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Trends and Determinants of Malnutrition among Children Age 0-59 Months in Kenya (KDHS 1993, 1998, 2003 and 2008-09)

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ABSTRACT

Objectives: The study was conducted to determine trends of undernutrition and overnutrition among children age 0 to 59 months in Kenya and to analyze the determinants of child undernutrition and overnutrition.

Data and methods: The study analysed data from the Kenya Demographic and Health Surveys (KDHS) 1993, 1998, 2003, and 2008-09. The study examined the trends in malnutrition over the four surveys and the relationship between malnutrition and selected household, maternal, and child characteristics.

Results: The levels of stunting and underweight declined significantly ($P<0.05$) over the study period, by 4.6 percentage points. Nonetheless, stunting remains of high public health significance in Kenya, while underweight is of medium public health significance, as per the World Health Organization (WHO) classification (WHO 1995). Household wealth index, maternal education, maternal Body Mass Index (BMI), and size of the child at birth were significant determinants of child undernutrition.

Conclusion and recommendations: The effect of wealth index, maternal education, and maternal BMI on child undernutrition changed over time, with wealth and maternal education having a reduced effect. The results suggest an emerging trend of a double burden of malnutrition, with stunted children whose mothers are overweight. The implementation of national nutrition strategies should focus on the vulnerable groups. Increasing women's access to secondary and post-secondary education would go a long way in harnessing the potential of improved maternal and child nutrition in the country.

INTRODUCTION

The importance of child malnutrition as an indicator for tracking the nutrition and health status of populations is well recognized (de Onis et al. 2004). Malnutrition leads to lower individual productivity, deterioration of health, and lower life expectancy (Caulfield et al. 2004, Pelletier and Frongillo 2003) and hinders the potential for countries to reduce poverty and maximize socioeconomic development (Grantham-McGregor et al. 2007). Poverty, poor health and nutrition, and deficient healthcare derail the potential for cognitive development of about 200 million children under age 5 in developing countries (Ezzati et al. 2002). This negatively affects school performance, thus lowering adult incomes, which in turn has negative implications for national development (Ezzati et al. 2002). The combined effects of child and maternal underweight or micronutrient deficiencies account for about 15% of the global burden of disease worldwide (Black et al. 2003). The link between malnutrition, morbidity, and child mortality makes undernutrition the underlying cause of over half of all child deaths (Chopra and Darnton-Hill 2006), especially in sub-Saharan Africa, where an estimated 4.8 million children die before age 5 every year (Todd and Meera 2006).

Literature Review

Child undernutrition is one of Africa's most fundamental challenges for improved human development, slowing achievement of the goal of reducing child malnutrition (Kasirye 2010). There is a general decline in levels of child malnutrition globally (de Onis et al. 2004; UNICEF 2009). An analysis of global trends in the prevalence of child stunting and underweight, covering the period 1990-2000, showed a decline in stunting from 34% to 27%, and a decline in underweight from 27% to 22% (de Onis et al. 2004). According to UNICEF (2009), the proportion of stunting among children under age 5 in the developing world decreased from 40% to 29% between 1990 and 2008. This decline was mainly in East and Southeast Asia and in Latin America and the Caribbean, while in Africa the numbers of stunted children increased from 40 million to 45 million, and the number of underweight children increased from 25 million to 31 million in the same period (UNICEF 2009).

Prevalence of child stunting is remains high in sub-Saharan Africa. In Ethiopia, Madagascar, Niger, Malawi, Senegal, and Rwanda more than half of children under age 5 are stunted (Kothari and Noureddine 2010). This persistent high level of stunting is an indication of the challenges of civil conflicts, commodity prices shocks, droughts and floods in these countries (Todd and Meera 2006).

In Kenya the prevalence of child stunting has remained above 35%, while underweight is at 16% (KNBS and ICF Macro 2010). Coupled with high rates of child mortality, these problems continue to undermine the government's efforts to provide quality healthcare and to reduce levels of mortality and malnutrition (Kabubo-Mariara et al. 2009). In the 1999-2004 strategic plan, the Kenya Ministry of Health aimed to reduce malnutrition among children under age 5 by 30%, reduce the proportion of under-five morbidity and mortality rates attributable to key childhood diseases and undernutrition from 70% to 40%, and eliminate vitamin A deficiency in this age group (MOH 1999).

Despite these efforts, lack of progress in addressing the key determinants of childhood malnutrition, morbidity, and mortality continues to slow the achievement of these objectives. Under-five mortality remains high, at 74 deaths per 1,000 live births in 2008-09, although this is a decrease from 115 deaths per 1,000 births in 2003 (KNBS and ICF Macro 2010). There is a need to identify the trends in the prevalence of child malnutrition and to examine its determinants over time. This concern is based on the understanding that a poor level of child nutrition can have detrimental effects on long-term human development (Kabubo-Mariara et al. 2009) and slow progress toward the achievement of internationally set goals such as the Millennium Development Goals (MDGs).

Nutritional inadequacy has long-lasting effects, especially on children's cognitive development and their productivity as adults, and particularly for children from poor households (Kabubo-Mariara et al. 2009). In Northwest Tanzania, for example, Alderman (2007) found that malnourished children were more likely to delay entry into school and to perform worse at school than children of normal nutrition status. The effects of good child nutrition go beyond the positive individual health outcomes and also help achieve development goals, such as increasing productivity, reducing poverty, improving maternal and child health and survival, and increasing gender equity (Kothari and Noureddine 2010).

There is an increasing concern about childhood overweight and obesity in industrialized countries and in less developed countries as well. The extent of the problem of overweight and obesity among young children remains largely unknown in developing countries, however. Studies on the African continent that report rates of overweight and obesity have concentrated on the South African region and North and West African countries (Monyeki et al. 2008; Senbanjo and Adejuyigbe 2007; Mokhtar et al. 2001). Studies on the prevalence of overnutrition in the East African region and particularly Kenya are relatively lacking. A recent analysis from the 2003 Kenya DHS reported a prevalence of 18% overweight and 4% obesity among children age 3 to 5, based on BMI for age z score (Gewa 2010). The most prevalent immediate consequences for obese children are social isolation and peer problems (Dietz 1998).

Determinants of Undernutrition and Overnutrition in Young Children

Some studies have examined the nature, extent, and determinants of child nutritional status in East Africa (Kabubo-Mariara et al. 2009; Alderman et al. 2006; Lawson and Appleton 2007). Using a pooled sample of 1998 and 2003 DHS data, Kabubo-Mariara et al. (2009) found that maternal education and use of public health services were key factors in child nutritional status in Kenya. In Uganda, research identified community development programs and household incomes as key determinants of the nutritional status of infants, especially young boys (Lawson and Appleton 2007). In a study in Northwestern Tanzania household income growth was found to be an important determinant of weight for age for children under age 5 (Alderman et al. 2006).

In Siaya district, Kenya, a smaller study (n=175) conducted among children under age 5 reported that children in their second year of life were more likely to be underweight and stunted. Early introduction to complementary feeding and presence of upper respiratory infections or other illness in the past month were strong predictors of underweight (Bloss et al. 2004). Other studies in Kenya have pointed to the importance of maternal education as a determinant of nutritional status among young children (Gewa 2010; Deolalikar 1996), showing that young children whose mothers have a secondary education are significantly taller than children whose mothers have no schooling. A higher maternal education is significantly associated with overnutrition and obesity in children age 3-5, according to Gewa (2010), who further suggests

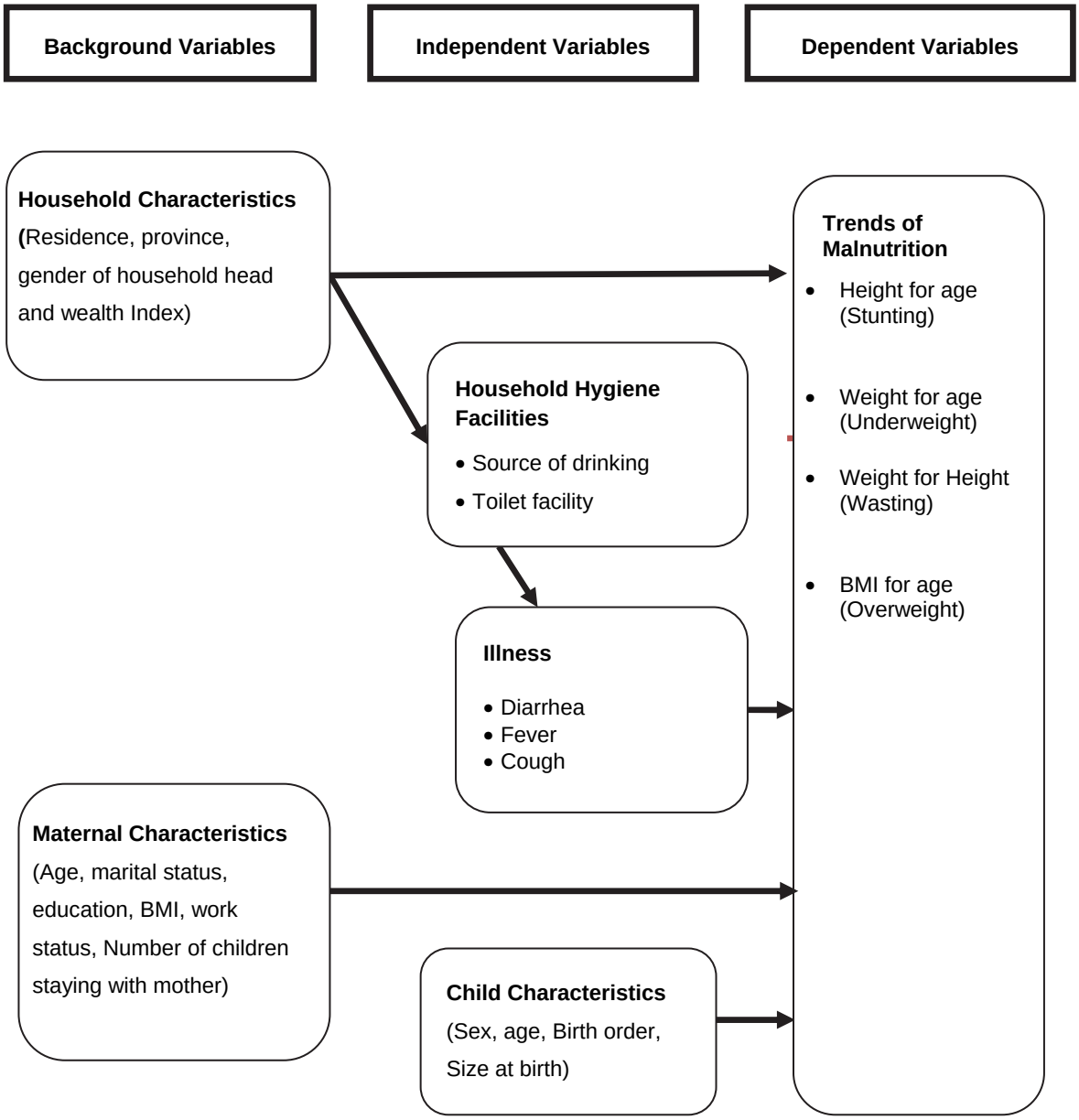
that a higher level of maternal education is associated with a higher income and a corresponding access to “high status foods” that are rich in sugars and saturated fats.

Factors associated with childhood overweight and obesity include gestational weight gain, child birth weight, rate of weight gain, maternal overweight, parental education, and household socioeconomic status (Senbanjo and Adejuyigbe 2007; Mamabolo et al. 2005; Bogen et al. 2004). Although the determinants of child undernutrition and overnutrition have been reported in Kenya, it is not well established if the factors are consistent over time or if there have been any changes, considering the rapidly changing economic and socio-demographic characteristics of the population, influenced by technological advances and rural-urban migration, among other factors.

This paper reports the trends of undernutrition and overnutrition among children under age 5 in Kenya and their association with selected household, maternal, and child characteristics. The background characteristics included in the analysis are: child’s place of residence (urban-rural), household headship, wealth index, and hygiene facilities. Maternal factors include age, education, marital status, Body Mass Index (BMI), work status, and number of children staying with the mother. Child-related factors include the age, sex, birth order, and size of child at birth, as well as the occurrence of diarrhea, fever, and cough among the children.

The conceptual framework (Figure 1) summarizes the determinants of the trends in childhood malnutrition included in the analysis.

Figure 1. Conceptual framework of the determinants of trends in malnutrition in Kenya



Objectives

- To determine the trends of undernutrition among children age 0 to 59 months in Kenya (1993 to 2008-09)
- To determine the trends of overnutrition among children age 0 to 59 months in Kenya (1993 to 2008-09)
- To analyze the determinants of undernutrition and overnutrition over time among children age 0 to 59 months in Kenya (1993 to 2008-09)

DATA AND METHODS

Subjects and Methods

This analysis used data from four national Kenya Demographic and Health Surveys (KDHS) conducted from 1993 to 2008-09. This includes 1993, 1998, 2003 and 2008-09 data collection intervals. A total of 8,805 households were selected for inclusion in 1993; 9,465 in 1998; 9,865 in 2003; and 9,936 in 2008-09. Household response rates were 96% or above in all surveys. The 1993 and 1998 samples excluded North Eastern Province and four other northern districts (Samburu and Turkana in Rift Valley Province and Isiolo and Marsabit in Eastern Province) because of security reasons. The excluded districts accounted for less than 4% of Kenya's population.

The DHS used a multistage stratified cluster sampling methodology in which samples of households within clusters (enumeration areas) were selected. Households were then systematically selected within each cluster and household residents were eligible to participate in the survey. Urban areas were oversampled, and this analysis is based on weighted data to account for the different sample proportions. This analysis includes only children under age 5 of interviewed mothers and whose weights and heights/lengths were measured in the survey.

Dependent Variables

Malnutrition was defined as stunting, wasting, underweight, and overweight as defined by the WHO 2006 growth reference standards, which use the WHO Multicentre Growth Reference Study population. Stunting was defined as height-for-age z-score <-2 standard deviation z scores; wasting was defined as weight-for-height z-score <-2 standard deviation z-scores; underweight was defined as weight-for-height z-score <-2 standard deviation z-scores; and overweight was defined as weight-for-height z-score >+2 standard deviation z-scores. BMI-for-age z-score (BAZ) based on the children’s weight and height measurements was also calculated (WHO 2010). Weight-for-height z-score was calculated for those with heights of 65 to 120 cm.

Background Characteristics

Background characteristics included in this analysis were urban or rural residence of the child, province, sex of the household head, wealth index, source of drinking water, and toilet facilities.

Wealth Index: The household wealth index is a socioeconomic index constructed as an indicator of the level of wealth that is consistent with expenditure and income measures. In the DHS the index is based on data from household ownership of assets and consumer goods such as source of drinking water, type of toilet facilities, type of fuel, ownership of various durable goods, and other characteristics relating to socioeconomic status of the household. A factor score generated through principal components analysis was assigned to each asset, and the resulting asset scores were standardized in relation to a normal distribution. Each household was then assigned a score for each asset and the scores were summed for each household (KNBS and ICF Macro 2010). The proxy indicator for the long-term standard of living on the household was based on this score. For this analysis, the wealth index was grouped into five categories: poorest, poorer, middle, richer, and richest.

Household Hygiene Facilities: Household hygiene facilities included in this analysis were the source of drinking water and availability of toilet facilities. Improved sources of drinking water included piped water, bottled water, and protected wells in the compound. Unprotected wells, springs, rivers, ponds, lakes, and dams were grouped as unimproved water source. Improved household toilet facilities included flush toilets and Ventilated Pit Latrines (VIP). Unimproved household toilet facilities were traditional pit latrines.

Maternal Characteristics

Maternal characteristics included in this analysis were: age, marital status, highest level of education obtained, BMI, work status, and the number of children under age 5 living with the mother. Maternal BMI was computed as weight in kilograms divided by the square of height in meters. BMI cut-offs were based on the recommended international cut-offs, as follows: underweight was defined as BMI<18.5 kg/m2, normal body weight was defined as BMI 18.5–

24.9 kg/ m2, overweight and obesity was defined as BMI > 25.0kg/m2. Pregnant mothers and those with babies two months postpartum were included in a separate category.

Child Characteristics

Child characteristics were the age, sex, birth order, size at birth, and presence of diarrhea, fever, or cough in the two weeks before the survey. Data on child's relative size at birth as reported by the mother was categorized as small, average, and large.

Data Analysis

Data were analyzed using SPSS version 18.0. Analysis was done at the descriptive, univariate, bivariate, and multivariate levels. The mean z-scores and standard deviations were calculated for the four anthropometric indices; (height-for-age, weight-for-age, weight-for-height, and BMI-for-age). Bivariate analysis was done and Pearson's chi square test used to check for associations between household, maternal, and child characteristics and malnutrition in the four surveys. Multivariate analysis used logistic regression to study the determinants of malnutrition, and a P value less than 0.05 was considered as significant. The multivariate model controlled for colinearity between variables. Analysis was carried out for the four KDHS surveys separately and then combined for trend analysis.

RESULTS

Characteristics of the Children

This study included 4,757 children of interviewed mothers in the 1993 KDHS, 4,413 in 1998, 4,893 in 2003, and 4,952 in 2008-09. In all the surveys half of the children were males and over 80% were in rural areas. Regionally, the largest percentages of children were in Rift Valley Province (22% in 1993, 26% in 1998, 27% in 2003, and 28% in 2008-09). The mean age was 29.5 months in 1993, 28.3 months in 1998 months, 27.8 months in 2003, and 28.7 months in 2008-09. The mean height and weight of the children in all the surveys was 82cm and 11kg.

Trends in the Levels of Malnutrition

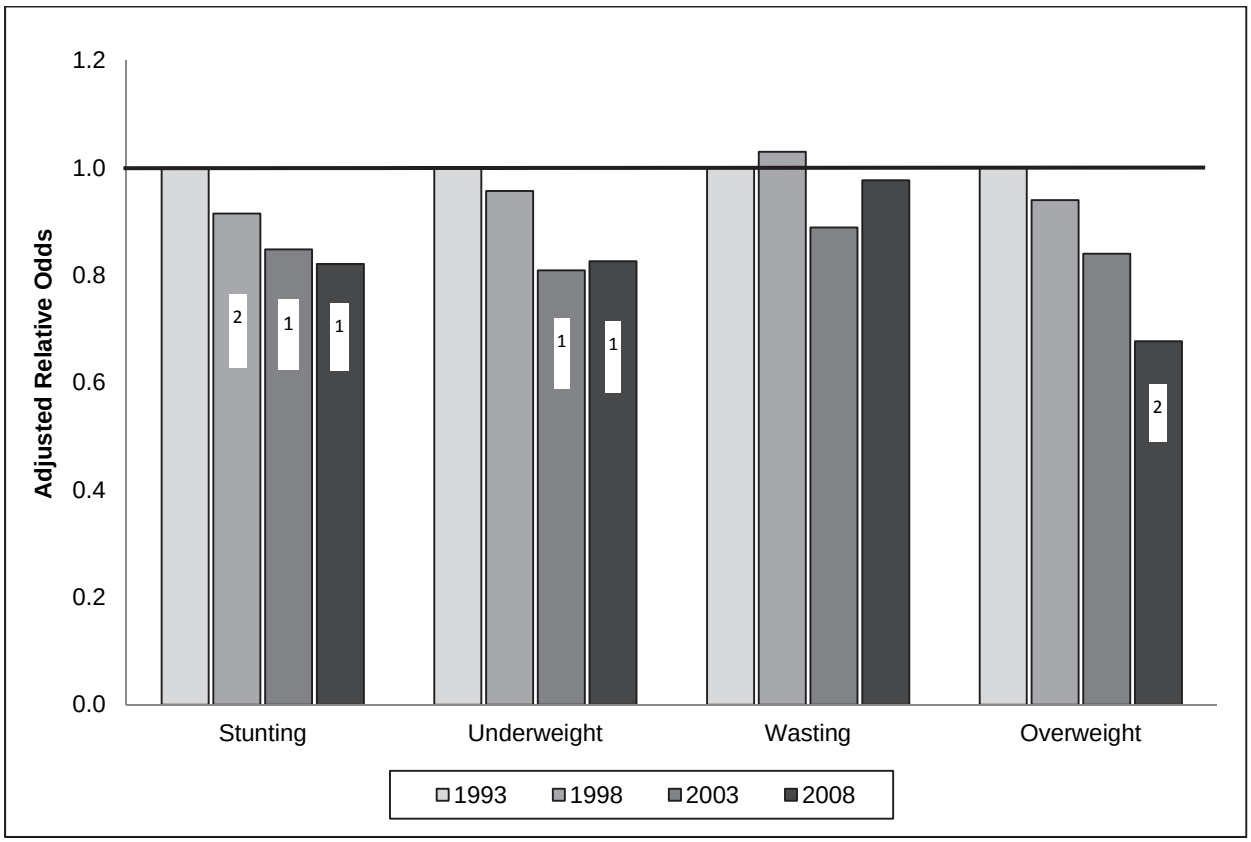
Table 1 presents the mean z scores and percent levels of malnutrition as measured by height-for-age, weight-for-age, weight-for-height, and BMI-for-age. The mean height-for-age z-score shows a slight increased from -1.6 in 1993 to -1.4 in 2008-09. The mean weight-for-age and BMI-for-age z-score did not change during the four surveys. The proportion of children stunted decreased from 40% in 1993 to 35% in 2008-09. The percent underweight declined from 19% to 16%, while wasting did not decline much between the first and fourth surveys.

A multivariate analysis of pooled data using 1993 as the reference category showed that, compared with 1993, children were significantly less likely to be stunted in the other three surveys and less likely to be underweight in 2003 and 2008-09 (Figure 2). The odds of wasting did not change significantly between the surveys. The overall proportion of overweight children measured by weight-for-height >+2SD decreased over the years.

Table 1. Trends of anthropometric indicators in children age 0 to 59 months (1993 to 2008-09), Kenya

	1993 (n=4,757)			1998 (n=4,413)			2003 (n=4,893)			2008-09 (n=4,958)		
Variable	**Mean**	**sd**	**%**	**Mean**	**sd**	**%**	**Mean**	**sd**	**%**	**Mean**	**sd**	**%**
Height-for-age (stunting)	-1.6	1.6	39.9	-1.5	1.7	37.7	-1.4	1.6	36.0	-1.4	1.6	35.3
Weight-for-age (underweight)	-0.9	1.3	18.7	-0.9	1.3	18.0	-0.8	1.2	15.7	-0.9	1.2	16.0
Weight-for-height (wasting)	0.0	1.3	6.7	-0.1	1.3	6.9	-0.0	1.3	6.0	-0.1	1.2	6.5
Weight-for-height (overweight)	0.0	1.3	5.7	-0.1	1.3	6.3	-0.0	1.3	5.7	-0.1	1.2	4.7
BMI for age overweight	0.1	1.3	7.2	0.1	1.4	7.7	0.1	1.3	7.0	0.1	1.3	6.2

Figure 2. Trends in adjusted relative odds of malnutrition among children age 0 to 59 months (1993 to 2008-09), Kenya



[1] Statistically significant at p value <0.001;

[2] statistically significant at p value < 0.05

Bivariate Analysis of Determinants of Undernutrition

Tables 2, 3, and 4 show the bivariate results of cross-tabulation between undernutrition and background characteristics in the four surveys. The results of the bivariate analysis using Pearson's chi square test showed significant associations between most of the household characteristics and child stunting (Table 2), wasting (Table 3), and underweight (Table 4) in the four surveys. The proportion of children with undernutrition was highest among rural residents compared with urban residents in all four surveys. The regional differentials of undernutrition showed that children in Coast Province and Eastern Province had the highest proportions of stunting and underweight throughout the surveys. Children in North Eastern Province had the highest proportions of wasting for the two surveys that sampled this region (2003 and 2008-09).

The proportion of stunted, wasted, and underweight children was negatively correlated with wealth index in all four surveys. Children in the lowest wealth quintile had the highest levels of stunting (Table 2). Similarly, wasting was 8% or more and underweight was above 20% in the four surveys among children in the lowest wealth quintiles (Tables 3 and 4.) Slightly more than half (51%) of the children living in households without toilet facilities were stunted in 1993, and 42% in 2008-09 (Table 2). The proportion of wasted children increased slightly in households without a toilet facility, from 9% in 1993 to 13% in 2008-09 (Table 3). More than one-quarter of children (28%) living in households without a toilet facility were underweight in 1993, 1998, and 2008-09, and 25% in 2003 (Table 4).

Among maternal characteristics studied, mother's education, BMI, and number of children living with the mother were significantly associated with undernutrition in the four surveys. The proportion of undernourished children declined as maternal educational attainment rose.

Child characteristics that were significantly associated with undernutrition included sex of child, age, birth order, size at birth, and presence of diarrhea in the two weeks before the survey. Male children had higher proportions of stunting in all four surveys (Table 2). Wasting was most prevalent among children age 7 to 12 months (Table 3). Children age 13 to 23 months had a higher prevalence of underweight in 1993 and 2003, while those age 24 to 35 months had a higher level of underweight in 1998 and 2008-09 (Table 4).

Children who were small at birth (as reported by the mother) were more stunted, wasted, and underweight throughout the four surveys compared with those average or large in size at birth. The level of stunting was higher in children who had diarrhoea preceding the surveys compared with those who did not have diarrhoea. Fever and cough were not significantly associated with stunting. The levels of stunting, wasting, and underweight were higher among children who had diarrhoea before the survey. Fever and cough were significantly associated with wasting and underweight, with higher levels of wasting and underweight among children who had fever and cough before the survey (Tables 3 and 4).

Table 2. Stunting among children age 0 to 59 months by household, maternal, and child characteristics (1993 to 2008-09), Kenya

Background characteristics	Stunting (Height-for-age <-2 SD)			
	1993 (n=4,757)	1998 (n=4,413)	2003 (n=4,893)	2008-09 (n=4,958)
Household characteristics				
Residence				
Rural	41.4	39.7	37.3	37.1
Urban	27.8	28.3	29.8	26.5
P value	*0.000*	*0.000*	*0.000*	*0.000*
Province				
North Eastern	na	na	29.2	36.1
Central	37.6	33.4	31.1	32.8
Coast	48.1	42.9	40.9	40.2
Eastern	47.6	43.3	40.5	41.6
Nyanza	39.5	35.8	35.7	31.3
Rift Valley	35.0	36.6	37.8	35.8
Western	36.7	39.9	35.1	32.1
Nairobi	32.1	28.5	23.7	29.1
P value	*0.000*	*0.000*	*0.000*	*0.000*
Sex of household head				
Female	41.8	37.1	35.8	37.8
Male	39.1	38.0	36.0	34.2
P value	*0.047*	*0.310*	*0.448*	*0.01*
Wealth index				
Poorest	43.1	49.2	44.5	44.2
Poorer	42.3	42.2	38.1	39.0
Middle	35.2	35.6	35.2	34.6
Richer	38.0	35.7	32.9	29.2
Richest	21.9	20.3	25.2	25.1
P value	*0.000*	*0.000*	*0.000*	*0.000*

Cont'd...

Table 2. Cont'd

Background characteristics	Stunting (Height-for-age <-2 SD)			
	1993 (n=4,757)	1998 (n=4,413)	2003 (n=4,893)	2008-09 (n=4,958)
Source of drinking water				
Non improved	42.4	40.4	40.3	38.8
Improved	37.3	30.4	30.7	32.5
P value	*0.000*	*0.000*	*0.000*	*0.000*
Toilet facilities				
No toilet facility	51.0	48.4	41.0	42.1
Not Improved	40.1	38.3	37.1	39.4
Improved toilet	21.9	21.3	23.2	27.9
P value	*0.000*	*0.000*	*0.000*	*0.000*
Maternal characteristics				
Mother's age (years)				
< 20	38.2	37.0	37.7	35.5
20 to 30	39.6	37.5	35.3	33.9
Above 30	40.6	38.4	36.8	37.7
P value	*0.676*	*0.834*	*0.468*	*0.037*
Marital status				
Married	40.1	37.7	36.1	35.1
Single	38.8	38.1	35.7	35.8
P value	*0.253*	*0.424*	*0.415*	*0.347*
Education				
No education	45.0	49.6	41.2	38.5
Primary	43.3	41.3	39.3	38.2
Secondary+	26.9	24.2	22.5	25.3
P value	*0.000*	*0.000*	*0.000*	*0.000*
Body mass index				
Pregnant and post-partum	43.3	37.7	37.1	32.3
Thin (<18.4)	46.8	47.4	44.5	45.3
Normal (18.5-24.9)	39.9	39.2	37.2	26.3
Overweight/obese (>24.9)	28.6	21.3	24.2	36.3
P value	*0.000*	*0.000*	*0.000*	*0.000*
Work status				
At home	39.9	36.8	36.6	36.6
Away from home	38.6	36.7	36.8	31.3
Not working	40.6	39.0	34.6	37.2
P value	*0.106*	*0.054*	*0.279*	*0.012*
Number of children < 5 living with mother				
One	34.1	34.1	30.4	30.2
Two	41.6	39.5	39.4	37.9
3 or more	42.7	39.8	37.7	37.2
P value	*0.000*	*0.002*	*0.000*	*0.000*

Cont'd...

Table 2. Cont'd

Background characteristics	Stunting (Height-for-age <-2 SD)			
	1993 (n=4,757)	1998 (n=4,413)	2003 (n=4,893)	2008-09 (n=4,958)
Child characteristics				
Sex				
Male	43.5	41.0	39.7	37.3
Female	36.3	34.4	32.2	33.1
P value	*0.000*	*0.002*	*0.000*	*0.001*
Age (months)				
< 6	16.0	14.8	14.8	10.4
7 to 12	26.1	24.9	21.3	29.9
13 to 23	45.2	42.5	46.9	45.2
24 to 35	53.7	49.9	48.1	45.9
36 to59	41.1	40.0	36.4	33.1
P value	*0.000*	*0.002*	*0.000*	*0.000*
Birth order				
First	35.3	34.7	30.6	32.0
2nd and 3rd	39.4	36.2	35.2	32.3
4th +	42.0	40.9	39.8	39.8
P value	*0.002*	*0.001*	*0.000*	*0.000*
Size at birth				
Small	47.7	44.1	46.8	44.9
Average	40.9	35.7	35.5	35.0
Large	34.3	33.2	30.5	30.5
P value	*0.000*	*0.001*	*0.000*	*0.000*
Diarrhoea				
Yes	46.3	44.8	40.3	37.0
No	38.7	34.6	35.1	34.9
P value	*0.000*	*0.000*	*0.003*	*0.136*
Fever				
Yes	40.2	33.8	35.9	34.9
No	39.6	40.0.	36.1	35.4
P value	*0.339*	*0.000*	*0.447*	*0.376*
Cough				
Yes	40.9	38.2	38.0	35.6
No	39.0	35.4	34.5	35.2
P value	*0.087*	*0.075*	*0.007*	*0.409*

[1] p values determined by Pearson Chi square compares differences within same characteristics in the same survey year.

[2] 1993 KDHS excluded North Eastern Province.

Table 3. Trends in wasting among children age 0 to 59 months by household, maternal, and child characteristics (1993 to 2008-09), Kenya

Background characteristics	Wasting (Weight-for-height) <-2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Household characteristics				
Residence				
Rural	6.8	7.0	6.3	6.9
Urban	5.2	6.0	4.6	5.1
P value	*0.910*	*0.160*	*0.000*	*0.036*
Province				
North Eastern[1]	na	na	26.5	20.0
Central	4.8	6.1	4.5	5.2
Coast	11.9	5.5	5.5	11.0
Eastern	7.8	5.3	4.3	7.0
Nyanza	6.0	8.4	3.1	3.9
Rift Valley	8.4	8.1	8.0	8.3
Western	3.9	4.8	6.4	2.3
Nairobi	1.8	8.4	3.9	3.9
P value	*0.000*	*0.017*	*0.000*	*0.000*
Sex of household head				
Female	5.5	7.0	5.5	5.6
Male	7.2	6.8	6.1	6.9
P value	*0.210*	*0.455*	*0.246*	*0.016*
Wealth index				
Poorest	10.7	7.9	9.0	11.7
Poorer	8.7	7.2	6.8	5.5
Middle	6.4	6.5	4.0	5.4
Richer	6.0	5.7	5.1	4.9
Richest	3.7	6.6	3.8	3.5
P value	*0.210*	*0.455*	*0.246*	*0.016*
Source of drinking water				
Non improved	7.8	7.1	6.2	7.7
Improved	5.6	6.2	5.5	5.6
P value	*0.001*	*0.172*	*0.177*	*0.002*
Toilet facilities				
No toilet facility	9.8	8.9	11.6	13.0
Not Improved	6.4	6.3	4.3	5.7
Improved toilet	4.1	1.0	4.0	4.7
P value	*0.000*	*0.036*	*0.000*	*0.000*
Maternal characteristics				
Mother's age				
Less than 20	5.4	6.2	7.7	7.8
20 to 30 years	7.0	7.2	6.0	6.3
Above30	6.4	6.4	5.6	6.9
P value	*0.524*	*0.538*	*0.338*	*0.538*

Cont'd...

Table 3. Cont'd

Background characteristics	Wasting (Weight-for-height) <-2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Marital status				
Single	7.9	5.6	6.1	6.5
Married	6.4	7.1	5.7	6.8
P value	*0.083*	*0.086*	*0.335*	*0.371*
Education				
No education	10.7	8.5	14.5	14.0
Primary	6.4	7.6	4.9	5.9
Secondary+	4.3	4.4	3.5	3.7
P value	*0.000*	*0.001*	*0.000*	*0.000*
Body mass index				
Pregnant and post-partum	5.6	7.1	6.7	6.0
Thin(<18.4)	13.7	10.8	14.1	11.7
Normal (18.5-24.9)	4.4	6.1	3.3	6.3
Overweight/obese (>24.9)	6.3	6.3	5.0	4.3
P value	*0.000*	*0.001*	*0.000*	*0.000*
Work status				
At home	6.0	6.8	5.0	7.5
Away from home	5.8	7.3	6.0	5.7
Not working	7.6	6.7	7.0	6.2
P value	*0.057*	*0.518*	*0.79*	*0.145*
Number of children < 5 living with mother				
One	4.8	5.4	5.4	4.9
Two	6.8	8.2	6.1	6.7
3 or more	8.3	6.4	6.7	8.4
P value	*0.002*	*0.005*	*0.340*	*0.001*
Child characteristics				
Sex				
Male	7.3	7.0	7.3	7.4
Female	6.1	6.8	4.7	5.6
P value	*0.052*	*0.392*	*0.000*	*0.006*
Age (months)				
< 6	9.1	10.7	7.5	9.5
7 to 12	10.2	10.8	8.5	9.7
13 to 23	8.6	7.8	8.0	5.2
24 to 35	5.2	4.0	4.8	6.3
36 to59	4.8	5.4	4.2	5.5
P value	*0.000*	*0.000*	*0.000*	*0.000*
Birth order				
First	4.5	5.0	5.8	5.7
2nd and 3rd	6.3	7.7	5.4	5.8
4th +	7.8	7.3	6.6	7.7
P value	*0.003*	*0.022*	*0.311*	*0.000*

Cont'd...

Table 3. Cont'd

Background characteristics	Wasting (Weight-for-height) <-2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Size at birth				
Small	10.8	8.4	8.6	11.0
Average	6.4	7.5	5.8	5.7
Large	5.3	7.4	4.8	5.6
P value	*0.000*	*0.814*	*0.002*	*0.000*
Diarrhoea				
Yes	12.3	11.0	10.3	9.5
No	5.7	7.0	5.1	5.9
P value	*0.000*	*0.002*	*0.000*	*0.000*
Fever				
Yes	7.3	8.6	6.6	8.0
No	6.2	7.0	5.5	6.0
P value	*0.860*	*0.062*	*0.056*	*0.009*
Cough				
Yes	6.8	7.4	6.0	6.8
No	6.6	7.8	5.9	6.4
P value	*0.405*	*0.362*	*0.461*	*0.358*

Table 4. Trends in underweight among children aged 0 to 59 months by household, maternal, and child characteristics (1993 to 2008-09), Kenya

Background characteristics	Underweight (Weight-for-age <-2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Household characteristics				
Residence				
Rural	19.8	19.6	16.9	17.1
Urban	10.3	10.6	10.0	10.4
P value	*0.000*	*0.000*	*0.000*	*0.000*
Province				
North Eastern[1]	na	na	30.1	25.4
Central	15.0	11.7	10.8	13.3
Coast	29.7	22.0	19.0	24.3
Eastern	23.6	22.7	17.2	19.9
Nyanza	17.2	18.7	11.6	10.3
Rift Valley	19.7	19.3	19.1	18.7
Western	12.7	15.5	16.1	10.5
Nairobi	8.6	7.6	5.2	7.8
P value	*0.000*	*0.000*	*0.000*	*0.000*
Sex of household head				
Female	19.7	18.0	15.2	15.3
Male	18.3	18.0	15.8	16.2
P value	*0.136*	*0.511*	*0.322*	*0.210*
Wealth index				
Poorest	22.9	26.1	24.1	24.7
Poorer	21.3	21.5	16.1	17.1
Middle	15.6	16.1	14.2	15.3
Richer	15.9	14.3	13.3	10.3
Richest	8.1	8.1	7.4	9.0
P value	*0.000*	*0.000*	*0.000*	*0.000*
Source of drinking water				
Non improved	20.1	20.0	18.0	19.2
Improved	14.3	12.6	11.0	13.4
P value	*0.000*	*0.000*	*0.000*	*0.000*
Toilet facilities				
No toilet facility	28.6	28.4	24.9	28.1
Not Improved	17.8	17.4	14.1	16
Improved toilet	10.1	7.6	8.2	10.4
P value	*0.000*	*0.000*	*0.000*	*0.000*
Maternal characteristics				
Mother's age				
Lessthan20	20.1	17.6	16.5	14.7
20 to 30years	18.1	16.8	15.4	14.4
Above 30	19.6	20.5	16.1	19.2
P value	*0.363*	*0.011*	*0.762*	*0.000*

Cont'd...

Table 4. Cont'd

Background characteristics	Underweight (Weight-for-age <-2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Marital status				
Single	18.6	17.8	16.2	16.1
Married	19.1	19.1	15.5	15.9
P value	*0.397*	*0.228*	*0.311*	*0.468*
Education				
No education	26.0	31.5	28.7	28.0
Primary	19.4	19.4	15.6	16.7
Secondary+	11.3	9.0	7.2	7.6
P value	*0.000*	*0.000*	*0.000*	*0.000*
Body mass index				
Pregnant and post-partum	17.6	17.0	12.8	16.2
Thin (<18.4)	34.3	32.7	29.5	28.8
Overweight/obese(>24.9)	18.1	17.5	16.2	7.1
Normal(18.5-24.9)	10.3	8.4	6.2	16.0
P value	*0.000*	*0.000*	*0.000*	*0.000*
Work status				
At home	18.9	17.3	15.3	16.5
Away from home	17.1	18.0	15.8	15.9
Not working	19.6	18.6	16.0	15.3
P value	*0.930*	*0.165*	*0.384*	*0.470*
Number of children < 5 living with mother				
One	13.1	14.7	11.8	11.1
Two	19.8	18.9	16.8	17.8
Three+	22.3	21.6	19.4	19.1
P value	*0.000*	*0.000*	*0.000*	*0.000*
Child characteristics				
Sex				
Male	21.0	19.0	18.7	16.4
Female	16.5	17.1	12.6	15.5
P value	*0.000*	*0.059*	*0.000*	*0.208*
Age (months)				
< 6	10.4	8.1	7.0	5.7
7 to 12	17.7	15.5	13.3	15.9
13 to 23	22.4	18.6	19.4	13.9
24 to 35	20.4	22.0	18.7	19.8
36 to59	18.7	19.7	16.0	17.8
P value	*0.000*	*0.000*	*0.000*	*0.000*
Birth order				
First	14.0	14.5	14.0	13.4
2nd and 3rd	17.6	16.8	13.7	12.8
4th +	21.3	21.2	18.5	20.3
P value	*0.000*	*0.000*	*0.000*	*0.000*

Cont'd...

Table 4. Cont'd

Background characteristics	Underweight (Weight-for-age <-2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Size at birth				
Small	30.0	25.8	28.6	28.9
Average	18.2	15.6	14.8	14.6
Large	14.1	14.9	10.0	11.1
P value	*0.000*	*0.000*	*0.000*	*0.000*
Diarrhoea				
Yes	25.7	23.3	23.1	19.2
No	17.5	15.8	14.2	15.3
P value	*0.000*	*0.000*	*0.000*	*0.030*
Fever				
Yes	19.9	20.3	17.3	17.3
No	17.8	14.6	14.6	15.5
P value	*0.043*	*0.000*	*0.006*	*0.670*
Cough				
Yes	19.8	19.0	17.2	18.2
No	17.8	16.0	14.6	15.1
P value	*0.036*	*0.023*	*0.006*	*0.005*

Bivariate Analysis of Determinants of Overweight

Table 5 presents the results of bivariate analysis of the relationship of background characteristics and overweight (weight-for-height > +2SD). Household background characteristics that were significantly associated with overweight were residence in (1993 and 2003), region (1993, 1998 and 2003), wealth index (1993, 1998 and 2003), source of drinking water (1998 and 2003), and availability of a toilet facility (1993 to 2003). The proportion of overweight children was higher in urban areas in 1993 (10%) and 2003 (9%) compared with the rural areas. In 1993 the proportion overweight was highest in Nairobi Province (13%) and lowest in Central Province (4%). However, this changed dramatically in 1998, when Central Province had the highest proportion of overweight (17%).

Children in the richest wealth quintile had a higher proportion of overweight, at 11% in 1993, 8% in 1998, 10% and 6% in 2008-09. Mother's education was significantly associated with overweight among their children in 1998 and 2008-09. Children of mothers with secondary or higher levels of education were more overweight, with 8% in 1998 and 7% in 2008-09, compared with children whose mothers had primary level or no education. Overweight mothers

(BMI >24.9) had a higher proportion of overweight children (9% in 1993, 8% in 1998, 8% in 2003 and 7% in 2008-09). Birth order was significantly associated with overweight in 1998 and 2008-09. In the first two surveys first-born children had a higher proportion of overweight compared with children of second to fourth birth orders. The size of child at birth was also significantly associated with overweight in 2003 and 1998-09. Children born large had higher prevalence of overweight compared with those born small or of average size.

Table 5. Trends in overweight/obesity in Kenya among children age 0 to 59 months (1993 to 2008-09) by household, maternal, and child characteristics (1993 to 2008-09), Kenya

Background characteristics	Overweight (Weight-for-Height > 2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Household characteristics				
Residence				
Rural	5.1	6.3	4.9	4.6
Urban	10.3	6.6	9.4	5.1
P value	*0.000*	*0.378*	*0.000*	*0.158*
Province				
North Eastern[1]			3.5	5.7
Central	4.2	16.5	6.8	5.2
Coast	3.4	2.6	4.0	3.4
Eastern	6.1	5.0	4.6	4.9
Nyanza	6.5	4.9	5.5	5.9
Rift Valley	5.2	6.6	5.5	3.7
Western	5.7	4.8	4.8	4.4
Nairobi	12.9	6.5	12.4	6.7
P value	*0.001*	*0.000*	*0.000*	*0.158*
Sex of household head				
Female	5.5	5.6	5.4	5.1
Male	5.8	6.6	5.8	4.5
P value	*0.134*	*0.134*	*0.315*	*0.204*
Wealth index				
Poorest	5.5	4.3	4.4	4.2
Poorer	6.0	6.0	3.2	4.0
Middle	6.0	7.1	6.0	4.2
Richer	6.0	7.1	6.0	5.8
Richest	11.4	7.7	9.9	5.5
P value	*0.000*	*0.019*	*0.000*	*0.221*
Source of drinking water				
Non improved	5.4	5.9	4.9	4.4
Improved	6.2	7.6	7.1	4.9
P value	*0.173*	*0.022*	*0.001*	*0.180*

Cont'd...

Table 5. Cont'd

Background characteristics	Overweight (Weight-for-Height > 2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Toilet facilities				
No toilet facility	5.6	3.7	4.5	4.0
Not Improved	5.2	6.9	5.0	4.7
Improved toilet	7.8	6.9	10.5	5.0
P value	*0.048*	*0.002*	*0.000*	*0.552*
Maternal characteristics				
Mother's age (years)				
< 20	6.2	7.3	8.1	7.3
20 to 30years	5.6	6.8	5.3	4.9
Above30	5.8	5.1	5.9	3.8
P value	*0.882*	*0.072*	*0.124*	*0.026*
Marital status				
Single	5.1	7.3	4.7	6.9
Married	5.8	6.1	5.8	4.1
P value	*0. 231*	*0.100*	*0.136*	*0.000*
Education				
No education	5.4	3.7	5.2	3.2
Primary	5.7	6.3	5.4	4.2
Secondary+	5.9	7.6	6.8	6.8
P value	*0. 913*	*0.014*	*0.181*	*0.000*
Body mass index				
Pregnant and post-partum	8.0	9.4	10.4	5.8
Thin (< 18.5)	2.3	2.9	2.5	1.0
Normal (18.5-24.9)	5.2	6.1	4.5	4.4
Overweight/obese (>24.9)	9.0	7.8	8.0	7.1
P value	*0. 000*	*0.000*	*0.000*	*0.000*
Work status				
At home	3.7	6.5	5.2	4.4
Away from home	7.0	6.3	5.9	4.1
Not working	6.0	6.2	5.9	5.7
P value	*0. 001*	*0.934*	*0.621*	*0.124*
Number of children < 5 living with mother				
One	6.7	7.9	7.0	5.4
Two	5.3	6.2	5.1	4.1
3 or more	5.3	4.1	4.9	4.7
P value	*0. 165*	*0.001*	*0.016*	*0.194*
Child characteristics				
Sex				
Male	5.7	6.6	5.6	4.4
Female	5.7	6.1	5.7	4.9
P value	*0. 471*	*0.270*	*0.476*	*0.207*

Cont'd..

Table 5. Cont'd

Background characteristics	Overweight (Weight-for-Height > 2 SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
Age (months)				
< 6	12.5	14.2	15.5	10.2
7 to 12	6.4	7.3	7.7	9.0
13 to 23	5.6	5.4	4.0	6.4
24 to 35	6.1	5.3	5.7	3.1
36 to 59	3.4	4.5	2.7	1.8
P value	*0. 000*	*0.000*	*0.000*	*0.000*
Birth order				
First born	5.4	8.3	6.6	6.6
2nd and 3rd born	6.0	6.0	5.7	4.7
4th born +	5.6	5.5	5.1	3.6
P value	*0. 768*	*0.008*	*0.208*	*0.001*
Size at birth				
Small	4.2	6.3	4.8	3.6
Average	5.6	7.6	5.3	4.1
Large	6.6	7.4	7.1	6.1
P value	*0. 071*	*0.649*	*0.043*	*0.004*
Diarrhoea				
Yes	5.7	4.3	4.4	3.0
No	4.9	8.0	5.9	5.0
P value	*0. 243*	*0.001*	*0.047*	*0.005*
Fever				
Yes	6.5	5.8	5.5	4.3
No	4.6	8.5	5.8	4.8
P value	*0. 0.003*	*0.004*	*0.359*	*0.293*
Cough				
Yes	6.4	3.9	5.3	4.6
No	4.8	9.6	6.0	4.7
P value	*0.011*	*0.000*	*0.181*	*0.460*

Multivariate Analysis: Adjusted Relative Odds of Undernutrition

Tables 6, 7, and 8 show the adjusted odds of undernutrition by background characteristics to identify the determinants of undernutrition among children and examine the changes in determinants over the four surveys. In Table 6, the factors that remained as significant determinants of stunting throughout the four surveys were household wealth index, availability and type of toilet facility, maternal education, maternal BMI, sex and age of child, and size at birth. In the earlier surveys (1993 and 1998), children in the poorest, poorer, middle, and richer

wealth quintiles were more than 1.5 times more likely to be stunted compared with those in the richest quintile. However, in the two more recent surveys, only children from the poorest wealth index were significantly more likely to be stunted (2.1 times more likely). Children in households without a toilet facility were 2.2 times more likely to be stunted in 1993, while children with an unimproved toilet facility were 1.5 times more likely. In 2003 and 2008-09, however, the association remained only among children in households with an unimproved toilet facility.

Table 6 also shows that children whose mothers had no education or had a primary education were over 1.5 times more likely to be stunted in 1993 and 1998 compared with those whose mothers had secondary or higher levels of education. Children were more likely to be stunted if their mothers were pregnant or two months postpartum, or were thin (BMI< 18.5) in 1993, 2003, and 2008-09. in 2008-09, children whose mothers were overweight (BMI <24.9) had significantly higher odds of being stunted (1.3). Male children were more likely than female children to be stunted throughout the surveys, while children of all ages were less likely to be stunted compared with those age 24-35 months. Children who were born small were two or more times more likely to be stunted in 1993, 1998, and 2003 compared with children born large. Similarly, children who were of average birth size were 1.4 times more likely to be stunted in the 1993 and 2003 surveys.

Table 6. Adjusted odds ratios of stunting among children age 0 to 59 month by household, maternal, and child characteristics (1993 to 2008-09), Kenya

Background characteristics	Adjusted odds ratios of stunting (height for age <-2SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Household characteristics				
Residence				
Rural	0.9[0.6,1.3]	1.1[0.7,1.7]	0.7[0.6,1.0]*	1.1[0.8,1.6]
Urban	Rc			
Province				
North Eastern[1]	na	na	0.5[0.3,0.9]*	0.5[0.3,0.8]**
Central	0.6[0.3,1.1]	0.7[0.4,1.5]	1.1[0.7,1.7]	0.7[0.4,1.2]
Coast	0.5[0.3,1.0]	0.8[0.4,1.6]	1.3[0.8,1.9]	0.8[0.4,1.5]
Eastern	0.6[0.3,1.1]	0.8[0.4,1.4]	1.3[0.8,2.0]	0.7[0.4,1.2]
Nyanza	0.5[0.3,0.9]*	0.6[0.3,1.1]	1.0[0.6,1.6]	0.5[0.3,0.8]**
Rift Valley	0.4[0.2,0.7]**	0.6[0.3,1]	1.1[0.7,1.7]	0.5[0.3,0.9]*
Western	0.4[0.2,0.7]**	0.7[0.4,1.4]	0.9[0.6,1.4]	0.4[0.2,0.7]**
Nairobi	Rc			
Sex of household head				
Female	1.2[1,1.5]	1.0[0.8,1.2]	1.0[0.8,1.2]	0.9[0.7,1.1]
Male	Rc			
Wealth index				
Poorest	2.1[1.3,3.3]**	2.6[1.6,4.3]***	1.6[1.1,2.4]*	2.1[1.4,3.1]**
Poorer	2.1[1.4,3.3]**	2.0[1.3,3.2]**	1.3[0.9,1.9]	1.5[1.0,2.1]
Middle	1.7[1.1,2.6]*	1.7[1.1,2.6]*	1.2[0.8,1.7]	1.3[0.9,2.0]
Richer	1.6[1.1,2.3]*	1.7[1.1,2.7]*	1.1[0.8,1.6]	1.2[0.9,1.8]
Richest	Rc			
Source of drinking water				
Non improved	0.8[0.6,1.1]	0.9[0.7,1.2]	1.2[1.0,1.4]	1.0[0.8,1.2]
Improved	Rc			
Toilet facilities				
No toilet facility	2.2[1.3,3.7]**	1.4[0.9,2.1]	1.1[0.8,1.6]	1.1[0.8,1.5]
Not Improved	1.5[1.0,2.3]*	1.3[0.9,1.8]	1.4[1.0,1.8]*	1.3[1.1,1.6]**
Improved toilet	Rc			
Maternal characteristics				
Mother's age				
Less than 20	1.2[0.7,2.1]	1.5[0.9,2.5]	1.8[1.2,2.8]**	1.1[0.7,1.8]
20 to 30 years	1.0[0.8,1.3]	1.2[0.9,1.5]	1.0[0.8,1.3]	0.9[0.7,1.2]
Above30	Rc			
Marital status				
Single	1.0[0.8,1.3]	1.2[0.9,1.5]	1.0[0.8,1.3]	1.1[0.9,1.4]
Married	Rc			
Education				
No education	1.6[1.1,2.3]*	1.7[1.2,2.5]**	1.7[1.2,2.4]**	0.9[0.7,1.3]
Primary	1.7[1.3,2.2]***	1.5[1.2,1.9]**	1.7[1.4,2.2]***	1.3[1.1,1.7]*
Secondary+	Rc			

Cont'd...

Table 6. Cont'd

Background characteristics	Adjusted odds ratios of stunting (height for age <-2SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Body mass index				
Pregnant and post-partum	1.5[1.1,1.9]**	1.3[1.0,1.7]	1.2[1.0,1.5]*	1.5[1.0,2.1]*
Thin(<18.4)	1.4[1.0,2.0]*	1.2[0.9,1.6]	1.2[1.0,1.5]*	1.7[1.2,2.5]**
Overweight/obese(>24.9)	0.8[0.6,1.2]	0.5[0.4,0.8]**	0.6[0.5,0.8]***	1.3[1,1.7]*
Normal (18.5-24.9)	Rc			
Work status				
At home	0.9[0.7,1.2]	0.9[0.8,1.2]	1.1[0.9,1.3]	1.3[1,1.6]*
Away from home	1.0[0.8,1.3]	1.0[0.8,1.2]	1.2[1,1.5]	1.1[0.9,1.4]
Not working	Rc			
Number of children < 5 living with mother				
One	0.7[0.5,1.0]*	0.9[0.7,1.3]	0.7[0.6,0.9]*	0.8[0.6,1.0]*
Two	1.0[0.8,1.3]	1.0[0.7,1.3]	1.0[0.8,1.2]	1.0[0.8,1.3]
3 or more	Rc			
Child characteristics				
Sex				
Male	1.5[1.3,1.8]***	1.6[1.3,1.9]***	1.5[1.3,1.7]***	1.3[1.1,1.5]**
Female	Rc			
Age (months)				
Less than 6 months	0.1[0.1,0.2]***	0.1[0.1,0.2]***	0.1[0.1,0.2]***	0.1[0.1,0.2]***
7 to 12	0.3[0.2,0.4]***	0.3[0.2,0.4]***	0.2[0.2,0.3]***	0.5[0.3,0.6]***
13 to 23	0.7[0.5,0.9]**	0.7[0.5,0.8]***	0.9[0.7,1.1]	1.0[0.8,1.4]
24 to 35	Rc			
36 to59	0.6[0.5,0.8]**	0.7[0.6,0.8]***	0.6[0.5,0.8]***	0.6[0.5,0.7]***
Birth order				
First	0.8[0.5,1.2]	0.7[0.5,1.0]	0.7[0.5,0.9]**	2.0[1.5,2.6]***
2nd and 3rd	0.9[0.7,1.2]	0.9[0.7,1.1]	0.9[0.7,1.1]	1.3[1.1,1.6]**
4th +	Rc			
Size at birth				
Small	2.2[1.6,3.0]***	2.0[1.5,2.9]***	2.1[1.6,2.6]***	0.9[0.7,1.2]
Average	1.4[1.1,1.7]**	1.2[1.0,1.5]	1.4[1.2,1.7]***	0.8[0.6,1.1]
Large	Rc			
Diarrhoea				
Yes	0.7[0.5,0.9]*	1.6[1.2,2.0]**	1.1[0.9,1.3]	1.0[0.8,1.2]
No	Rc			
Fever				
Yes	1.1[0.9,1.4]	1.1[0.9,1.4]	0.9[0.8,1.1]	1.0[0.8,1.2]
No	Rc			
Cough				
Yes	0.9[0.8,1.1]	1.0[0.8,1.3]	1.2[1.0,1.4]*	1.0[0.8,1.2]
No	Rc			

*P<0.05; ** P<0.005; ***P<0.001; Rc (reference category)

In Table 7, region of residence and household wealth index were not associated with wasting in the 1993 and 2003 surveys. However, wasting was associated with region of residence in 1998, and wealth index in 2008-09. In the 2008-09 survey children in the poorest to richer wealth indexes were more likely to be wasted compared with the richest, and children in the poorest wealth index were 3.8 times more likely. Maternal education was a determinant of child wasting in 1993. In 1998 and 2003 children of non-educated mothers were more than twice as likely as women with the highest level of education to be wasted, but differences in wasting by education were no longer significant in 2008-09. Low maternal BMI was a determinant of wasting in 1993, 1998, and 2003. Diarrhoea was also a determinant of wasting in 1998 and 2003.

Table 7. Adjusted odds ratios of wasting among children age 0 to 59 month by household, maternal, and child characteristics (1993 to 2008-09), Kenya

	Adjusted odds ratios of wasting (weight for height <-SD)			
Background characteristics	**1993 (n=4,757)**	**1998 (n=4,433)**	**2003 (n=4,893)**	**2008-09 (n=4,958)**
	Exp. B [CI]			
Household characteristics				
Residence				
Rural	0.7[0.4,1.5]	2.2[1.2,3.9]**	1.1[0.6,2.0]	0.6[0.3,1.0]*
Urban	Rc			
Province				
North Eastern[1]	na	na	2.2[0.7,6.7]	2.4[0.8,7.4]
Central	1.3[0.3,5.5]	0.4[0.1,1.1]	1.1[0.4,2.9]	1.2[0.4,3.8]
Coast	3.7[0.9,14.9]	0.4[0.1,1.0]*	0.5[0.2,1.3]	1.7[0.6,4.8]
Eastern	1.9[0.4,8.0]	0.4[0.1,0.9]*	0.7[0.2,1.9]	1.3[0.4,3.9]
Nyanza	1.5[0.3,6.2]	0.8[0.3,1.9]	0.4[0.1,1.1]	0.8[0.2,2.3]
Rift Valley	1.8[0.4,7.7]	0.4[0.2,1.0]*	0.9[0.4,2.3]	1.3[0.5,3.8]
Western	0.8[0.2,3.7]	0.3[0.1,0.9]*	1.2[0.5,2.9]	0.3[0.1,1.2]
Nairobi	Rc			
Sex of household head				
Female	0.7[0.5,1.0]*	1.3[0.9,1.9]	0.9[0.6,1.4]	0.7[0.5,1.0]*
Male	Rc			
Wealth index				
Poorest	1.5[0.7,3.3]	0.8[0.3,1.9]	1.1[0.5,2.6]	3.8[1.7,8.5]**
Poorer	1.3[0.6,2.7]	0.9[0.4,1.9]	1.3[0.6,3.0]	2.4[1.1,5.2]*
Middle	1.1[0.5,2.4]	0.6[0.3,1.4]	0.8[0.4,1.9]	2.2[1.1,4.7]*
Richer	1.0[0.5,2.1]	0.6[0.3,1.3]	1.2[0.6,2.4]	1.7[0.9,3.2]
Richest	Rc			

Cont'd...

Table 7. Cont'd

Background characteristics	Adjusted odds ratios of wasting (weight for height <-SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Source of drinking water				
Non improved	1.3[0.8,2.2]	0.9[0.5,1.5]	1.1[0.8,1.6]	1.0[0.7,1.4]
Improved	Rc			
Toilet facilities				
No toilet facility	1.6[0.6,3.8]	1.0[0.4,2.1]	1.5[0.7,3.0]	1.0[0.6,1.7]
Not Improved	1.6[0.7,3.5]	1.0[0.5,1.9]	0.8[0.5,1.5]	1.0[0.6,1.5]
Improved toilet	Rc			
Maternal characteristics				
Mother's age (years)				
< 20	1.0[0.4,2.6]	0.7[0.3,1.7]	1.1[0.5,2.3]	0.7[0.3,1.5]
20 to 30	1.7[1.1,2.7]*	1.1[0.7,1.6]	1.0[0.6,1.5]	0.8[0.5,1.2]
Above 30	Rc			
Marital status				
Single	1.6[1.1,2.4]*	0.7[0.4,1.1]	1.2[0.6,2.3]	1.2[0.8,1.8]
Married	Rc			
Education				
No education	1.7[0.9,3.2]	2.3[1.2,4.5]*	2.2[1.1,4.4]*	1.6[0.9,3.1]
Primary	1.3[0.8,2.2]	2.1[1.4,3.3]**	1.1[0.7,1.9]	1.3[0.8,2]
Secondary +	Rc			
Body mass index				
Pregnant and post-partum	0.7[0.4,1.2]	0.8[0.5,1.4]	1.5[1,2.2.0]	0.8[0.5,1.3]
Thin (<18.4)	1.9[1.2,2.9]**	1.7[1.1,2.5]*	2.5[1.7,3.9]***	1.4[1,2.1]
Overweight/obese (>24.9)	0.7[0.3,1.3]	1.0[0.5,1.8]	0.9[0.5,1.6]	0.9[0.5,1.5]
Normal (18.5-24.9)	Rc			
Work status				
At home	1.0[0.6,1.5]	0.9[0.6,1.4]	0.9[0.6,1.3]	0.9[0.6,1.4]
Away from home	0.9[0.6,1.4]	1.1[0.8,1.6]	1.4[0.9,2.1]	1.1[0.7,1.6]
Not working	Rc			
Number of children < 5 living with mother				
One	0.7[0.4,1.2]	0.8[0.5,1.2]	0.7[0.5,1.1]	0.8[0.5,1.2]
Two	0.9[0.6,1.4]	1.3[0.8,1.9]	0.9[0.6,1.3]	1.0[0.7,1.4]
3 or more	Rc			
Child characteristics				
Sex				
Male	1.2[0.9,1.7]	1.1[0.8,1.5]	1.6[1.2,2.2]**	1.4[1.0,1.9]
Female	Rc			
Age (months)				
< 6	1.8[1.0,3.3]*	3.3[2.0,5.4]***	1.7[1,2.8]	1.6[1.0,2.8]
7 to 12	1.7[0.9,3.0]	2.7[1.6,4.5]***	2.0[1.2,3.3]**	1.4[0.8,2.5]
13 to 23	1.4[0.8,2.5]	1.9[1.2,2.9]**	1.7[1.1,2.7]*	0.8[0.5,1.3]
24 to 35	Rc			
36 to 59	1.2[0.6,2.2]	1.3[0.8,2.1]	1.0[0.7,1.5]	0.8[0.5,1.2]

Cont'd...

Table 7. Cont'd

Background characteristics	Adjusted odds ratios of wasting (weight for height <-SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Birth order				
First	0.5[0.2,1.1]	1.0[0.5,1.8]	1.1[0.6,1.9]	1.2[0.7,1.9]
2nd and 3rd	0.7[0.4,1.0]	1.1[0.7,1.7]	1.0[0.6,1.6]	1.0[0.6,1.5]
4th +	Rc			
Size at birth				
Small	1.6[1,2.6]*	1.3[0.8,2.1]	1.5[1,2.3]	1.8[1.2,2.7]**
Average	1.0[0.7,1.5]	1.2[0.8,1.8]	1.2[0.8,1.7]	1.0[0.7,1.3]
Large	Rc			
Diarrhoea				
Yes	0.5[0.4,0.8]**	1.5[1,2.2.0]*	1.8[1.3,2.6]**	1.3[1.0,1.8]
No	Rc			
Fever				
Yes	0.8[0.6,1.2]	1.2[0.8,1.7]	1.2[0.9,1.6]	1.3[0.9,2.0]
No	Rc			
Cough				
Yes	1.2[0.8,1.8]	0.8[0.6,1.1]	0.9[0.7,1.2]	0.7[0.5,1.0]
No	Rc			

*P<0.05; ** P<0.005; ***P<0.001; Rc (reference category)

Table 8 shows that determinants of underweight differed to a large extent from those of stunting and wasting in the four surveys. Household background factors did not play a crucial role in determining underweight. Maternal education, BMI, and the number of children living with the mother, as well as the child's sex, age, size at birth, and the presence of diarrhoea remained significant in determining underweight over the four surveys. Children whose mothers had no education were significantly more likely to be underweight in 1993, 1998, and 2003 compared with those whose mothers had secondary or higher education. Underweight was 1.6 times more likely to occur in children whose mothers had primary education in 1993, 1998 and 2003, and 1.7 times more likely in 2008-09, compared with children whose mothers had secondary or higher levels of education. In all four surveys underweight was one-and-a-half times more likely to occur in children of thin mothers compared with children of mothers with normal BMI.

Table 8. Adjusted odds ratios for underweight among children age 0 to 59 month by household, maternal, and child characteristics (1993 to 2008-09), Kenya

Background characteristics	Adjusted Odds ratios of underweight (weight for age <-SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Household characteristics				
Residence				
Rural	1.4[0.7,2.5]	1.3[0.8,2.2]	0.9[0.6,1.3]	0.9[0.6,1.3]
Urban	Rc			
Province				
North Eastern[1]	na	na	2.0[0.8,4.9]	1.2[0.6,2.3]
Central	0.7[0.3,1.8]	0.6[0.2,2.0]	1.6[0.7,3.8]	1.3[0.6,2.6]
Coast	1.2[0.5,2.8]	1.0[0.3,2.9]	1.6[0.7,3.6]	1.7[0.8,3.7]
Eastern	0.8[0.3,2.0]	1.1[0.4,3.4]	2.0[0.9,4.5]	1.3[0.7,2.7]
Nyanza	0.7[0.3,1.7]	1.6[0.5,4.7]	1.1[0.5,2.6]	0.8[0.4,1.6]
Rift Valley	0.7[0.3,1.6]	0.8[0.3,2.4]	1.8[0.8,4.1]	1.2[0.6,2.3]
Western	0.4[0.2,1]	1.0[0.3,2.9]	1.7[0.7,3.8]	0.6[0.3,1.3]
Nairobi	Rc			
Sex of household head				
Female	1.1[0.8,1.5]	1.0[0.8,1.4]	0.9[0.6,1.2]	0.8[0.6,1.1]
Male	Rc			
Wealth index				
Poorest	1.5[0.8,2.7]	1.6[0.8,3.1]	1.6[0.9,2.7]	1.6[0.9,3.1]
Poorer	1.6[0.9,2.7]	1.2[0.7,2.1]	1.2[0.7,2.1]	1.3[0.7,2.3]
Middle	1.3[0.7,2.2]	1.0[0.5,1.9]	1.2[0.7,1.9]	1.3[0.8,2.2]
Richer	1.3[0.8,2.2]	1.1[0.6,1.9]	1.2[0.7,1.9]	0.9[0.6,1.5]
Richest	Rc			
Source of drinking water				
Non improved	1.1[0.7,1.6]	0.8[0.6,1.2]	1.2[0.9,1.5]	1.1[0.8,1.4]
Improved	Rc			
Toilet facilities				
No toilet facility	1.2[0.7,2.3]	2.7[1.5,5.0]**	1.1[0.7,1.8]	1.5[1,2.2.0]
Not Improved	1.0[0.6,1.8]	2.1[1.2,3.6]**	1.1[0.7,1.6]	1.2[0.9,1.7]
Improved toilet	Rc			
Maternal characteristics				
Mother's age				
Less than 20	2.0[1.1,3.7]*	0.8[0.5,1.5]	1.5[0.9,2.6]	0.8[0.5,1.3]
20 to 30 years	1.3[1.0,1.7]	0.8[0.6,1.1]	1.0[0.8,1.4]	0.7[0.6,1.0]*
Above30	Rc			
Marital status				
Single	1.2[0.9,1.7]	1.3[0.9,1.8]	1.3[0.9,1.9]	1.2[0.9,1.5]
Married	Rc			
Education				
No education	2.1[1.3,3.3]**	2.5[1.5,4.0]***	2.7[1.8,4.0]***	1.5[0.9,2.5]
Primary	1.6[1.1,2.2]**	1.6[1.1,2.3]*	1.6[1.2,2.2]**	1.7[1.2,2.4]*
Secondary+	Rc			

Cont'd...

Table 8. Cont'd

Background characteristics	Adjusted Odds ratios of underweight (weight for age <-SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Body mass index				
Pregnant and post-partum	1.1[0.8,1.6]	1.2[0.8,1.8]	0.9[0.6,1.3]	1.2[0.9,1.6]
Thin (<18.4)	1.8[1.3,2.5]**	1.8[1.3,2.5]**	1.8[1.3,2.3]***	1.7[1.2,2.3]**
Overweight/obese (>24.9)	0.6[0.4,0.9]*	0.8[0.5,1.2]	0.4[0.3,0.7]***	0.5[0.3,0.8]**
Normal (18.5-24.9)	Rc			
Work status				
At home	1.1[0.9,1.5]	0.8[0.6,1.1]	1.1[0.8,1.4]	0.9[0.7,1.2]
Away from home	1.0[0.8,1.4]	1.0[0.7,1.4]	1.3[1,1.7]	1.0[0.7,1.3]
Not working	Rc			
Number of children < 5 living with mother				
One	0.5[0.4,0.8]**	0.6[0.4,0.9]**	0.5[0.4,0.7]***	0.6[0.5,0.9]**
Two	0.8[0.6,1.1]	0.7[0.6,1.0]*	0.7[0.6,1.0]*	1.0[0.7,1.3]
3 or more	Rc			
Child characteristics				
Sex				
Male	1.5[1.2,1.9]**	1.5[1.2,1.9]**	1.7[1.4,2.2]***	1.2[1,1.5]
Female	Rc			
Age (months)				
< 6 months	0.3[0.2,0.6]***	0.3[0.2,0.4]***	0.3[0.2,0.4]***	0.2[0.1,0.4]***
7 to 12	0.6[0.4,0.9]*	0.6[0.4,0.9]*	0.5[0.4,0.7]***	0.7[0.4,1.0]
13 to 23	1.0[0.7,1.4]	0.8[0.6,1.0]*	0.9[0.7,1.3]	0.6[0.5,0.9]*
24 to 35	Rc			
36 to59	0.8[0.6,1.2]	1.1[0.9,1.4]	0.9[0.7,1.2]	0.9[0.6,1.1]
Birth order				
First	0.5[0.3,0.8]**	1.0[0.6,1.6]	0.8[0.5,1.2]	1.0[0.7,1.5]
2nd and 3rd	0.7[0.5,1.0]*	1.1[0.8,1.5]	0.8[0.6,1]	0.8[0.6,1.0]
4th +	Rc			
Size at birth				
Small	2.4[1.7,3.4]***	2.8[1.9,4.1]***	3.7[2.7,5.0]***	3.3[2.4,4.7]***
Average	1.1[0.8,1.5]	1.4[1.0,1.9]*	1.7[1.3,2.3]***	1.4[1.1,1.8]*
Large	Rc			
Diarrhoea				
Yes	0.6[0.5,0.8]**	1.4[1.0,1.9]*	1.7[1.3,2.2]***	1.1[0.9,1.5]
No	Rc			
Fever				
Yes	0.9[0.7,1.2]	1.2[1,1.6]	1.2[1,1.5]	1.0[0.7,1.3]
No	Rc			
Cough				
Yes	1.0[0.8,1.2]	1.0[0.8,1.4]	1.1[0.9,1.4]	1.1[0.8,1.5]
No	Rc			

*P<0.05; ** P<0.005; ***P<0.001; Rc (reference category)

Multivariate Analysis: Adjusted Relative Odds of Overweight

Table 9 shows that, most notably, maternal BMI was a determinant of overweight among children in 1993 and 2008-09. In 2008-09 children whose mothers were overweight (BMI> 24.5) were 1.8 times more likely to be overweight compared with children of mothers who had normal BMI, and in the other surveys 1.5 or 1.4 times more likely. Also, in 1993 children in rural areas were significantly less likely to be overweight compared with urban children. However, the likelihood of overweight among children in rural areas increased to the same level as children in urban areas in 2003, and rural children were 1.4 times more likely than urban children in 2008-09, although this difference was not statistically significant.

Table 9. Adjusted odds ratios for overweight among children age 0 to 59 month by household, maternal, and child characteristics (1993 to 2008-09), Kenya

Background characteristics	Adjusted odds ratios for overweight (weight for height >+2SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Household characteristics				
Residence				
Rural	0.4[0.2,0.8]*	0.8[0.4,1.6]	1.0[0.5,1.8]	1.4[0.7,2.7]
Urban	Rc			
Province				
North Eastern[1]	na	na	0.5[0.1,1.7]	2.1[0.7,5.9]
Central	0.6[0.2,1.9]	2.9[1.1,7.6]*	0.8[0.4,1.5]	0.7[0.3,1.9]
Coast	0.6[0.2,1.7]	0.4[0.2,1.1]	0.5[0.2,1.1]	0.6[0.3,1.6]
Eastern	1.2[0.5,3.3]	1.2[0.5,2.9]	0.6[0.3,1.3]	0.8[0.3,2.0]
Nyanza	1.0[0.4,2.8]	0.7[0.3,1.7]	0.8[0.4,1.6]	0.8[0.3,2.0]
Rift Valley	1.1[0.4,3.0]	1.7[0.7,3.9]	0.8[0.4,1.4]	0.6[0.3,1.4]
Western	0.9[0.3,2.6]	0.8[0.3,2.0]	0.8[0.4,1.5]	0.8[0.3,1.8]
Nairobi	Rc			
Sex of household head				
Female	1.0[0.7,1.5]	0.8[0.5,1.1]	1.1[0.8,1.6]	1.0[0.7,1.5]
Male	Rc			
Wealth index				
Poorest	0.6[0.3,1.2]	0.9[0.4,1.8]	0.8[0.3,2.0]	1.1[0.5,2.5]
Poorer	0.6[0.3,1.2]	1.3[0.6,2.6]	0.5[0.2,1.2]	0.9[0.4,2.0]
Middle	0.7[0.3,1.2]	0.9[0.5,1.8]	1.0[0.5,2.0]	0.9[0.5,1.9]
Richer	0.6[0.3,1.2]	0.9[0.5,1.8]	0.9[0.5,1.7]	1.3[0.6,2.5]
Richest	Rc			

Cont'd...

Table 9. Cont'd

Background characteristics	Adjusted odds ratios for overweight (weight for height >+2SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Source of drinking water				
Non improved	1.1[0.7,1.7]	0.8[0.5,1.3]	1.0[0.7,1.4]	1.0[0.7,1.4]
Improved	Rc			
Toilet facilities				
No toilet facility	1.6[0.8,3.4]	0.7[0.3,1.8]	0.7[0.3,1.6]	1.3[0.7,2.4]
Not Improved	1.4[0.7,2.5]	1.4[0.7,2.7]	0.6[0.0.4,1]*	1.1[0.8,1.7]
Improved toilet	Rc			
Maternal characteristics				
Mother's age				
Less than 20	0.9[0.4,2.1]	0.9[0.4,2.1]	0.6[0.3,1.3]	0.6[0.3,1.5]
20 to 30 years	0.8[0.5,1.2]	1.1[0.6,1.7]	0.7[0.5,1]	0.9[0.6,1.4]
Above30	Rc			
Marital status				
Single	0.8[0.5,1.2]	1.0[0.7,1.5]	0.7[0.4,1.0]	1.5[1.0,2.4]
Married	Rc			
Education				
No education	1.0[0.5,2.0]	1.0[0.5,2.1]	1.3[0.7,2.6]	0.6[0.3,1.2]
Primary	1.3[0.8,2.0]	1.1[0.8,1.7]	1.1[0.8,1.7]	0.8[0.5,1.2]
Secondary+	Rc			
Body mass index				
Pregnant and post-partum	1.4[0.9,2.1]	1.5[1,2.3.0]*	1.7[1.2,2.4]*	1.2[0.8,1.8]
Thin(<18.4)	0.4[0.2,1.0]*	0.6[0.3,1.2]	0.6[0.3,1.2]	0.3[0.1,0.6]*
Overweight/obese(>24.9)	1.5[0.9,2.3]	1.4[0.8,2.4]	1.5[1.0,2.2]	1.8[1.1,2.7]*
Normal (18.5-24.9)	Rc			
Work status				
At home	0.6[0.4,1.0]*	1.2[0.8,1.8]	1.0[0.7,1.5]	1.1[0.7,1.8]
Away from home	1.1[0.7,1.6]	1[0.7,1.6.0]	1.1[0.8,1.7]	1.4[0.9,2.2]
Not working	Rc			
Number of children < 5 living with mother				
One	1.6[0.9,2.7]	1.6[0.9,2.6]	1.4[0.8,2.2]	0.9[0.6,1.5]
Two	1.6[1.0,2.5]*	1.3[0.8,2.0]	1.1[0.8,1.6]	0.9[0.6,1.5]
3 or more	Rc			
Child characteristics				
Sex				
Male	1.0[0.7,1.4]	1.1[0.8,1.5]	1.0[0.7,1.3]	0.8[0.6,1.2]
Female	Rc			
Age (months)				
< 6 months	2.2[1.4,3.6]**	3.0[1.9,4.7]***	3.3[2.2,5.0]***	3.4[2.0,5.6]***
7 to 12	1.2[0.7,2.2]	1.5[0.9,2.5]	1.6[1.0,2.7]	3.5[1.9,6.5]***
13 to 23	1.0[0.6,1.7]	1.2[0.8,1.8]	0.8[0.5,1.2]	2.6[1.5,4.4]*
24 to 35	Rc			
36 to59	0.3[0.1,0.6]**	0.8[0.5,1.2]	0.4[0.3,0.7]**	0.5[0.3,0.9]*

Cont'd...

Table 9. Cont'd

Background characteristics	Adjusted odds ratios for overweight (weight for height >+2SD)			
	1993 (n=4,757)	1998 (n=4,433)	2003 (n=4,893)	2008-09 (n=4,958)
	Exp. B [CI]			
Birth order				
First	0.9[0.4,1.9]	1.3[0.6,2.5]	1.6[0.9,2.9]	2.0[1.1,3.8]*
2nd and 3rd	1.1[0.7,1.8]	1.1[0.6,1.8]	1.4[0.9,2.0]	1.4[0.8,2.3]
4th +	Rc			
Size at birth				
Small	0.5[0.3,1.0]*	0.7[0.4,1.1]	0.7[0.4,1.2]	0.6[0.3,1.1]
Average	0.7[0.5,1.0]	0.8[0.5,1.1]	0.7[0.5,1.0]	0.6[0.4,0.9]*
Large	Rc			
Diarrhoea				
Yes	0.9[0.6,1.4]	0.7[0.4,1.1]	0.6[0.4,0.9]*	0.4[0.3,0.8]*
No	Rc			
Fever				
Yes	1.7[1.1,2.5]**	1.2[0.8,1.7]	1.0[0.7,1.4]	1.0[0.5,1.7]
No	Rc			
Cough				
Yes	1.1[0.7,1.6]	0.4[0.3,0.6]***	1.0[0.7,1.4]	1.1[0.7,1.9]
No	Rc			

*P<0.05; ** P<0.005; ***P<0.001; Rc (reference category)

DISCUSSION

Trends in Malnutrition

The analysis shows a slight but statistically significant decline in chronic malnutrition as well as a slight decline in the percentage underweight in Kenya between 1993 and 2008-09. Nonetheless, stunting remains of high public health significance in Kenya, while underweight is of medium public health significance, as per the WHO classification (WHO 1995). The 1999-2004 Kenya Ministry of Health strategic plan (MOH 1999), which aimed to reduce undernutrition among the under-five population by 30%, is far from being achieved, considering the very small change in the proportion of stunted children between 2003 and 2008-09, which might be attributed to the increasing social and human development efforts in the country in recent years. Examples of such programs are the social revolving development funds, such as the community development fund, youth fund, and the women's fund. These resources are part of the government's efforts to stimulate human and economic development through the micro and small enterprises that cut across all sectors of the economy, resulting to an increase in economic growth.

Regional differentials show very high public health significance of stunting in Coast and Eastern Provinces, at over 40%. The levels of acute malnutrition measured by wasting did not change much over the surveys, remaining at about 6%. This form of malnutrition is caused mainly by recent inadequate food intake infections or incorrect feeding practices and reflects the nutritional status of children in the short-term. Kenya has been faced with repeated cycles of famine and drought, resulting to insufficient food production at the household level and nationally. This, coupled with the global increases in food prices, has resulted in food insecurity in the country that may have contributed to the lack of decline in the proportion of wasted children in the country over the surveys.

This study found the level of overnutrition among the children was less than 10% in all the surveys. This finding is contrary to a study by Gewa (2010) that reported 18% prevalence of overweight and 4% prevalence of obesity among Kenyan children age 3-5 years based on the 2008-09 KDHS. The Gewa study defined overweight and obesity as BMI for age z-score above +1SD and above +2SD, respectively.

The main determinants for undernutrition in Kenya identified by this study were household wealth index, area of residence, province, maternal education, and maternal BMI, as well as sex of the child, size at birth, and age of the child. The influence of the wealth index on child stunting has changed over the years. There was a much stronger influence in the earlier surveys in 1993 and 1998, when children from the poorest, poorer, middle, and richer quintiles were more likely to be stunted compared with the richest. In 2003 and 2008-09 only children from the poorest households were significantly more likely to be stunted compared with children from the richest households.

This change in the influence of wealth index on chronic child malnutrition may be explained by the increasing growth of the middle-income group in Kenya. The African Development Bank's (ADB) market brief for 2011 states that almost half (45%) of Kenyan households are categorized as middle-income, which is above the African average of 38% (Mubila et al. 2011). The emergence of a large middle-class has meant a reduction of poverty in Africa, by lifting previously poor households out of poverty. The middle-class in Africa is more likely to be in salaried jobs or to have small businesses compared with poorer families. People in the middle-class also tend to have fewer children and spend more on the nutrition and schooling of their children (Mubila et al. 2011).

This study demonstrates the importance of maternal education for child nutrition outcomes in Kenya. These findings agree with results of an analysis by Giroux of the effect of maternal education on child stunting in sub-Saharan Africa (Giroux 2008). In the present study, attaining a secondary or higher level of maternal education was associated with lower odds of childhood stunting and underweight. Higher maternal education was associated with maternal employment and higher household income. The relevance of maternal education on childhood stunting and underweight has shifted over time, however. This may be due to the reduction in the proportion of mothers without education, which declined from 17% in 1993 to 13% in 2008-09 in Kenya.

Maternal undernutrition is a persistent determinant of child undernutrition identified in this study. Children whose mothers were thin (BMI <18.5) were more likely to be undernourished. At the same time, the likelihood of undernutrition significantly increased among children who were small at birth, demonstrating further the importance of maternal nutrition

during pregnancy, which is known to significantly affect the nutrition of their children. Optimum maternal nutrition before and during pregnancy is important for a healthy pregnancy outcome, as low maternal BMI is associated with intrauterine growth retardation (Black et al. 2003).

This study found a change in the effect of maternal BMI on child stunting, whereby children with overweight mothers were more likely to be stunted in 2008-09 than in earlier surveys. This suggests an emerging pattern of a dual burden of malnutrition in the same households in Kenya, where the mother is overweight while the child is suffering from chronic malnutrition. A presence of the dual burden in the same household has also been reported in other studies. This coexistence of maternal overnutrition and child undernutrition in the same households reflects the rapid nutritional transition in developing countries (Bouzitou et al. 2005) and has been reported in middle-income countries such as Indonesia and Russia, where between 9% and 13% of households contain both underweight and overweight members (Doak et al. 2004).

Determinants of Overweight

This study found rural or urban residence to be a determinant of overweight among Kenyan children. In 1993, children living in the rural areas were significantly less likely to be overweight. However, in 2003 rural children were equally likely as urban children to be overweight, and 1.4 times more likely in 2008-09. Although this change is not statistically significant, it suggests a change in the association between residence and childhood overnutrition. The influence of maternal overweight on the likelihood of overnutrition among the children increased over the surveys, and in 2008-09 overweight mothers were significantly more likely to have overweight children compared with women of normal weight. These results agree with Gewa (2010), who found, using the KDHS 2008-09, that maternal overnutrition was a determinant of overnutrition among preschool children.

Conclusion and Policy Implications

This study analyzed the trends and determinants of malnutrition among under children under age 5 in Kenya. The study found that levels of stunting and underweight are slowly

decreasing, with more likelihood of undernutrition among children from the Coast, North Eastern, and Eastern Provinces than other regions. It found that household wealth index, maternal education, maternal BMI, and the child's age, sex, and size at birth are important determinants of child undernutrition. The effect of household wealth and maternal education on child undernutrition changed over the survey period, suggesting advances in women's educational attainment and economic status.

Considering these findings, it is critical for the national strategies on nutrition interventions to reach the most vulnerable people in the poorest households as well as those in the most affected regions. Further research on the apparent increase and expansion in the wealth indicators in the country would be important to identify what is driving the wealth of households and how that can be translated to support the poorest households that remain left behind in the country's reduction of malnutrition.

In designing nutrition interventions, some practical considerations should be kept in mind. It is important to translate the national strategies such as the food and nutrition strategy 2008 into practical achievable goals that meet the needs of the most vulnerable households. One of the goals of the national food and nutrition strategy 2008 (MOH 1999) is to increase household resource productivity. This goal and strategy is an example of a plan that can be targeted to the poorest households, with a view to improve the nutrition of the children.

Policymakers should also take heed of the evidence of changes in maternal education, as these changes have critical implications for reducing maternal and child malnutrition. Improving maternal education to secondary level or more and above will make significant improvements in the nutritional status of children. In order to realize the benefit of improved schooling in a timely manner, education policymakers need to urgently explore methods of ensuring that women of reproductive age who did not have a chance to attend secondary schooling now have an opportunity to attend secondary education or to get the equivalent of secondary education and more, through restructuring the education system to allow for adult education in the country.

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