0.0039	-0.0114	-0.0178
	(0.0345)	(0.0359)	(0.0074)	(0.0115)	(0.0135)
Multiple Birth	-0.0074	0.6347	0.3520	0.5139	1.0147***
	(0.6287)	(0.4927)	(0.3055)	(0.3181)	(0.3077)
Birth Interval	-0.0120	-0.0032	-0.0076	-0.0007	0.0099
	(0.0068)	(0.0087)	(0.0053)	(0.0055)	(0.0068)
Mother's Age	-0.0534*	0.0042	0.0217	0.0063	-0.0010
	(0.0256)	(0.0210)	(0.0176)	(0.0161)	(0.0234)
Number of Kids Under 5 yrs	0.0666	0.0626	-0.0706	0.1066	-0.0347
	(0.0994)	(0.1299)	(0.0691)	(0.1319)	(0.1696)
Electricity in House	-0.3704	0.3347	-0.5971	-0.0002	-0.2842
	(0.5247)	(0.4688)	(0.4886)	(0.1063)	(0.3232)
Tetanus Vaccination	-0.2082	-0.0075	0.0436	-0.0891	0.1475
	(0.3431)	(0.1168)	(0.0790)	(0.1034)	(0.1032)
Prenatal Care By Medical Professional	0.4094	-0.8388**	-0.2548	-0.1521	-0.6068
	(0.3003)	(0.3757)	(0.2429)	(0.3451)	(0.6286)
Delivery Care By Medical Professional	0.0431	0.3117	0.1537	-0.3877*	-0.4895*
	(0.3966)	(0.3272)	(0.1888)	(0.2134)	(0.2841)
Breastfeeding Duration (months)	0.0762*	0.1714***	0.0139	0.0168	0.0357*
	(0.0390)	(0.0422)	(0.0086)	(0.0136)	(0.0188)
Constant	-0.4040	-0.5435	-1.1173	-0.5928	-0.4231
	(0.8191)	(0.8638)	(0.7998)	(0.7644)	(1.1076)
Number of Observations	201	343	684	612	459
F-test	29.72	3.35	1.1500	1.36	2.12
Prob>F	0.0088	0.0039	0.3409	0.2156	0.0810

*,**, and *** represents the significance at the 10, 5, and 1 percent level. Standard errors are presented in the parentheses.

Breastfeeding has a positive influence on being underweight and mother's age has a negative effect on being underweight. In the second survey, breastfeeding is once again a positive, significant variable; it is significant at the 1 percent level. A child's age is also significant at the 1 percent level, while gender is significant at the 10 percent level. Having a prenatal visit with someone who is medically trained is significant at the 5 percent level. Age of the child, being male, and a prenatal visit with a medically trained care giver have a negative effect of being underweight. None of the same variables were statistically significant in the model analyzing the 1998 survey data. With the 2003 survey data, only one variable is significant: having a person with medical training assist with the delivery. This variable is significant at the 10 percent level. In the fifth model using the 2008 survey data, gender and being a part of a multiple birth have negative and significant effects on being underweight. These variables are significant at the 5 percent level. Having a medically trained person assist with the delivery and the duration of breastfeeding are both significant at the 10 percent level. Breastfeeding has a positive impact on being underweight and having someone with medical experience present at the birth has a negative impact on being underweight. Overall, breastfeeding seems to have a consistently positive impact on being underweight. This may be attributed to the child not receiving any other complementary foods in their diet. It is recommended that children are exclusively breastfed for the first six months of life but after that time period, it is recommended to introduce some complementary foods into a child's diet to ensure that they are receive the caloric intake and sufficient micronutrients to support growth and development (WHO, 2001).

Estimates of effects on the likelihood of wasted children (Table 2.) indicate that gender, the number of children under five in the household, and being a part of a multiple birth are significant variables in the model using the 1988 data. The number of kids and being a twin or multiple has a positive impact on being wasted and being male has a negative impact. No variables had a significant impact on wasting the second model analyzing the 1993 data. With the 1998 data, the age of the child and having the mother receive a tetanus shot while pregnant have a negative, significant impact on wasting. These variables are significant at the 5 percent level. In the model with the 2003 data, the age of the child has a negative and significant influence on wasting at the 1 percent level. In the final model with 2008 data, the age of the child has, once again, a negative and significant impact on wasting. Father's education level also has a negative, significant effect on wasting. Being a twin or multiple and having a mother receive a tetanus shot during pregnancy has a positive and significant impact on wasting at the 10 percent level. The age of the child is one of the more consistent factors associated with wasting in this analysis.

Table 2: Estimates from Wasted Logit Model for the Five Survey Rounds

Children Malnutrition: Wasted	DHS Survey Rounds				
	1988	1993	1998	2003	2008
Independent Variables					
Child Gender	-0.8447**	-0.1421	-0.4371	0.0244	0.1726
	(0.3950)	(0.2907)	(0.2674)	(0.2537)	(0.2930)
Children Age Group	-0.2769	-0.1636	-0.3761***	-0.5048***	-0.5129***
	(0.2142)	(0.2060)	(0.0953)	(0.1082)	(0.1054)
Multiple Birth	0.6440	0.0000	0.3946	-0.1511	0.5940*
	(0.3676)	-	(0.3939)	(0.4123)	(0.3413)
Mother's Education	-0.0407	-0.1113	0.2201	0.0171	-0.2692
	(0.5808)	(0.2989)	(0.2245)	(0.2659)	(0.2422)
Father's Education	0.3393	0.0070	0.0268	-0.0399	-0.2165**
	(0.3278)	(0.1319)	(0.0697)	(0.0629)	(0.0982)
Number of Kids Under 5 yrs	0.3158**	0.0474	0.0595	-0.1010	-0.2869
	(0.1185)	(0.0788)	(0.0845)	(0.1862)	(0.1964)
Tetanus Vaccination	0.3203	0.1195	-0.2513**	0.0587	0.1963*
	(0.5311)	(0.1282)	(0.1214)	(0.1019)	(0.1072)
Prenatal Care By Medical Professional	-0.2501	-0.4406	0.3768	0.0605	0.0466
	(0.4965)	(0.3955)	(0.3412)	(0.3878)	(0.7585)
Breastfeeding Duration (months)	-0.0259	0.0093	-0.0113	0.0144	0.0155
	(0.0247)	(0.0278)	(0.0131)	(0.0115)	(0.0110)
Constant	-0.9370	-0.6909	-0.2233	-0.6990	-0.2016
	(0.6351)	(0.5355)	(0.6275)	(0.7289)	(1.1246)
Number of Observations	235	390	807	717	538
F-test	3.67	0.64	4.93	3.63	3.77
Prob>F	0.0832	0.7391	0.0001	0.0010	0.0005

*,**, and *** represents the significance level at the 10, 5, and 1 percent level.

Standard errors are represented in the parentheses.

Estimates of effects on the likelihood of stunted children (Table 3.) indicate that the age of the child and the duration of breastfeeding is significant at the 1 and 5 percent level, respectively. Both variables have a positive impact on stunting in 1988. With the 1993 data, breastfeeding once again has a significant positive effect on stunting. Being male has a negative and significant effect on stunting. The mother's education level and her age at birth also have negative and significant impact on stunting. In the model with the 1998 data, child's age and breastfeeding have a positive, significant impact on stunting. Father's education level has significant and negative effect on stunting.

Table 3: Estimates from Stunted Logit Model for the Five Survey Rounds

Children Malnutrition: Stunted	DHS Survey Rounds				
	1998	1993	1998	2003	2008
Independent Variables					
Child Gender	-0.3680	-0.4121**	-0.2171	-0.7218***	-0.2983
	0.2253	0.1910	0.1696	0.1698	0.2376
Child Age (months)	0.0544***	-0.0337	0.0256***	-0.0096	0.0151
	0.0158	0.0272	0.0057	0.0200	0.0125
Mother's Age at Child's Birth	-0.0201	-0.0315**	-0.0121	-0.0237**	-0.0158
	0.0229	0.0147	0.0115	0.0118	0.0150
Mother's Education	-0.4562	-0.4360*	0.2057	-0.2060	0.2521
	0.3485	0.2431	0.1507	0.2054	0.1895
Father's Education	-0.1456	-0.1030	-0.1240**	-0.0820	-0.0160
	0.3210	0.1302	0.0558	0.0695	0.0713
Source of Drinking Water	-0.3783	-0.4470	-0.2761	-0.7822***	-0.1038
	0.3032	0.2911	0.1897	0.2408	0.3960
Prenatal Care By Medical Professional	0.2180	-0.3764	-0.1771	-0.2109	-0.2558
	0.3576	0.2685	0.1623	0.2364	0.5068
Delivery Care By Medical Professional	-0.0601	0.2869	0.1916	-0.0774	-0.3499
	0.3448	0.2365	0.1712	0.3206	0.2641
Breastfeeding Duration (months)	0.0561**	0.1420***	0.0217**	0.0544	0.0380
	0.0243	0.0316	0.0100	0.0348	0.0242
Constant	-0.7054	0.1095	-0.5353	1.7353***	-0.5939
	1.1135	0.5324	0.5302	0.5536	0.7654
Number of Observations	236	395	809	709	539
F-test	11.60	13.11	7.83	6.93	4.22
Prob>F	0.0074	0.0000	0.0000	0.0000	0.0002

*,**, and *** represents the significance level at the 10, 5, and 1 percent level.

Standard errors are represented in the parentheses.

Using the 2003 data, the model has three significant variables: gender, mother's age at birth, and source of drinking water. Being a male has a negative impact on stunting and mother's age at birth has a similar effect on stunting. Having drinking water come from a man-made source has a negative effect on stunting. In the final model with 2008 data, none of the variables are statistically significant.

Table 4 provides the prevalence rates and standard errors for each of the three nutritional states in each of the five survey periods. A comparison between the prevalence rates for each of the three nutritional states was conducted using t-tests to determine if the rates are statistically different across the survey periods. Shared alphabetic letters among the prevalence rates represent statistical difference at the 5 percent level between the prevalence rates across the survey periods. For instance, the prevalence rate for underweight children in the DHS 1988 survey round was 35.44 percent, which is statistically different from the prevalence rate estimated from the DHS 2008 survey (20.94 percent).

Table 4: Comparison of Prevalence Rates of Underweight, Wasted, and Stunted Children 5 years or Younger in northern Ghana for the Five Rounds of Ghana DHS Survey (1988-2008)

	Underweight (Weight-for-Age)				Wasted (Weight-for-Height)				Stunted (Height-for-Age)			
	Mean	Std. Error	N	Code	Mean	Std. Error	N	Code	Mean	Std. Error	N	Code
1988	35.44%	0.03	237	a	9.70%	0.02	237	g	48.74%	0.04	238	k,l
1993	36.59%	0.02	399	b,c,d	21.55%	0.02	399	g,h,i,j	39.10%	0.03	399	k,m
1998	28.57%	0.02	841	b,e	10.29%	0.01	832	h	42.72%	0.02	834	n
2003	28.74%	0.02	986	c,f	9.86%	0.01	985	i	48.22%	0.02	986	m,o
2008	20.94%	0.02	785	a,d,e,f	13.44%	0.01	777	j	31.92%	0.02	785	l,n,o

The prevalence rate for wasted children in the 1993 survey round is statistically different from the rates estimated in other four survey rounds. Apart from the 1993 survey, the prevalence rates for children in the three northern regions (Northern, Upper East and Upper West) are not statistically different. In regards to the underweight and stunted prevalence rates, there is statistical difference between multiple survey rounds. The 2008 underweight prevalence rate (20.94 percent) is statistically different from the underweight prevalence rates in the other four surveys. In addition to being different from the underweight prevalence rate in the 2008 survey, the prevalence rate from the 1993 survey is statistically different from 1998 survey (28.57 percent) and 2003 survey (28.74 percent). For the stunted prevalence rates, the 2008 survey rate (31.92 percent) is statistically different from three of the other survey rounds: 1988 survey (48.74 percent), 1998 survey (42.72 percent), and 2003 survey (48.22 percent).

Conclusion

This paper examines the changes in prevalence of child malnutrition over time in northern Ghana. The findings have a potential to contribute useful insights on magnitude and dynamics of child malnutrition that will assist policy makers and program managers in the design and implementation of more effective programs. The methods are based on a comprehensive longitudinal analysis of child malnutrition trends in Ghana using nationally representative data from Ghana Demographic and Health Surveys (DHS) 1988-2008. It investigates various factors that have influenced child malnutrition in Ghana and how these factors have changed over a twenty year period. The main results indicate that mother's education, prenatal care, breastfeeding practices, as well as access to clean drinking water and sanitation have significant effect on child malnutrition prevalence.

Although it is expected that the prevalence of child malnutrition will decrease over time, it is also expected that the disparity between northern Ghana and the Greater Accra Area with respect to child malnutrition will be more pronounced over time. Even though most individual programs have impact evaluation component as part of their respective projects, these evaluations can only provide a snapshot over the duration of their project or focus area and do not provide a complete view of the changes in child malnutrition over a extended period of time. An important contribution of this paper is that it provides a more in-depth longitudinal study of the magnitude and dynamics of child malnutrition in Ghana which can become a useful platform for further research to gain insight on ways to improve children's well-being.

References

Arnold, F., P. Nangia and U. Kapila. "Indicators of Nutrition for Women and Children in India: Current Status and Programme Recommendations." Paper presented at workshop on National Family Health Survey, Centre for Economic and Social Studies, Hyderabad, 2003.

(CDC) Centers for Disease Control and Prevention. Updated recommendations for use of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (Tdap) in pregnant women - Advisory Committee on Immunization Practices (ACIP), 2012. Morbidity and *Mortality Weekly Report (MMWR)*. 62 (2013):131-5.

Ghanaian Statistical Service and Institute for Resource Development. Ghana Demographic and Health Survey 1988. Accra, Ghana: Ghana Statistical Services; Columbia, Md.: Institute for Resource Development/Macro Systems, Inc, 1989.

Ghana Statistical Service (GSS) and Macro International Inc. (MI). Ghana Demographic and Health Survey 1993. Calverton, Maryland: GSS and MI. Ghana, 1994.

Ghana Statistical Service (GSS), Macro International Inc: Ghana Demographic and Health Survey 1998. Calverton, Maryland: GSS and MI. Ghana, 1999.

Ghana Statistical Service (GSS), and Noguchi Memorial Institute of Medical Research ORC Macro. Ghana Demographic and Health Survey 2003. Calverton, Maryland: GSS, NMIMR, and ORC Macro. Ghana, 2004.

Ghana Statistical Service (GSS) and Ghana Health Service (GHS). Demographic and Health Survey 2008. Ghana: Accra, Ghana: GSS, GHS, and ICF Macro, 2009.

Gillespie, S. and G. McNeill. *Food Health and Survival in India and Developing Countries*, Oxford University Press, 1994.

ICF Macro. *Trends in Demographic, Family Planning, and Health Indicators in Ghana, 1960-2008*: *Trend Analysis of Demographic and Health Surveys Data.* Calverton, Maryland, USA: ICF Macro, 2010.

Shah, I. H., and L. Say. "Maternal Mortality and Maternity Care from 1990 to 2005: Uneven but Important Gains." *Reproductive Health Matters*. 15(2007):17-27.

(UNICEF) United Nations Children's Fund. *The State of the World's Children 2007: Women and Children- The Double Dividend of Gender Equality.* New York, NY, 2006.

(WHO) World Health Organization. *Global strategy for infant and young child feeding: the optimal duration of exclusive breast-feeding*. Fifty-Fourth World Health Assembly. Document A54/INF.DOC./4, Geneva, 2001.

___. World health report 2005: Make every mother and child count. Geneva, 2005.