Original Article

A New Avenue for Understanding the Nutritional Status of Children in Guinea

Dorothée Boccanfuso[a] and Ohiniba Bruce[b]

[a]Département d'économique et chercheure au GRÉDI, Université de Sherbrooke, 2500, boulevard de l'Université, Sherbrooke, Québec, Canada.
[b]Chercheure au GRÉDI, Université de Sherbrooke, 2500, boulevard de l'Université, Sherbrooke, Québec, Canada.

Abstract Despite notable progress, under-5 mortality remains a major issue in developing countries. Malnutrition continues to be a serious problem, and its reduction remains the primary target of health policies developed in many countries and organizations. In Guinea, contrary to other African countries, the rate of stunting for children under 5 years of age has increased between 1999 and 2005. To be able to recommend policies to improve the nutritional status of Guinean children, we used an approach to decompose the nutritional status gap of Guinean children that was observed into the effects of changes in the means of the determinants of nutritional status and changes in the effects of the determinants of nutritional status. The results indicate that, regardless of the health indicator considered, the aggregate effect of the coefficients is substantially stronger than that of the characteristics. With this study, we further explain the health status of children.

Malgré les progrès notables de la médecine, la mortalité infanto-juvénile reste un enjeu majeur dans les pays en développement. L'une des principales causes de cette mortalité, la malnutrition, reste un fléau important et sa réduction demeure la cible principale de nombreuses politiques en matière de santé, développées dans plusieurs pays et organisations internationales. En Guinée, contrairement à certains pays africains, les taux de retard de croissance des enfants de moins de 5 ans ainsi que celui de l'insuffisance pondérale ont augmenté entre 1999 et 2005. Afin de recommander des politiques visant à contribuer à l'amélioration de l'état nutritionnel des enfants guinéens, nous décomposons l'écart de l'état nutritionnel des enfants guinéens observé entre 1999 et 2005 en l'effet détaillé de ses caractéristiques et celui des coefficients des caractéristiques. Les résultats montrent que quelque soit l'indicateur de santé considéré, l'effet agrégé des coefficients l'emporte significativement sur celui des caractéristiques.

European Journal of Development Research (2013) **25,** 714–736. doi:10.1057/ejdr.2013.19; published online 4 July 2013

Keywords: health; children; anthropometric indicators; Millennium Development Goals; Guinea

Introduction

Despite notable medical progress, infant–juvenile mortality remains a major issue in developing countries. Malnutrition has been identified as one of the main causes of increased child mortality rates, which makes it a serious problem (Horton, 1988; Van Den Broeck *et al*, 1993; Pelletier *et al*, 1995 and Rice *et al*, 2000). According to the World Health Organization (WHO), malnutrition mainly refers to poor nutrition characterized by insufficient or excessive intake of proteins, energy and micronutrients. Reducing malnutrition remains a priority for health policies implemented in many countries and international organizations. Indeed, in many regional conferences and workshops organized by international institutions[1], the Millennium Development Goals (MDG) and the Poverty Reduction Strategy Papers (PRSP) of developing countries, reducing malnutrition is a top priority. Despite the commendable efforts of these institutions and the political will of leaders in developed and developing countries, objectives concerning the reduction of malnutrition have not yet been reached.

The situation is very worrisome in Guinea. Between 1999 and 2005, the growth retardation rate of children under 5 years of age in the country increased from 26 to 35 per cent, and the underweight rate from 23 to 26 per cent, representing an increase of roughly 35 per cent and 13 per cent, respectively, in the number of children suffering from stunting and underweight (Direction Nationale de la Statistique (DNS) et ORC Macro (2006)). This situation compelled country authorities to establish two major objectives in the PRSP2 of 2007: (i) reduce the prevalence of stunting among children under 5 years of age from 35 per cent in 2005 to 18 per cent in 2010 and to 13 per cent in 2015; and (ii) reduce the infant–juvenile mortality rate from 130 per cent in 2005 to 90 per cent in 2010 and to 63 per cent in 2015.

A number of studies have been conducted to determine the factors accounting for the nutritional status of children under 5 years of age; however, very few of them have examined the nutritional status of children in Guinea. In choosing relevant policies, we must emphasize the importance of knowing the economic, social and political determinants of the evolution of the nutritional status of Guinean children. The studies very often limit themselves to determining the factors explaining the nutritional status of children over a given period of time (Horton, 1988; Strauss *et al*, 1996; Glewwe, 1999; Haddad *et al*, 2003) or to comparing the nutritional status of children between two areas of residence, two groups of individuals or two periods of time (Badji and Boccanfuso, 2006).

Wagstaff *et al* (2003) went further by proposing a method for decomposing inequalities in the health status of Vietnamese children. Our study runs along similar lines. Similar to the study by Wagstaff *et al* (2003), we sought to ascertain how the gap in the average nutritional status of Guinean children under 5 years of age (as observed between 1999 and 2005) is decomposed; this nutritional status is represented by long-term indicators, that is, *height-for-age z*-score, and by general indicators, that is, *weight-for-age z*-score[2] . The major contribution of our work is that it not only allows for the identification of the determinants of the health status of Guinean children in 1999 and 2005 – and hence the evaluation of its evolution – but also the decomposition into the detailed effect of changes in means in the determinants and the detailed effect of changes in the impact of these determinants on each indicator considered. This decomposition will help us identify the factors that contributed the most to the deterioration observed over the course of the study period and the individual contribution of each factor.

In light of this context, our research is split into five sections. The first presents a brief literature review of analyses on the determinants of children's health. The second sets out our data and variables. The third introduces our methodology. The fourth presents the results obtained, and the fifth our concluding remarks.

Literature Review

Malnutrition has often been considered a result of a combination of structural and situational factors determining the availability, accessibility and use of food (Latham, 2001; Holmes *et al*, 2008; FAO, 2005). These authors assume that an element essential to the prevention of malnutrition within a community is its access to sufficient food to meet the nutritional needs of all its members. In order to have sufficient access to food, adequate food production or sufficient funds at the national, local and family levels to be able to purchase sufficient food are required. Nevertheless, food availability is only one aspect of the problem, and children who eat enough to satisfy their immediate hunger can still be malnourished. Similar to poverty, malnutrition can be considered a multidimensional phenomenon, and factors other than food availability can affect the nutritional status of children under 5 years of age (Tharakan and Suchindran, 1999;[3] Handa, 1999). Ignoring these factors may be very problematic.

In the literature, we observed that analysing the determinants of the nutritional status of children other than food-based contributions had been the subject of a multitude of studies favouring the analysis of the determinants of nutritional status at a given period. In a 1988 study on Filipino children, Horton emphasized that the age, sex and birth order of children were significantly correlated with their nutritional status and that the degree of correlation of these variables varied according to the use of a long- or short-term health indicator. On the basis of a study involving Brazilian children under 5 years of age, Duncan and Strauss (1992) found a significant link between the prices of certain products (dairy products, cereals, meat, fish and sugar) and child height. Strauss *et al* (1996) studied the impact of the decrease in public expenditure on health infrastructure on the health of children under 12 years of age in the Ivory Coast. Their analysis showed that the impact of health personnel and infrastructure on the health of children under 12 years of age varies according to whether one considers the personnel and infrastructure assumed available or those that actually are. With regard to household characteristics, they also found that the height of older men and women in households is positively linked to the *height-per-age* of children, thus reflecting the influence of family and genetic background.

Handa (1999) estimated a function of nutritional status using the *height-for-age z*-score and found that the increase in education level of any woman, and of mothers in particular, has a positive impact on the health and nutritional status of children in Jamaica. It also showed that the father's presence in the household has a very significant positive impact on the height of children. In a Moroccan study, Glewwe (1999) demonstrated that, *inter alia*, a mother's health knowledge remains crucial to improving the health of her children. Duncan *et al* (1991) showed that, in Brazil, the mother's education has a significant impact on the height of children. Despite the recognized importance of these factors, the availability and treatment of information have also been found to have a critical role in the transmission of the advantages of education.

Morrison and Linskens (2000) conducted a comparative study of malnutrition factors for children under 5 years of age in 20 African countries. They found that the mother's access to various media has a positive impact on the health of her children, whereas polygamy has the opposite effect. Using data on Nigeria, Ukwuani and Suchindran (2003) studied the relation between the nutritional status of children under 5 years of age and women's occupation. First, they showed that the children's level of stunting increases when their mother does not take them with her to work and that a short breast-feeding period also increases the risk of child stunting; they also found that children with a Christian mother are less likely to suffer from growth retardation and stunting. Haddad *et al* (2003) observed that twins and children whose mother had been younger than 20 years at the time of the child's birth are more prone to poor nutritional status in Senegal. They also demonstrated that the presence of a health centre in the child's area of residence has a positive impact on health.

Others studied the determinants of child health based on a comparison of two groups of individuals, two areas of residence or two periods. Badji and Boccanfuso (2006), on the basis of a comparative study on the nutritional status in Senegal before and after the 1994 devaluation of the CFA franc, demonstrated that the age of the child, the educational level of the mother and the area of residence significantly explain the nutritional status of Senegalese children under 5 years of age. Lachaud (2004) used a spatial econometric approach to study the relation between various forms of malnutrition among children under 5 years of age and urbanization in Burkina Faso. His analysis revealed that urbanization is accompanied by a decrease in malnutrition among children;

however, a rise in malnutrition disparities was also seen between children of urbanized areas and those of non-urbanized areas.

Finally, others have gone further by using decomposition techniques to understand the determinants that best explain the inequality gap of children's nutritional status between two periods (Wagstaff *et al*, 2003). These authors decomposed the inequality gap in the health sector using a concentration index defined by Wagstaff *et al* (1991) and taken up by Kakwani *et al* (1997). They decomposed the inequalities observed in 1993 and 1998 into changes caused by the variation in inequalities in children's health in Vietnam in the determinants of the interest variable, changes caused by the variation in the averages of the determinants and finally changes caused by the variation of the effects of the determinants on the interest variable. This study provided the conceptual background for our study.

Data and Variables

Data

To understand the health evolution of Guinean children under 5 years of age, we used data taken from Demographic and health studies in Guinea from 1999 (DHSG-II) and 2005 (DHSG-III).[4] These survey-based studies were carried out between May and July 1999 and between February and June 2005[5] , respectively, and are representative at various levels (national, strata (urban and rural) and eight studied areas (Conakry and the country's seven regions)).

These data provide information on breast-feeding practices, the nutritional status of women and children under 5 years of age, infant mortality and the health of mothers and children. The first survey deals with 5090 households, comprising 6753 women aged 15–49 years and 1980 men aged 15–59 years. The 2005 survey deals with 6282 households, comprising 7954 women aged 15–49 years and 3174 men aged 15–59 years.

Finally, to ensure the representativeness of our two samples, we calculated the descriptive statistics by taking into account certain characteristics. The results confirm the representativeness of the two samples (cf. Table 1)

Health indicators and variables

A wide range of measurements can be used to evaluate the nutritional status of children.[6] Anthropometric measurements are most often used to estimate the nutritional status of a population. There are three main anthropometric measurements: *height-for-age*, *weight-for-age* and *weight-for-height* indices. The *height-for-age* index is one of malnutrition and helps to measure child stunting. Stunting is a good long-term indicator of the nutritional status of a population because it is not markedly affected by short-term factors such as the season in which data is collected, epidemics and recent political, economic and social changes. As for the w*eight-for-age* index, it helps to measure underweight, a general indicator of a population's health. Finally, the *weight-for-height* index measures a child's wasting. Wasting reflects a current situation that is not necessarily long-lasting, and is influenced by the season in which data is collected.

For this study, we used the *height-for-age* and *weight-for-age* indices to evaluate the health status of Guinean children. This choice is explained by the strong prevalence rate of the indicators of these indices, the consistency of the wasting prevalence rate (9 per cent in Guinea over the course of the 2 years) and their advantages in relation to each other. Moreover, although the

Table 1: Descriptive statistics

	haz				*waz*			
	1999		*2005*		*1999*		*2005*	
	Mean	*Standard deviation*	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*
	Continuous variables							
Haz/waz	−1.21	1.90	−1.45	2.08	−0.83	2.76	−1.04	1.43
Severe (*haz/waz*<-2)	−3.12	0.91	−3.29	1.10	−2.96	1.02	−2.90	0.79
Moderate (−2⩽−2 *haz/waz* ⩽−1)	−1.51	0.29	−1.47	0.29	−1.47	0.29	−1.45	0.29
Normal (*haz/waz*>-1)	0.54	1.36	0.52	1.63	0.37	3.27	0.07	0.94
Age of child (in month)	27.25	17.02	27.37	17.85	27.40	17.00	27.21	17.84
Age squared	1031.89	977.15	1067.61	1066.08	1039.67	978.44	1058.71	1062.37
Height of mother (in cm)	158.12	14.81	158.91	6.22	158.13	14.88	158.91	6.24
Size of household	9.32	4.95	8.71	4.44	9.33	4.94	8.70	4.44
Number of children under 5 years of age	2.44	14.81	2.36	1.28	2.45	1.34	2.36	1.28
Number of women	2.02	1.30	1.91	1.10	2.02	1.30	1.91	1.10
	Qualitative variables (shares in percentage)							
Gender: girl	47.56	—	49.5	—	47.7	—	49.3	—
Gender: boy	52.44	—	50.5	—	52.5	—	50.7	—
Twin child	3.4	—	4.84	—	3.43	—	4.82	—
Child had prior diarrhoea	21.69	—	16.14	—	21.67	—	16.44	—
Child had prior fever	44.12	—	35.35	—	44.12	—	35.98	—
Child had prior cough	28.61	—	25.55	—	28.55	—	25.55	—
Mother is married	92.48	—	92.77	—	92.59	—	92.88	—
Mother cannot read	93.4	—	93.39	—	93.39	—	93.17	—
Sanitation: yes	62.91	—	41.21	—	62.81	—	41.16	—
Electricity: yes	13.83	—	14.92	—	13.88	—	15.33	—
Safe water: yes	66.59	—	67.05	—	66.66	—	67.22	—
Household head is female	8.9	—	9.95	—	8.91	—	9.67	—
Area of residence: rural	74.11	—	77.75	—	74.13	—	77.48	—
Religion: Muslim	85.06	—	86.31	—	85.06	—	86.41	—
Religion: Christian	7.96	—	8.73	—	7.99	—	8.74	—
Soussou	18.93	—	18.53	—	18.91	—	18.58	—
Peulh	33.63	—	34.28	—	33.75	—	34.44	—
Malinke	30.92	—	31.01	—	30.84	—	30.99	—
Kissi	4.56	—	4.83	—	4.54	—	4.78	—
Toma	2.26	—	4.1	—	2.28	—	4.01	—
Guerze	8.45	—	6.32	—	8.42	—	6.29	—
Conakry	13.24	—	9.12	—	13.25	—	9.46	—
Central Guinea	20.47	—	15.8	—	20.54	—	15.89	—
Upper Guinea	18.93	—	25.88	—	18.8	—	25.69	—
Lower Guinea	21.21	—	25.66	—	21.29	—	25.53	—
Forest Guinea	26.13	—	23.54	—	26.03	—	23.42	—
Partner of mother is not educated	74.01	—	75.71	—	73.96	—	75.28	—

Sources: Calculations performed by authors using data from the DHSG-II and -III *weight-for-height* index should have been used in this analysis, we did not use it because of its dependence on the data collection season and because we did not dispose of a method allowing us to extract the seasonal impact.

Hence, each of the two previously cited indices can be expressed otherwise: by *z*-score, by percentage in relation to the median or by percentiles. In accordance with the recommendations of the WHO and National Center for Health Statistics (NCHS), we standardized the indices by using the median and standard deviation of an international reference standard for children of the same gender and age. We also used a reference threshold allowing for the various individual measurements to be converted into prevalence statistics. The threshold value of '−2 units of standard deviation' accepted as a universal reference was chosen as a delimitation to separate children who are malnourished from children who are not. In this work, we used the *height-for-age* and *weight-for-age* *z*-scores to represent the health status of each child. The following formula was used to calculate the *z*-score:

$$z_i = \frac{h_i^{x,y} - H^{x,y}}{\sigma^{x,y}} \quad (1)$$

where z_i is the *height-for-age* *z*-score (respectively *weight-for-age*) of child *i*; $h^{x,y}$ is the height in centimetres (respectively weight in kilograms) of child *i* of sex *x* and age *y*; $H^{x,y}$ is the median height in centimetres (respectively median weight in kilograms) for children of sex *x* and age *y* in the reference population; and $\sigma^{x,y}$ is the standard deviation of the height in centimetres (respectively weight in kilograms) for children of sex *x* and age *y* in the reference population.

To better explain how the nutritional status among Guinean children varies, we favoured a few variables present in both surveys considered; these include characteristics related to the child, to his/her mother and to the household in which he/she lives.

In terms of child characteristics, we introduced the *age* variable (in months) because children in developing countries are more likely to see their nutritional status deteriorate with age. Nevertheless, the child's immune system tends to strengthen at a certain age. To determine the age at which the immune system strengthens (or deteriorates), we, as in the study by Glewwe (1999), introduced the age squared. The choice of gender is included to ascertain its correlation to health. As for the number of months of breast-feeding, we retained this variable in light of the nature of maternal breast-feeding practices and the nutritional status of Guinean infants[7]. In addition, Haddad *et al* (2003) show that twins tend to be underweight. The introduction of the number of children born before the child considered also allows us to see the impact that a high number of births by the same mother (including both living and deceased children) might have on the health of the child considered (Morrison and Linskens, 2000). Finally, we took into account the sickness phases to find out whether having experienced diarrhoea, coughing or fever in the 2 weeks before the study might have an impact on the child's health. We should specify that in order to avoid the risk of endogeneity we excluded the sickness phases in the regression of the *weight-for-age* *z*-score. Indeed, an underweight child has a higher risk of contracting other infectious and respiratory diseases; a child who has experienced a period of respiratory and infectious diseases in the 2 weeks before the data collection has a higher chance of seeing his/her weight decrease in the short term (Latham, 2001). Given the lack of valid instruments for these variables, we chose to exclude them from the regression.

With regard to the characteristics of the mother, as in Strauss (1990) and Horton (1988), the height of the mother was introduced to ascertain genetic effects on the health of the children. The age of the mother at the time of her child's birth is a determining element as young mothers generally have higher risks of unfavourable results at childbirth or even when raising their baby (in terms of the baby being underweight or having a higher mortality risk) (Linnemayr *et al*, 2008).

Concerning this last variable and following Strauss (1990), we introduced a dichotomic variable with the value 1 when the mother was younger than 18 years at the time of birth. The choice of this age group is also justified by the fact that in Guinea, according to a United Nations estimate, between 1998 and 2007, more than half of the women between 20 and 24 years of age were married before the age of 18 and more than a third were already mothers at that age.[8] The mother's occupation was also considered, as certain types of employment do not give mothers sufficient time to give their child the attention required (Ukwuani and Suchindran, 2003). Finally, the literacy level as a determinant highlights the mother's ability to read, understand and become informed about children's health (Poder and He, 2010).

In terms of the characteristics of the household in which the child lives, the addition of the administrative region (Conakry, Upper Guinea, Lower Guinea, Central Guinea and Guinea Forest Region) and area of residence (rural and urban) helped to identify disparities between regions and areas of residence. Moreover, to take into account the cultural, ethnic and religious preferences in this country, we inserted dichotomic variables for the six main ethnic groups and for the two major religions (Muslim and Christian). Following Poder and He (2010), our model also includes the number of children under 5 years of age living in the same household and competing for maternal care. We also considered the household size and the number of women over 15 years of age living in the household as independent variables. To verify whether these last two variables are endogenous, we conducted the endogeneity test and found that only the number of women over 15 years of age is endogenous with respect to the *weight-for-age z*-score. Thus, unable to find a valid instrument for this variable, we removed it from the *weight-for-age z*-score regression[9]. We finally used the access to sanitation and safe water. Indeed, according to Charmarbagwala *et al* (2004), 'the provision of sanitation and drinking water is seen as an essential complement to the availability of food in preventing child malnutrition. Even if the food supply for children is sufficient, diarrhoea hampers the intake of calories and micro-nutrients and thereby prevents adequate nutritional outcomes and increase the likelihood of mortality. By reducing the risk of bacterial infections and diarrhoeal diseases, sanitation and clean water will indirectly contribute to a child's nutrition'. For all those reasons, we included a dummy variable for the access to sanitation and another one for access to safe water.

Methodology

Similar to the study by Wagstaff *et al* (2003), we used a decomposition method to answer three essential questions. The first concerns the determinants of the nutritional status of Guinean children in 1999 and 2005. This question is simply meant to determine the factors according to which the health of children varied in 1999 and 2005. This step is crucial insofar as it helps to identify the significant influential factors for at least 1 year in order to be able to select the factors to be used in the decomposition. The second question aims to explain the gap observed in the nutritional status between 1999 and 2005. We calculated the gap in the average nutritional status following the deterioration observed in the country. Finally, a third question helps to ascertain the reason for the existence of a nutritional status gap between 1999 and 2005, as well as the causes of this gap.

Decomposition

A number of decomposition methods were developed to explain the gap observed in the average of certain interest variables. Oaxaca (1973) was the first to use a decomposition method to explain the gap in the average wage between men and women in urban areas on the American labour market. He sought to provide a quantitative evaluation of the causes of the gap observed. Later in the same year, Blinder (1973) used the same method, this time to analyse the wage gap between Black men and White men and between White men and White women in the United States. Both authors aimed to explain the average wage gap observed between the two demographic groups according to two types of effects. These included the effect explained by the difference between the two groups in terms of characteristics and the one explained by the variation in the coefficients of these characteristics – that is, the variation in the impact each characteristic has on wage. The effects of characteristics thus provide the contribution of each factor when the coefficients of these characteristics remain fixed. The effect of coefficients expresses the contribution of the coefficients when the characteristics within each group are the same. There is therefore a question of discrimination in the context of the work conducted by Oaxaca (1973) and Blinder (1973). It is important to mention that the Blinder–Oaxaca decomposition method was the subject of numerous applications in several economic sectors very early on. This approach has been the most frequently used in recent decades to identify and quantify the underlying causes of differences between races or individuals of different genders observed on the labour market, in education and in many other areas. Still more recently, it has been used to explain the difference in the level of poverty and inequality (Booroah and Iyer, 2005; Biewen and Jenkins, 2005; Bhaumik *et al*, 2006; Adoho and Boccanfuso, 2007).

Nevertheless, few works have decomposed the health status of children. Based on a comparative study in Cameroon, Burkina Faso and Togo, Lachaud (2004) used the Oaxaca–Blinder decomposition to explain the variation in the growth retardation inequality of children in these countries. Using Vietnamese data, Wagstaff *et al* (2003) decomposed the inequality gap in children's health between 1993 and 1998 based on the *height-for-age z*-score into the effect of changes caused by the variation in inequalities in determinants, the effect of changes caused by the variation in the averages of the determinants and the effect of the variation of the impact of the determinants on the interest variable. The Blinder–Oaxaca decomposition was also used by Charasse-Pouélé and Fournier (2006) to decompose the difference in health status between South African Blacks and Whites into the effect because of socioeconomic inequalities and unexplained racial differences. The authors used a self-evaluative health indicator to measure the health level of individuals. O'Donnell *et al* (2008) used this decomposition method to explain the difference between poor malnourished children and non-poor malnourished children in Vietnam.

The Oaxaca–Blinder decomposition technique is very easy to apply insofar as it only requires a simple linear regression of the interest variable on the characteristics chosen; next, it uses the average of the estimate of the interest variable and that of the characteristics to proceed with the decomposition. Nevertheless, in the presence of qualitative explanatory variables such as occupation, area of residence or gender, we can no longer use the coefficients stemming from such a regression for decomposition directly. Jones (1983) was the first to point out this weakness in the decomposition proposed by Oaxaca and Blinder. Characterizing their application method as arbitrary and non-interpretable, he demonstrated that the contribution of a dichotomic variable varies on the reference group chosen. To respond to the criticism of Jones, Oaxaca and Ransom (1999) showed that, generally speaking, conventional decompositions do not allow for the identification of the contribution of nominal variables, as it is only possible to estimate the relative effect of a nominal variable. Hence, they emphasize that the detailed decomposition of the effect of coefficients necessarily suffers from an identification problem, given that the detailed effect of the coefficients attributed to the nominal variables varies on the choice of reference group. Gelbach (2002) notes that the problem is not related to the identification but rather to the heterogeneity of the population in estimating the parameters.

In 2000, Nielsen proposed a way to solve the identification problem posed by the Oaxaca–Blinder decomposition by transforming the effect of coefficients. He obtained the invariance of the detailed effect of coefficients; however, the transformation he obtained failed to distinguish the constant of the nominal variables. Moreover, the calculations leading to this transformation are fairly cumbersome when dealing with a set of nominal variables. Later in 2005, Yun (2005a) proposed a different approach consisting of transforming the normal equation stemming from the ordinary least squares (OLS) of Oaxaca–Blinder into an equation referred to as the 'normalized regression equation'. This equation is based on the one developed by Suits (1984) to address the problem concerning nominal variables in a linear regression. In this context, he deemed it necessary to impose a restriction on the coefficients estimated in the Oaxaca–Blinder regression. The method proposed by Yun (2005a) thus helps to solve the identification problem regarding the choice of reference groups in the Oaxaca–Blinder decomposition when trying to carry out a detailed decomposition.

The methodology favoured in our study is an application of the principle of decomposition set forth by Yun (2005a). It was conducted in two steps: first, we produced a linear regression model using the OLS of the *height-for-age* z-score and the *weight-for-age* z-score, respectively, of children on the characteristics considered, and second we proceeded with the decomposition.

We used a static approach to express the health status of Guinean children according to the characteristics considered for each year. Our linear model thus appears as follows:

$$z^t_{score_i} = \left(\alpha^t + \sum_{l=1}^{L} X^t_{il}\,\delta^t + \sum_{m=1}^{M} \sum_{k_m=2}^{Km} D^t_{imk_m}\,\beta^t_{mk_m} \right) \qquad (2)$$

where $z^t_{score_i}$ is the z-score attributed to individual i at time t (t=1999, 2005); X^t_{il} is the continuous variable l attributed to individual i at time t; D^t_{im} is a modality k of qualitative variable m at time t; $K_m$represents the number of modalities of qualitative variable m; α^t,δ^t and β^t, respectively, represent the constant at time t, the coefficient attributed to the continuous variables and the coefficient attributed to each modality of the qualitative variables.

A regression using OLS allowed us to estimate the various coefficients. In light of the equation of normalized regression proposed by Yun (2005a), equation (2) becomes:

$$z^{*t}_{score_i} = \left(\hat{\alpha}^{*t} + \sum_{l=1}^{L} X^t_{il}\,\hat{\delta}^{*t} + \sum_{m=1}^{M} \sum_{k_m=1}^{Km} D^t_{imk_m}\hat{\beta}^{*t}_{mk_m} \right) \qquad (3)$$

where $\hat{\alpha}^{*t} = \overset{\wedge}{\alpha}t + \sum_{m=1}^{M} \bar{\hat{\beta}}_m$, with $\bar{\hat{\beta}}_m$ being the average of the estimate of the coefficients of the modalities (including the coefficient of the modality omitted, which is here equal to 0) of the qualitative variable m. These coefficients are the ones obtained in the first step; $\hat{\delta}^{*t} = \hat{\delta}^t$ and $\hat{\beta}^{*t} = \hat{\beta}^t_{mk_m} - \bar{\hat{\beta}}_m$, k_m=1, …, K_m et m=1, …, M.

These normalized coefficients enabled us to decompose the gap in our interest variables into the detailed effect of characteristics considered and the effect of the impact of these characteristics on the interest variable (coefficients effect).

Hence,

$$\bar{z}^*_{score_{2005}} - \bar{z}^*_{score_{1999}} = \left[\underbrace{\bar{F}(X_{2005}\,\hat{\beta}^*_{2005}) - \bar{F}(X_{1999}\,\hat{\beta}^*_{2005})}_{aggregated\ effect\ of\ characteristics} \right] + \left[\underbrace{\bar{F}(X_{2005}\,\hat{\beta}^*_{2005}) - \bar{F}(X_{2005}\,\hat{\beta}^*_{1999})}_{aggregated\ effect\ of\ coefficients} \right] \quad (4)$$

$$\bar{z}^*_{score_{2005}} - \bar{z}^*_{score_{1999}} = \left[\underbrace{\sum_{k=1} (\bar{X}_{k2005} - \bar{X}_{k1999})\hat{\beta}^*_{k2005}}_{sum\ of\ detailed\ effect\ of\ characteristics} \right] + \left[\underbrace{\sum_{k=1} (\hat{\beta}^*_{k2005} - \hat{\beta}^*_{k1999})\bar{X}_{k1999}}_{sum\ of\ detailed\ effect\ of\ coefficients} \right] \quad (5)$$

Finally, we used the method developed by Yun (2005) to test the significance of the effects of characteristics and coefficients in the decomposition analysis. This method, which draws on the delta method to calculate the asymptomatic variances of each effect, helped us identify the variables whose variation significantly contributed to the health status gap observed between 1999 and 2005.

Results

In the first section, we have presented the results generated by the linear regression of the interest variables on health factors for children under 5 years of age for the 2 years considered. In a second section, we have presented the decomposition results.

Results of the linear regressions

Table 2 presents the results of the long-term nutritional status stemming from the linear regression of the *height-for-age z*-score and *weight-for-age z*-score on determinants in 1999 and 2005. This table presents the regressions for the overall sample, for girls' samples and for boys'samples.

For these three regressions, a negative and significant coefficient was obtained for the *age* variable for both health indicators considered and both years. This result assumes that the nutritional status of Guinean children deteriorates with age; however, the significant positive coefficient obtained for the age^2 variable reveals the existence of non-linearity with regard to the relation between the age of Guinean children and their health. This result led us to calculate the month when age started having a positive rather than a negative correlation. We found that beyond 38 months, on average, age did not appear to be a factor diminishing health status. However, up to the age of 3 years, this age variable proved to be negatively correlated with the health status of babies and young children. In addition, children who were twins and those breast-fed for less than 6 months tended to suffer from stunting and underweight in 1999 and 2005. In most cases, the negative effect of being breast-fed for less than 6 months and that of being a twin was more significant in 2005. As for the gender of children, girls in Guinea tended to have better nutritional status compared with boys. This result holds for both years. In contrast to the results obtained by Morrisson and Linskens (2000), the coefficient of the birth order of the child considered was positive and not significant for any indicator. This positive effect can be justified by the fact that in Guinea the number of children born before (including deceased children) is, on average, three for 1999 and 2005. This reduces the risk of having a mother who had many prior pregnancies. Finally, although most of the disease variables were not significant, children who experienced episodes of diarrhoea, cough or fever 2 weeks before the surveys showed stunting.

Table 2: Regression of *z*-scores for 1999 and 2005

	Overall				*Girls*				*Boys*			
Variables	*Height-for-age z-score*		*Weight-for-age z-score*		*Height-for-age z-score*		*Weight-for-age z-score*		*Height-for-age z-score*		*Weight-for-age z-score*	
	1999	*2005*	*1999*	*2005*	*1999*	*2005*	*1999*	*2005*	*1999*	*2005*	*1999*	*2005*
Characteristics of the child												
Age (in months)	−0.108***	−0.124***	−0.0386***	−0.0378***	−0.105***	−0.125***	−0.0432***	−0.0463***	−0.111***	−0.122***	−0.0432***	−0.0299***
Age^2 (in months)	0.00146***	0.0016***	0.0006***	0.0005***	0.00137***	0.00157***	0.0007***	0.0006***	0.00155***	0.0016***	0.0007***	0.0005***
Gender (girl)	0.105**	0.295***	0.0323	0.218***	—	—	—	—	—	—	—	—
Twin status (twin)	−0.698***	−1.062***	−0.729***	−0.945***	−0.669***	−0.789***	−0.709***	−0.474**	−0.708***	−1.313***	−0.709***	−1.312***
Birth order	0.0008	0.00927	0.0106	0.00148	0.0122	0.00259	0.0103	0.00795	0.00953	0.0154	0.0103	0.0022
Breast-feeding (less than 6 months)	−0.269***	−0.242**	−0.470***	−0.590***	−0.205*	−0.313*	−0.422***	−0.424***	−0.335***	−0.176	−0.422***	−0.735***
Prior diarrhoea	−0.104	−0.239**	—	—	−0.129	−0.119	—	—	−0.0650	−0.336**	—	—
Prior cough	−0.118*	−0.0213	—	—	−0.0631	−0.0095	—	—	−0.170*	−0.0271	—	—
Prior fever	−0.107	−0.0311	—	—	−0.0674	−0.0028	—	—	−0.134	−0.0255	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
Characteristics of the mother												
Age of mother at birth (under 18 years of age)	−0.232***	−0.229*	−0.0879	−0.0494	−0.189	−0.282*	0.00150	−0.0960	−0.276**	−0.164	0.00150	−0.0117
Height of mother (in cm)	0.0098***	0.0325***	0.0063***	0.0265***	0.0104***	0.0225***	0.00510**	0.0208***	0.00910***	0.0398***	0.00510**	0.0306***
Mother married (yes)	0.133	0.0735	0.276***	0.160**	0.293*	0.101	0.346***	0.203**	0.0276	0.191	0.346***	0.114**
Illiterate (yes)	−0.356***	0.0647	−0.231**	−0.0317	−0.592***	−0.0516	−0.416***	−0.0208	−0.0915	0.129	−0.416***	−0.0763
Mother unemployed (since 1 year)	0.132	−0.238**	0.0281	−0.182**	0.127	−0.125	−0.0490	−0.169	0.138	−0.393***	−0.0490	−0.217*
Characteristics of the household												
Household size	0.0111	−0.0152*	−0.00282	−0.00550*	−0.0131	−0.0018*	−0.00525	−0.0047*	−0.0104	−0.0500**	−0.00525	−0.0071*
Number of children under 5 years of age	0.0604*	−0.0354	0.0303	−0.0192	0.0443	−0.0505	0.0295	−0.0539	0.0753**	0.0054	0.0295	0.0254
Number of women over 15 years of age	−0.0497	0.0828*	—	—	−0.0442	0.0565*	—	—	−0.0607	0.139*	—	—
Gender of household head: female	0.150*	0.135	0.153*	0.0437	0.152	−0.00787	0.201*	0.0308	0.144	0.282	0.201*	0.0593

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Partner uneducated	–0.0146	–0.320***	–0.0707	–0.279***	–0.0406	–0.236*	–0.0827	–0.236**	–0.000490	–0.414***	–0.0827	–0.303**
Sanitation: yes	0.00311	0.0836	0.0630	0.0625	0.0952	0.0940	0.0332	0.0377	0.104	0.0578	0.0332	0.171*
Safe water: yes	0.109	0.201**	0.0372	0.0971	0.217**	0.209*	0.0364	0.0779	0.0235	0.214*	0.0364	0.144
Electricity: yes	0.304***	0.118	0.0957	–0.293**	0.212	–0.242	0.0142	–0.295*	0.396***	0.00344	0.0142	–0.275
Conakry	–0.0428	0.447*	–0.387***	0.495***	0.0905	0.684**	–0.367**	0.660***	–0.155	0.235	–0.367**	0.347
Lower Guinea	0.0927	0.542***	–0.0671	0.520***	0.0259	0.761***	–0.165	0.531***	0.143	0.348*	–0.165	0.544***
Central Guinea	0.00478	0.208	–0.0690	0.483***	–0.196	0.489**	–0.226	0.541***	0.177	–0.0449	–0.226	0.466***
Upper Guinea	0.135	0.127	–0.120	–0.0363	0.120	0.0539	–0.218*	–0.188	0.155	0.201	–0.218*	0.116
Rural	–0.255***	–0.427***	–0.324***	–0.338***	–0.151	–0.444**	–0.290***	–0.267**	–0.325**	–0.428***	–0.290***	–0.416***
Muslim	0.156	0.300	0.181	–0.0468	0.115	0.272	0.125	0.120	0.137	0.470	0.125	–0.175
Christian	0.172	0.0592	0.113	–0.115	0.250	–0.291	0.284*	–0.393	0.0643	0.367*	0.284*	0.127
Soussou	–0.149	–0.530	0.110	–0.0400	–0.368	0.163	0.0279	–0.175	0.0968	–0.831	0.0279	0.0511
Peulh	–0.0942	–0.257	–0.0868	0.0858	–0.176	0.419	–0.0886	–0.0752	0.0479	–0.510	–0.0886	0.237
Malinke	–0.187	–0.620	–0.0205	0.0277	–0.396	0.229	–0.0516	–0.00503	0.0441	–1.025	–0.0516	0.0873
Kissi	–0.439	–0.444	–0.0776	0.0593	–0.645*	0.839*	–0.349	0.420	–0.261	–1.183	–0.349	–0.299
Toma	–0.0226	–0.348	0.347*	0.253	–0.417	0.618	–0.0423	–0.0626	0.383	–0.786	–0.0423	0.557
Guerze	-0.0949	–0.322	0.345*	0.261	–0.322	0.570	0.239	0.363	0.151	–0.642	0.239	0.215
Constant	–0.938*	–4.454***	–1.184***	–4.197***	–0.682	–3.085**	–0.603	–3.057***	–1.159*	–5.523***	–0.603	–4.933***
Observations	**4466**	**2681**	**4576**	**2731**	**2125**	**1337**	**2174**	**1357**	**2341**	**1344**	**2174**	**1374**
R^2	**0.161**	**0.242**	**0.082**	**0.162**	**0.174**	**0.246**	**0.093**	**0.160**	**0.157**	**0.254**	**0.093**	**0.193**

* significant at 10 per cent, ** significant at 5 per cent, *** significant at 1 per cent.

Sources: Calculations performed by authors using data from the DHSG-II and -III.

Children whose mother was illiterate showed the worst nutritional status in 1999 for the *height-for-age* and *weight-for-age z*-scores. In 2005, the effect of this characteristic on the health of a mother's children was not as significant. This may be because of the establishment of programmes raising awareness of children's health by targeting mothers in Guinea between 2000 and 2005. Although we expected the nutritional status of children born to mothers aged less than 18 years of age to be negatively affected for the overall sample, this variable was only significant for the *height-for-age z*-score, regardless of the period. Considering the girls' sample, it was significant only in 2005, and in 1999 for the boys' sample. This result may be explained by the presence of very large households (on average, nine persons per household) in Guinea. The risk of children's health being affected by adolescent mothers was reduced by the assistance of other household members. *A contrario*, the mother's height had a significant positive correlation with the health of her children, regardless of the indicator considered, the sample considered and the year studied. Moreover, with regard to the characteristics of the mother, we observed that having an unemployed mother for the past year in 2005 led to significant deterioration of the health of children, in contrast with what we observed in 1999, as 6 years earlier the mother's unemployed status was not significant. This result is valid only for the overall sample. That being said, children whose mother was married have a higher *height-for-age z*-score *and weight-for-age z*-score, reflecting a better health status for children born to married mothers, regardless of the year considered; however, this characteristic of the mother had no significant effect on the height of children.

In terms of the characteristics of the household, we found that the risk of malnutrition increased significantly when the child lived in a rural area, with the exception of the *height-for-age z*-score for girls in 1999. Moreover, between 1999 and 2005, the health status worsened for children living in rural areas, based on both *z*-scores. Ethnicity, religion and the number of women over 15 years of age were not significantly linked to children's health. In terms of the gender of the household head, when it was a woman it increased the children's health status in 1999 but when we considered the girls' and boys' samples separately the positive impact of this variable only remained significant for the *weight-for-age z*-score. In addition, children with a mother whose partner had never gone to school and children living in a large household saw their health worsen in 2005 compared with 1999. That being said, in terms of significance, in 1999, these variables did not seem to have a role in malnutrition. The negative relation between household size and the health of children in 2005 might be explained by the very low standard of living of most Guinean households during that year. Indeed, given the high proportion of unemployed people during the year before the 2005 survey (18.5 per cent of women and 23.1 per cent of men), even if the household contained individuals likely to care for the child, the very low standard of living of the households prevented members, especially children, from being able to meet their basic needs.

In 2005, the increase in the number of women over 15 years of age living in the same household with the child constituted a factor contributing to the reduction in the risk of stunting among Guinean children, although this was not observed in 1999. This result is explained by the fact that women (not only the mother of the child) tend to give more care to very young children. Further, there is a positive link between the number of children under 5 years of age per household and the health of children in 1999. Indeed, the fewer the number of children under 5 years of age in Guinean households, the fewer the number of risks of conflict for access to maternal care. Finally, in both 1999 and 2005, the greater the access of households to sanitation and safe water, the better the health of children living in these households. It should nevertheless be noted that, although the effects were not always significant, they kept increasing over time.

Decomposition results

Tables 3 and 4 present the results stemming from the decomposition of the average deviation of the *height-for-age z*-score (*haz*) and *weight-for-age z*-score (*waz*), respectively, with the level of significance of the aggregate and detailed effects of the variables. These two tables also show the aggregate and detailed contribution (as a percentage) of the characteristics and those of the coefficients of the characteristics. The decomposition is made for the overall sample, girls' sample and boys' sample in both tables.

The explanatory variables chosen for the decomposition were those that proved to be significant over at least 1 of the 2 years studied with the exception of the mother's height.[10]

On the basis of the average of the *height-for-age z*-score and *weight-for-age z*-score, Tables 3 and 4 show, respectively, that malnutrition increased in Guinea between 1999 and 2005 with regard to stunting and overweight.[11] It should be kept in mind that these results are consistent with the information contained in the reports of the DHSG-II and -III surveys. In addition, we found that the estimated average of the *z*-score*s* obtained following the regressions carried out for the overall sample (haz_{2005}=−1.43 and haz_{1999}=−1.20; waz_{2005}=−1.03 and waz_{1999}=−0.82) are roughly equal to those of the *z*-score*s* observed (haz_{2005}=−1.45 and haz_{1999}=−1.21; waz_{2005}= −1.04 and waz_{1999}=−0.83). We also found that the aggregate effects of the characteristics and those of the coefficients significantly explained the gap observed for the two health indicators between the 2 years, regardless of the sample considered. All this leads us to believe that our models are relevant for a prediction.

The decompositions obtained using the approach developed by Yun (2005a) indicated that the aggregate effect of the coefficients is significantly stronger than that of the characteristics, regardless of the health indicator and sample considered. Thus, one can say that the changes in the impact of the determinants on each indicator considered are those that contribute the most to the changes in inequality observed between 1999 and 2005. These results assume that, even if the characteristics considered were the same in 1999 and 2005, the nutritional status of Guinean children would still deteriorate. That being said, taken in an aggregate way, the variation in terms of characteristics enabled a significant reduction in the stunting rate gap (−22 per cent, −40 per cent and −13 per cent for the overall, girls' and boys' samples, respectively), whereas this variation contributed to a significant increase in the underweight prevalence rate gap (11 per cent, 11 per cent and 13 per cent for the overall, girls' and boys' samples, respectively). We can thus consider that there was a net improvement in the determinants of children's health between 1999 and 2005.

The results obtained at the detailed level change slightly according to the sample used. Indeed, by using the overall sample we showed that the deterioration of the indicator based on the *height-for-age z*-score of children can be essentially attributed to the variation in the coefficients of the characteristics of children (341 per cent) and in the characteristics of children (81 per cent). The variation in the coefficients of the characteristics of the household had a preponderant role in the gap reduction observed for this indicator between 1999 and 2005. At a more disaggregate level, it is the variation in the coefficients of the age of the child (274 per cent), of the household size (117 per cent) and the twins variable (252 per cent) that helped to better explain the gap observed. That being said, the variation in the effect of the coefficients of the variable number of women in the household (−110 per cent) allowed for the significant reduction of the effect obtained for the number of children under 5 years of age.

On the basis of the decomposition of the *height-for-age z*-score using the girls' sample, it is actually the variation in their characteristics and those of the coefficients of the characteristics of the mother that had a preponderant role in the deterioration observed. As for the overall sample, the variation in the coefficients of the characteristics of the household had a preponderant role in the reduction of the gap observed for this indicator between 1999 and 2005. Using the boys' sample, the results showed that the coefficients of the boys' and mothers' characteristics had a significant role. Although they are significantly linked to the stunting of children, variables such as the area of residence, gender of the household head and access to safe water did not play a preponderant role in the gap observed in terms of the *height-for-age* z-score, regardless of the sample considered.

Unlike the indicator based on the *height-for-age z*-score, the variation in the coefficients of the characteristics of the household (488 per cent, 738 per cent and 902 per cent for the overall, girls' and boys' samples, respectively) largely explains the increase in the number of underweight children. The mother's characteristics strongly favoured a gap reduction observed between 1999 and 2005 for the overall and girls' samples, whereas the coefficients of the girls' and boys' characteristics mostly favoured the decrease in the prevalence of the underweight in Guinea. Examination of the disaggregate effects for the overall sample revealed that the coefficient of the mother's partner's education (127 per cent), number of breast-feeding months (102 per cent), coefficient of the mother's occupation (81 per cent) and coefficient of the number of children under 5 years of age (120 per cent) constitute the important determinants of the health status gap observed during the studied period.

The decomposition carried out for the two indices enabled us to confirm certain results obtained in terms of linear regressions. Indeed, although it significantly favoured children's health in 2005, the variable of the number of women over 15 years of age present in the household proved to be among those that significantly contributed to reducing the gap observed between 1999 and 2005. Moreover, the variation in the coefficient of household size significantly contributed to widening the gap observed in the stunting rate, which is perfectly normal as, in 2005, this variable significantly contributed to the deterioration in children's health. In addition, although it was a factor of health deterioration in 2005, the variation in the coefficient of the mother's occupation significantly allowed for the increase in the health gap. With respect to the mother's literacy, we found that being illiterate led to significant deterioration in the child's health in 1999 but did not have a significant effect in 2005, and the result of the decomposition showed that this variable contributed to reducing the gap between 1999 and 2005 even though its contribution was not significant.

In Guinea, despite the implementation of significant education system reforms between 1985 and 2000, the number of educated people remained low. In light of these results, the government introduced the Structural education adjustment programme in 2001. The main goal of this programme was to make education a driving force in Guinea's development by: providing access to primary quality education for all children irrespective of their origin or gender; contributing to reducing gender-based disparities in terms of completing basic education; and providing access to education to both young and old. The implementation of this programme may explain the positive role of the mother's education in reducing the underweight prevalence gap between 1999 and 2005.

Moreover, although many reforms were implemented to improve the health of Guineans between 2000 and 2005, the level of health service to mothers and their children remained extremely low. Indeed, although the proportion of mothers who received assistance from medical staff during their childbirth increased from 35 per cent in 1999 to 38 per cent in 2005, this proportion remained relatively low. Moreover, during this same period, although the proportion of children receiving full medical vaccinations increased (from 32 per cent in 1999 to 37 per cent in 2005), it remained very low compared with the situation in other countries. [12] With regard to the resources allocated to the health sector, they remained insufficient and represented only 6 per

Table 3: Aggregate decomposition of the gap in average *height-for-age* (*haz*) between 1999 and 2005 for the overall sample

Variables	*haz – Overall sample*						*haz – Girls*			
	Overall	*In percentage*	*Effect of characteristics*	*In percentage*	*Effect of coefficient*	*In percentage*	*Overall*	*In percentage*	*Effect of characteristics*	*In percentage*
Average 2005	−1.445***	—	—	—	—	—	−1.277***	—	—	—
Average 1999	−1.211***	—	—	—	—	—	−1.151***	—	—	—
Gap	−0.234***	—	—	—	—	—	−0.126*	—	—	—
Effect of characteristics	0.0512**	−21.88	—	—	—	—	0.0507**	−40.46	—	—
Effect of coefficients	−0.286***	122.22	—	—	—	—	−0.176**	140.46	—	—
Characteristics of the child	—	—	**0.042**	**81.42**	**−0.978**	**341.99**	—	—	**0.05335**	**105.23**
Age (in months)	—	—	0.001	1.46	−0.786**	274.83	—	—	0.0212	41.81
Age^2 (in months)	—	—	0.046	88.87	0.374*	−130.77	—	—	0.0360	71.01
Gender	—	—	0.003	5.98	−0.214***	74.83	—	—	—	—
Twins	—	—	−0.0123***	−24.02	−0.723***	252.8	—	—	−0.00854	−16.84
Breast-feeding	—	—	−0.0119***	−23.24	0.242***	−84.62	—	—	−0.0113*	−22.29
Prior diarrhoea	—	—	0.00842**	16.45	0.205**	−71.68	—	—	0.0107*	21.10
Prior cough	—	—	0.005	10.31	0.034	−11.85	—	—	0.00142	2.80
Prior fever	—	—	0.003	5.63	−0.11	38.46	—	—	0.00387	7.63
Characteristics of the mother	—	—	**0.005**	**9.18**	**−0.099**	**34.44**	—	—	**−0.0016588**	**−3.27**
Age of mother at birth	—	—	0.00591**	11.54	−0.008	2.94	—	—	0.00287	5.66
Mother married	—	—	0	0.77	−0.02	7.13	—	—	−4.68e−05	−0.09
Literacy	—	—	0	0,81	−0.03	10.31	—	—	0.00021	0.41
Mother employed	—	—	−0.002	−3.91	−0.0402**	14.06	—	—	−0.00469	−9.25
Characteristics of the household	—	—	**0.005**	**9.24**	**0.793**	**−277.33**	—	—	**−0.0010621**	**−2.09**
household size	—	—	0	0.59	−0.337**	117.83	—	—	−0.00264	−5.21
Number of children under 5 years of age	—	—	−0.003	−5.27	−0.221**	77.27	—	—	−0.00086	−1.69
Number of women over 15 years of age	—	—	0	−0.37	0.315**	−110.14	—	—	1.89e−05	0.04
Gender of the household head	—	—	0.001	2.11	0.007	−2.33	—	—	−0.00049	−0.96
Partner education	—	—	−0.002	−3.38	−0.229***	80.07	—	—	−0.00276	−5.44
Sanitation	—	—	0.006	12.38	−0.053	18.5	—	—	0.0208	41.03
Electricity	—	—	0.002	3.2	0.216**	−75.52	—	—	0.00039	0.78
Safe water	—	—	0.001	1.74	0.073	−25.42	—	—	0.00125	2.47
Area of residence	—	—	−0.0114***	−22.27	−0.149	52.1	—	—	−0.0130**	−25.64
Administrative areas	—	—	0.011	20.51	−0.086	30.17	—	—	−0.00378	−7.46
Constant	—	—	—	—	1.258***	−439.86	—	—	—	—
Observations	**7240**	—	**7240**	—	**7240**	—	**3498**	—	**3498**	—

Table 3: *Continued*

Variables	*haz – Girls*		*haz – Boys*					
	Effect of coefficient	*In percentage*	*Overall*	*In percentage*	*Effect of characteristics*	*In percentage*	*Effect of coefficient*	*In percentage*
Average 2005	—	—	−1.608***	—	—	—	—	—
Average 1999	—	—	−1.265***	—	—	—	—	—
Gap	—	—	−0.344***	—	—	—	—	—
Effect of characteristics	—	—	0.0446**	−12.99	—	—	—	—
Effect of coefficients	—	—	−0.388***	112.99	—	—	—	—
Characteristics of the child	**−0.12753**	**72.46**	—	—	**0.02159**	**48.41**	**−0.6799**	**175.23**
Age (in months)	−0.819*	465.34	—	—	−0.0210	−47.09	−0.713	183.76
Age^2 (in months)	0.357	−202.84	—	—	0.0569	127.58	0.367	−94.59
Gender	—	—	—	—	—	—	—	—
Twins	−0.00410	22.33	—	—	−0.0162**	−36.32	−0.0261**	6.73
Breast-feeding	0.187*	−106.25	—	—	−0.0122**	−27.35	−0.168	43.30
Prior diarrhoea	0.103	−58.52	—	—	0.0060*	13.48	−0.0488	12.58
Prior cough	0.0422	−23.98	—	—	0.0023	5.16	−0.154**	39.69
Prior fever	0.0064	−3.62	—	—	0.0058	12.96	0.063	−16.24
Characteristics of the mother	**−0.5548**	**315.23**	—	—	**0.0101538**	**22.77**	**0.42516**	**−109.58**
Age of mother at birth	−0.0131	7.44	—	—	0.0099**	22.40	−0.00774	1.99
Mother married	−0.261	148.30	—	—	0.0003	0.67	0.0682	−17.58
Literacy	−0.248	140.91	—	—	5.08e−05	0.11	0.287	−73.97
Mother employed	−0.037**	18.58	—	—	−0.0002	−0.42	0.077**	−20.03
Characteristics of the household	**0.506**	**−287.5**	—	—	**0.012766**	**28.62**	**−0.134**	**34.54**
household size	−0.141	80.11	—	—	0.0054	12.15	−0.706***	181.96
Number of children under 5 years of age	−0.257*	146.02	—	—	−0.0045	−10.18	−0.133	34.28
Number of women over 15 years of age	0.219	−124.43	—	—	−0.0005	−1.23	0.482**	−124.23
Gender of the household head	−0.0140	7.95	—	—	0.0034	7.62	0.0213	−5.49
Partner education	0.0508	−28.86	—	—	−0.0006	−1.27	−0.293***	75.52
Sanitation	0.00421	−2.39	—	—	−0.0061	−13.74	−0.101	26.03
Electricity	−0.0625*	35.51	—	—	0.0037	8.18	−0.0830**	21.39
Safe water	−0.0545	30.97	—	—	0.0006	1.32	0.233***	−60.05
Area of residence	−0.339**	192.61	—	—	−0.0068	−15.27	0.0587	−15.13
Administrative areas	−0.390	221.59	—	—	0.0183**	41.03	0.110	−28.35
Constant	1.490**	−846.59	—	—	—	—	0.277	−71.39
Observations	**3498**	—	**3742**	—	**3742**	—	**3742**	—

* significant at 10 per cent, ** significant at 5 per cent, *** significant at 1 per cent.
Sources: Calculations performed by authors using data from the DHSG-II and -III.

Table 4: Aggregate decomposition of the gap in average weight-for-age (*waz*) between 1999 and 2005 for the overall sample

Variables	*waz – Overall Sample*						*waz – Girls*			
	Overall	*In percentage*	*Effect of characteristics*	*In percentage*	*Effect of coefficient*	*in percentage*	*Overall*	*In percentage*	*Effect of characteristics*	*In percentage*
Average 2005	−1.037***	—	—	—	—	—	−0.934***	—	—	—
Average 1999	−0.832***	—	—	—	—	—	−0.812***	—	—	—
Gap	−0.205***	—	—	—	—	—	−0.122*	—	—	—
Effect of characteristics	−0.0218**	10.63	—	—	—	—	−0.0132*	10.80	—	—
Effect of coefficients	−0.183***	89.27	—	—	—	—	−0.109*	89.20	—	—
Characteristics of the child	—	—	**−0.014**	**64.82**	**−0.071**	**38.74**	—	—	**−0.00869**	**65.83**
Age (in months)	—	—	0.002	−8.07	0.237	−129.51	—	—	0.0088	−66.67
Age^2 (in months)	—	—	0.017	−78.44	−0.173	94.54	—	—	0.0130	−98.48
Gender	—	—	0.002	−7.84	−0.0934*	51.04	—	—		
Twins	—	—	−0.0124***	56.88	0.0705	−38.52	—	—	−0.0078	59.02
Breast-feeding	—	—	−0.0223***	102.29	−0.112	61.2	—	—	−0.0227***	171.97
Prior diarrhoea	—	—	—	—	—	—	—	—	—	—
Prior cough	—	—	—	—	—	—	—	—	—	—
Prior fever	—	—	—	—	—	—	—	—	—	—
Characteristics of the mother	—	—	**0.009**	**−40.2**	**0.128**	**−69.79**	—	—	**0.009**	**−68.26**
Age of the mother at birth	—	—	0.002	−10.18	0.00652	−3.56	—	—	−0.00013	1.02
Mother married	—	—	0.001	−3.38	−0.0288	15.74	—	—	0.0001	−0.80
Literacy	—	—	0.001	−2.61	0.299	−163.39	—	—	−3.12e−05	0.24
Mother employed	—	—	0.00524*	−24.04	−0.149**	81.42	—	—	0.0091*	−68.71
Characteristics of the household	—	—	**−0.016**	**75.32**	**−0.8945**	**488.8**	—	—	**−0.01348**	**102.15**
Household Size	—	—	0.008	−37.29	0.0873	−47.7	—	—	0.0113	−85.61
Number of children under 5 years of age	—	—	−0.003	15.6	−0.220*	120.22	—	—	−0.0035	26.52
Gender of the household head	—	—	0.001	−4.72	−0.0572	31.26	—	—	−0.0005	3.89
Partner education	—	—	−0.001	5.32	−0.232***	126.78	—	—	−0.0043	32.35
Sanitation	—	—	−0.009	40.5	−0.0412	22.51	—	—	0.0155	−117.42
Electricity	—	—	−0.002	11.06	−0.0234	12.79	—	—	−0.0018	13.64
Safe water	—	—	0.001	−5.5	−0.0646	35.3	—	—	0.0018	−13.64
Area of residence	—	—	−0.0129**	59.17	0.0986	−53.88	—	—	−0.0214*	162,12
Administrative areas	—	—	0.002	−8.81	−0.442***	241.53	—	—	−0.0106	80.30
Constant	—	—	—	—	0.655	−357.92	—	—	—	—
Observations	**7245**	—	**7245**	—	**7245**	—	**3500**	—	**3500**	—

Table 4: *Continued*

Variables	*waz – Girls*		*waz – Boys*					
	Effect of coefficient	*In percentage*	*Overall*	*In percentage*	*Effect of characteristics*	*In percentage*	*Effect of coefficient*	*In percentage*
Average 2005	—	—	−1.137***	—	—	—	—	—
Average 1999	—	—	−0.850***	—	—	—	—	—
Gap	—	—	−0.286***	—	—	—	—	—
Effect of characteristics	—	—	−0.0366*	12.77	—	—	—	—
Effect of coefficients	—	—	−0.250***	87.23	—	—	—	—
Characteristics of the child	**0.35272**	**−323.60**	—	—	**−0.0229**	**62.49**	**2.056**	**−822.40**
Age (in months)	−0.148	135.78	—	—	−0.00617	16.86	0.661	−264.40
Age^2 (in months)	−0.0098	8.96	—	—	0.0224	−61.20	−0.371	148.40
Gender			—	—	—	—	—	—
Twins	0.509**	−466.97	—	—	−0.0176**	48.09	1.276***	−510.40
Breast-feeding	0.0015	−1.37	—	—	−0.0215**	58.74	0.490***	−196.00
Prior diarrhoea	—	—	—	—	—	—	—	—
Prior cough	—	—	—	—	—	—	—	—
Prior fever	—	—	—	—	—	—	—	—
Characteristics of the mother	**0.3439**	**−315.53**	—	—	**0.0091**	**−24.86**	**−0.0506**	**20.24**
Age of the mother at birth	−0.0117	10.73	—	—	0.0067	−18.25	0.0209	−8.36
Mother married	−0.323	296.33	—	—	−0.0004	1.05	0.0961	−38.44
Literacy	0.670**	−614.68	—	—	0.0003	−0.75	−0.0952	38.08
Mother employed	0.0086	−7.92	—	—	0.00253	−6.91	−0.0724	28.96
Characteristics of the household	**−0.8045**	**738.07**	—	—	**−0.0228**	**62.25**	**−2.2551**	**902.03**
Household Size	0.243	−222.94	—	—	0.0029	−7.98	−0.0910	36.40
Number of children under 5 years of age	−0.353*	323.85	—	—	−0.0032	8.80	−0.0682	27.28
Gender of the household head	−0.0185	16.97	—	—	0.0016	−4.43	−0.0509	20.36
Partner education	−0.0150	13.76	—	—	−4.41e−05	0.12	−0.0320	12.80
Sanitation	−0.0643	58.99	—	—	−0.0269	73.50	0.00112	−0.45
Electricity	−0.192	176.15	—	—	−0.0023	6.17	−0.0391	15.64
Safe water	−0.169	155.05	—	—	0.0007	−1.91	0.158**	−63.20
Area of residence	−0.0627	57.52	—	—	−0.0055	15.16	−0.387***	154.80
Administrative areas	−0.612**	561.47	—	—	0.00995	−27.19	−0.244	97.60
Constant	0.439	−402.75	—	—	—	—	−1.502***	600.80
Observations	**3500**	—	**3745**	—	**3745**	—	**3745**	—

* significant at 10 per cent ** significant at 5 per cent, *** significant at 1 per cent.
Sources: Calculations performed by authors using data from the DHSG-II and -III.

cent of the GDP (Rapport national de la République de Guinée (RNRG), 2004). All these factors contributed to the increase in inflation rate from 5.4 per cent in 2002 to 39.1 per cent in 2006 (Rapport national de la République de Guinée (RNRG), 2004), which may explain the deterioration in children's nutritional status because it seriously reduces the population's purchasing power. An increased inflation rate worsens poverty and thus contributes to factors worsening the children's nutritional status.

Conclusion

This study allowed us to identify the determinants explaining the health of Guinean children in 1999 and 2005. Most of our results confirm those obtained for other countries. Indeed, our results showed that in Guinea the child's age, gender, twin status, number of months of breast-feeding, mother's occupation, region and area of residence, mother's education and level of access to sanitation and safe water all constitute important factors that influence the nutritional status of children under 5 years of age.

We also showed, based on the decomposition by Yun (2005a), that despite the improvement in some of these determinants, their connection to children's health was very unfavourable between 1999 and 2005, resulting in an increase in the number of malnourished children. Indeed, we observed that all of the significant regression variables were nevertheless insufficient to explain the negative nutritional status gap observed between 1999 and 2005. Only the variables significantly linked with children's health in 2005 proved to be influential in reducing the prevalence of children suffering from growth retardation and underweight in Guinea.

Consequent to this study, it appears to us that an appropriate policy – one that would reinforce the education of Guineans and put greater emphasis on an educational method targeting the ability to read, understand and become informed about subjects relative to maternal and child health – remains indispensable in Guinea. In addition, it appears necessary to reinforce mechanisms to control the health of young boys as soon as they are born. In order to reduce the number of malnourished children, it would also be advisable to establish mechanisms of ongoing care for young mothers before and after pregnancy, reinforce breast-feeding duration awareness campaigns and implement policies aimed at meeting the needs of very young children, thus reducing poverty among large families.

Although this study did not allow for the identification of the causal relations and reasons why the coefficients of the characteristics underwent a negative variation (the unexplained part of the decomposition), the results remain quite interesting and relevant for decision makers. Although the use of the OLS does not allow us to identify the causal relationship between the health of Guinean children and the factors selected, it makes it possible to explain how the health of these children varies according to the factors considered, and this explanation constitutes our primary objective. O'Donnell *et al*, 2008 showed that the problems one might attribute to the use of such a method – notably, omitted variable bias or endogeneity – are not very relevant. That being said, it would be interesting to look at the possible causal relations between the health of Guinean children and certain socioeconomic, demographic and other factors in a future study. Moreover, we did not consider the effect of seasonality in this study.[13] Moreover, we mentioned that the *height-for-age* index is one that measures a child's stunting, which is a good long-term indicator of the nutritional status of a population because it is not markedly affected by short-term factors such as the season during which the data is collected. Nevertheless, it would be important to look at a method to eliminate a possible seasonal effect in the data we used for this analysis.

Acknowledgements

We thank the participants at the EcoMod2010 conference for their valuable comments that helped improve this article. We also thank the Fonds de recherche du Québec for their financial support.

Notes

1. In 1974, following the reduction in food production in 1972 and the resulting increase in the price of agricultural products, the *World Food Conference* was held in Rome. The Food and Agriculture Organization of the United Nations (FAO) and WHO jointly organized the *International Conference on Nutrition,* followed by the second and third *World Food Summits* in 1996 and 2002. In November 2009, a *World Summit on food security* was held during which participants highlighted the need to take into account the diversity of situations at the regional, national and global levels.
2. Wagstaff *et al* (2003) used the decomposition on the concentration index for y, whereas we used the decomposition on y.
3. According to these authors, the determinants of malnutrition among children in Botswana involved not only economic but also biological, social and cultural factors.
4. These two surveys were conducted by the Direction Nationale de la Statistique (DNS) and benefited from the technical assistance of ORC Macro, an American cooperation institution in charge of the international Demographic and Health Survey programme.
5. Given the different data collection periods, results may have been affected by a seasonal effect. Unfortunately, this data is longitudinal, which prevents the use of a filter to extract the seasonal component.
6. Children's health is generally represented by one of the following measurements: clinical measurements of physical characteristics; anthropometric measurements of age, height and weight; and reported symptoms (Poder and He, 2010)
7. According to the report of the DHSG-III survey, experts recognize that the mother's milk is the most complete form of nourishment for children during the first 6 months and that finding a substitute remains difficult. Breast-feeding and nourishment practices constitute determining factors in the nutritional status of children, which in turn affects child morbidity and mortality. The frequency and intensity of the mother's breast-feeding prolongs postpartum infertility, and this influences the fertility level and hence the health status of mothers and children.
8. cf. www.un.org/fr/millenniumgoals/pdf/MDG%20Report%202009%20FR.pdf.
9. Behrman and Deolalikar, (1988) found that the household size as well as the number of women over 15 years of age living in the household are endogenous. In our case, household size is found exogenous. This result can be explained by the fact that household size can be seen as being endogenous with respect to mortality but not with respect to the *z*-score *height/weight-for-age*. The common story with respect to the demographic transition is that fertility reduction follows the decline in mortality, as large numbers of children for 'replacement' are no longer necessary and parents begin to invest in child quality rather than in child quantity. However, it is less clear whether the individual child characteristics of birth order should also be regarded as endogenous; hence, mortality estimated using these variables sidesteps the endogeneity problem (Charmarbagwala *et al*, 2004).
10. The fact that the variance of the variable of the mother's height is null for both indicators over both years entails an exaggerated increase in the effect of the impact of this variable; this effect is compensated by that of the constant. For this reason, we decided to exclude this variable from our two decompositions.
11. We refer to an increase when the gap between the average of the estimated *haz* and the average of the estimated *waz* of 2005 and 1999 are negative.
12. cf. DHSG-II and -III surveys.
13. Not taking into account the seasonality is explained by its absence in our database.

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