Determinants of non-Monetary Indicators of Poverty in Kenya

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Background

Analysis of the determinants of nutritional status of children using the 1998 and 2003 Demographic and health survey data. Like for other objectives, we first analyze and present detailed descriptive statistics exploring the nature and trend of the key determinants of child nutritional status. The empirical analysis is based on a series of survey regressions to explain chronic and acute malnutrition for the whole sample, by region of residence (rural vs. urban) and by gender of child. Both descriptive and regression results suggest that child, household and community characteristics are all important determinants of children nutritional status. Mother's height and education are found to be particularly important household characteristics. Ethnicity and religion do not seem to matter. The results also suggest that rural children are likely to suffer more malnutrition than urban children, while boys are more likely to be malnourished than girls.

The outstanding tasks for this section include: estimating pooled regressions for the two datasets; carrying out joint tests of significance for the pooled model and employing the Oaxaca decomposition to the differences in nutritional status in the two periods.

Objective of the Study

- To estimate the main determinants of health and nutrition status of children in Kenya

The report presents a discussion of the nutrition status of children in Kenya.

1.0 Determinants of Child Nutritional Status 1998-2003

1.1 Analytical Framework

Studies of determinants of children nutritional status follow the household production framework following Becker, 1965 and Strauss and Thomas 1995. Starting with a simple household utility maximizing model, we assume that a household has preferences that can be characterized by the utility function, U which depends on consumption of a vector of commodities, X, leisure, L, and the quality of children represented by their nutritional status, N :

$$U = u(X, L, N) \quad \text{(4.1)}$$

Where N is measured using standardized anthropometric measures of height for age (*haz*), weight for age (*waz*) and weight for height (*whz*). The assumption in such a model is that good nutrition, as represented by the vector of nutritional status of children is desirable in its own right, and it is likewise assumed that households make consumption decisions on the basis of reasons other than nutrition (Pitt and Rozenzweig, 1995).

The household utility is maximized subject to several constraints, including a time-nutritional production function and income constraints. Guided by the underlying determinants, the reduced form nutritional function for each child can be derived as:

$$N_i = n(C, W, H, Z, \varepsilon) \quad \text{(4.2)}$$

Where C is consumption, W is a vector of child-specific characteristics; H is a vector of household specific characteristics; Z is a vector of community-level characteristics and ε is the child-specific disturbance term. The reduced form model can enable us to capture the total impact of child, household and community characteristics rather than their impact conditional on a set of choice variables through a structural model (Strauss and Thomas, 1995, Thomas et al. 1996). The specified nutritional production function allows us to estimate the following equations:

haz_i = f(child characteristics, household characteristics, community characteristics, ε_{ha})

waz_i = f(child characteristics, household characteristics, community characteristics, ε_{wa})
whz_i = f(child characteristics, household characteristics, community characteristics, ε_{wh})

Where ε_{ha}, ε_{wa}, ε_{wh} are random error terms assumed to be uncorrelated with the covariates included in the reduced nutritional outcome models.

Like in the education demand models, important individual child characteristics include age and gender of the child. Household level characteristics can be divided into parental characteristics and other household characteristics. Parental characteristics include height of the mother and parents' age and education and marital status. Height of the mother captures both the genetic effects and the effects resulting from family backgrounds characteristics not captured by the maternal education. Maternal education is expected to improve nutrition through altering the household preference function and also through better child care practices. Other household characteristics include structure of the household (captured by the number of persons in a specific age and sex group), headship and assets. The structure of the household enable us to test whether presence of older siblings may improve a child's nutritional status, and also whether presence of more adult women, holding household size and age composition of the household constant improve the nutritional status of a child (Sahn 1994). Community characteristics represent access to public facilities such as immunization and health care as well as environmental factors such as water and sanitation (Strauss and Thomas 1995).

1.2 The Data

The data used to analyze the determinants of children nutritional status is taken from the 1998 and 2003 Demographic and Health Surveys (DHS). The DHS are nationally representative samples of women aged 15 to 49. The two surveys, while relatively comparable differ in a number of ways: The 1998 DHS collected information on 7,881 women aged 15-49, and 6,185 children aged less than 60 months from 8,380 households in the months of March to July 1998. The 2003 DHS covered 8,195 women aged 15-49 and 6,102 children aged less than 59 months from 8,195 households in the months of April to August, 2003. Both surveys covered both rural and urban populations. The surveys collected information relating to demographic and socio-economic characteristics for all respondents and more extensive information on pre-school children.

The demographic and health Surveys utilized a two-stage sample design. The first stage involved selecting sample points (clusters) from a national master sample maintained by Central Bureau of Statistics (CBS) the fourth National Sample survey and Evaluation Programme (NASSEP) IV. In 2003, a total of 400 clusters, 129 urban and 271 rural, were

selected. From these clusters, the desired sample of households was selected using systematic sampling methods. The 1998 DHS selected 536 clusters, of which 444 were rural and 92 urban.

1.3 Sample Characteristics

We base our analysis on children aged less than 35 months in the two survey periods. After making this adjustment and further cleaning the data to remove children with missing values for nutritional indicators, our sample narrowed down to 2914 and 2956 children aged less than 36 months in 1998 and 2003 respectively. The descriptive statistics for the key variables from the two datasets are presented in table 1.1. The distribution of children across 1 year age groups is almost similar in the two surveys with 33% and 36% children aged less than 12 months and 35% and 34% aged between 12 and 24 months in 1998 and 2003 respectively. The rest (32% in 1998 and 30% in 2003) were aged 24 and 36 months.

In general, table 1.1 indicates robustness of the two datasets across all variables. While the mean current age of mothers in the two years is similar at 27 years, household heads recorded a difference of one year, with a mean of 39 and 38 years in 1998 and 2003 respectively. Minor differences are also observed for schooling except for mothers with primary education. This pattern for education is consistent with that of husbands. There is no clear pattern in the change in education attainment between the two years. However, the data suggest that the mean years of schooling fell marginally for both men and women with primary education but increased marginally for both groups with respect to post primary schooling. The mean asset index fell from –0.12 in 1998 to –0.17 in 2003, implying that on average Kenyan households were worse off in terms of asset poverty in 2003 compared to 1998.

The nutritional status of children aged 0-35 months in our samples is indicated in the last 3 rows of table 1.1. The measure for chronic under nutrition; height for age scores (*haz*) ranged from –5.98 to 5.96 and -5.93 to 5.88 in 1998 and 2003 respectively. The corresponding mean scores for these two periods are estimated to be –1.18 and –1.19 respectively. This implies that there was little difference in the levels of chronic under nutrition in the 2 years. There are however more pronounced differences in the measures for acute under nutrition (*whz*) and underweight (*waz*) in the two years. For instance, in 1998, the *whz* scores ranged from -3.87 to 5.7compared to a range of -3.99 to 5.07 in 2003. For underweight, the range for 1998 was -5.12 to 5.34 compared to -5.74 to 5.35 in 2003. Overall, the data suggest some improvement in children nutritional status between 1998 and 2003. The mean scores for current malnutrition and underweight for the two years also show more variation than for chronic malnutrition (table 1.1).

Table 1.1: Descriptive statistics

	1998			2003		
Variable Description	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**
Current age of child in years	0.99	0.81	2914	0.95	0.81	2956
Age in months	17.39	10.02	2914	16.91	10.10	2956
Sex of child	1.49	0.50	2914	1.50	0.50	2956
Weight of child	9.29	2.55	2914	9.25	2.53	2956
Height of child	74.79	10.18	2914	74.32	9.97	2956
Age of household head	39.13	13.24	2909	38.02	12.49	2956
Mother's age	27.28	6.44	2914	27.45	6.54	2956
Partners age	35.41	9.78	2478	35.26	9.04	2529
Height of mothers	160.00	6.29	2898	159.78	6.46	2892
Number of household members	6.19	2.64	2914	6.05	2.43	2956
Number of children 5 and under	1.91	0.94	2914	1.91	0.91	2956
Number of women aged 15-49	1.42	0.75	2914	1.37	0.71	2956
Mother's years of primary education.	6.23	2.72	2914	5.98	2.95	2956
Mother's years of post-primary education	3.41	1.57	688	3.48	1.98	673
Mother has no education	0.11	0.31	2914	0.15	0.35	2956
Primary	0.64	0.48	2914	0.64	0.48	2956
Secondary	0.24	0.43	2914	0.17	0.38	2956
Higher	0.02	0.14	2914	0.03	0.18	2956
Father years of primary education	6.83	2.37	2633	6.57	2.69	2740
Father's years of post-primary education	3.44	1.76	1074	4.25	2.69	1047
Father has no education	0.07	0.26	2636	0.12	0.33	2956
Primary education dummy	0.50	0.50	2636	0.52	0.50	2956
Secondary education dummy	0.39	0.49	2636	0.28	0.45	2956
Higher education dummy	0.04	0.19	2636	0.08	0.27	2956
Household asset index	-0.12	0.78	2914	-0.17	0.80	2946
Christian dummy	0.91	0.28	2914	0.88	0.32	2956
Muslim dummy	0.06	0.23	2914	0.09	0.28	2956
Other religion dummy	0.03	0.17	2914	0.03	0.18	2956
Nairobi	0.06	0.23	2914	0.07	0.25	2956
Central	0.09	0.28	2914	0.11	0.31	2956
Coast	0.08	0.27	2914	0.09	0.28	2956
Eastern	0.17	0.38	2914	0.16	0.37	2956
Nyanza	0.21	0.41	2914	0.16	0.36	2956
Rift Valley	0.25	0.43	2914	0.27	0.44	2956
Western	0.14	0.35	2914	0.13	0.34	2956
Kalenjin community	0.16	0.36	2914	0.17	0.38	2956
Kikuyu, Embu, Meru and Kamba	0.33	0.47	2914	0.34	0.47	2956
Luo, Luhya and Kisii	0.40	0.49	2914	0.35	0.48	2956
Other tribes	0.10	0.29	2914	0.14	0.35	2956
Haz- Height for Age Z-Score	-1.18	1.65	2899	-1.18	1.55	2953
Waz- Weight for Age Z-Score	-0.93	1.41	2899	-0.86	1.40	2953
Whz- Weight for height Z-Score	-0.24	1.33	2914	-0.15	1.29	2956

Table 1.2 presents a tabulation of the mean `Z' scores by background characteristics of the children in the sample, focusing on child age groups, gender of the child, region and place of residence as well as parental characteristics. The analysis indicates that chronic under nutrition increased with age in the two years. However, acute under nutrition and underweight show no particular pattern. Further, the data shows lower `Z' scores for boys than for girls indicating that boys are more likely to suffer chronic and acute under nutrition as well as being underweight than girls. This finding is consistent with other studies on nutritional status of children in Africa (Alderman, 1990; Sahn, 1990; Ssewanyana, 2002). The distribution of mean 'Z'scores across regions is not consistent in the two years. For instance, Central province reported the lowest mean score for chronic under nutrition in 1998, while Eastern province reported the lowest mean and Coast province the highest. Overall urban areas reported lower mean scores than rural areas for all measures of malnutrition, implying that rural children are likely to suffer more malnutrition than urban children. Except for acute under nutrition, the data suggests that children from female headed households are likely to be more malnourished than children from male headed households. This could be explained by the fact that most female-headed households may be more income constrained due to absence of a spouse and may therefore not be able to provide all required nutrients for their children.

Education attainment is expected to be inversely correlated with malnutrition. This expectation is supported by our data for the two years. Only mean weight for height scores show contradicting results. For chronic under nutrition and under weight, mean scores clearly decline with an increase in the level of mothers education.

Table 1.3 shows the percentage of children falling below minus 2 z scores by social-economic characteristics. This table follows the U.S. National Centre for Health Statistics (NCHS) median reference where a cut-off of minus two standard deviations for *haz* is taken as measure of past or chronic malnutrition, and minus two *whz* taken as a measure of current or acute malnutrition. The results across child age groups for the two years are consistent with table 2. Malnutrition increases with age except for children aged 24-35 months. This is probably explained by the ceasing of breastfeeding and weaning especially for children aged 12-24 months. After the first 2 years, a child is likely to get more nutrients from a wider range of foodstuffs than at a more tender age. Except for children aged 6-12 months, there are larger proportions of malnourished children by age group in 2003 compared to 1998. This behaviour of malnutrition with age is consistent with findings in previous studies (Alderman, 1990; Ssewanyana, 2003).

Table 1.2: Mean Z-Scores by background characteristics 1998 - 2003

Variable	1998				2003			
Grouped child age (months)	**Height for Age**	**Weight for Height**	**Weight for Age**	**N**	**Height for Age**	**Weight for Height**	**Weight for Age**	**N**
0-6	-0.09	0.52	0.41	440	-0.110	0.540	0.420	484
6-12	-0.69	0.33	-0.84	520	-0.730	-0.110	-0.680	574
12-24	-1.67	-0.37	-1.29	1013	-1.110	-0.360	-1.310	1006
24-35	-1.44	-0.40	-1.24	941	-1.470	-0.310	-1.180	893
Sex of Child								
Male	-1.24	-0.26	-0.97	1490	-1.303	-0.204	-0.970	1487
Female	-1.12	-0.21	-0.89	1424	-1.063	-0.088	-0.749	1469
Region								
Nairobi	-0.85	0.05	-0.54	168	-0.652	0.329	-0.171	181
Central	-0.81	0.24	-0.38	258	-1.087	0.088	-0.607	303
Coast	-1.39	-0.37	-1.13	238	-1.368	-0.312	-1.094	249
Eastern	-1.42	-0.25	-1.09	496	-1.303	-0.233	-0.999	488
Nyanza	-1.15	-0.51	-1.13	615	-1.111	-0.005	-0.703	473
Rift Valley	-1.15	-0.19	-0.87	735	-1.295	-0.243	-1.019	796
Western	-1.24	-0.25	-0.95	404	-1.195	-0.207	-0.890	402
Type of place of residence								
Urban	-0.73	-0.03	-0.51	503	-0.974	0.193	-0.478	509
Rural	-1.28	-0.28	-1.02	2411	-1.230	-0.221	-0.944	2447
Sex of household								
Male	-1.17	-0.23	-0.92	2155	-1.171	-0.154	-0.856	2221
Female	-1.20	-0.27	-0.96	759	-1.226	-0.124	-0.872	735
Mother's highest educational level								
None	-1.57	-0.56	-1.41	313	-1.329	-0.512	-1.234	434
Primary	-1.29	-0.31	-1.06	1852	-1.274	-0.173	-0.939	1906
Secondary	-0.74	0.03	-0.45	690	-0.882	0.203	-0.393	513
Higher	-0.72	0.52	-0.08	59	-0.461	0.113	-0.198	102

Consistent with table 2, boys are more likely to suffer malnutrition than girls and the same scenario is observed for rural vs. urban areas. Like the mean scores earlier suggested, we confirm here that children from female headed households are more likely to be malnourished than those from male headed households, except for current (acute) malnutrition.

In table 1.4 we present nutritional indicators by age group and gender. In the second part of the table (1.4b) we only present results for the percentage of children under different Z score groups for chronic and acute malnutrition. This is done to save on space and avoid too much detail; otherwise the results for wasting are robust in that they follow more or less the same pattern as the *haz* and *whz* scores for the two years.

Table 1.4a suggest that the levels of malnutrition in the two years are almost equal, though there seem to be considerable differences between the percentages of children with a *haz* score greater than 2 in the two years (4.4% and 2.7% in 1998 and 2003 respectively). The tabulation for acute malnutrition also suggests some considerable differences in the second and fourth most malnourished groups.

Table 1.3: Percentage of children below -2 Z-Scores

	1998				***2003***			
Variable	**Height for Age**	**Weight for Height**	**Weight for Age**	**N**	**Height for Age**	**Weight for Height**	**Weight for Age**	**N**
Child age group (months)								
0-6	6.96	5.17	2.26	440	7.28	3.93	2.43	484
6-12	17.53	7.77	14.86	520	15.63	6.07	15.22	574
12-24	41.51	9.44	26.77	1013	43.98	9.68	27.12	1006
24-35	32.59	4.89	28.18	941	36.17	5.32	25.1	893
Sex of child								
Male	33.5	7.25	22.76	1490	33.38	7.61	22.85	1487
Female	27.86	6.8	19.98	1424	26.8	5.83	17.45	1469
Type of place of residence								
Urban	22.42	5.17	11.38	503	23.88	4.77	13.48	509
Rural	32.49	7.42	23.49	2411	31.41	7.12	21.55	2447
Sex of household head								
Male	30.62	7.06	21.42	2155	29.38	7.23	19.7	2221
Female	30.92	6.94	21.36	759	32.32	5.02	21.55	735
Mother's highest educational level								
None	42.62	9.7	34.17	313	35.1	14.53	30.8	434
Primary	33.79	7.85	23.58	1852	31.97	5.76	20.71	1906
Secondary	18.8	3.95	11.08	690	22.44	3.75	11.68	513
Higher	21.12	3.12	6.16	59	12.95	6.37	7.46	102

Height for age Z-score less than -2.0 indicates chronic malnutrition
Weight for height Z-score less than -2.0 indicates acute malnutrition
Weight for age Z-score less than -2.0 indicates underweight children

From table 1.4b, it is not explicitly clear what the pattern of malnutrition is when comparing boys and girls, though there are almost 6% more boys than girls in the lowest *haz* score group implying that boys are more likely to suffer chronic malnutrition than girls. Thought not as pronounced, the results for acute malnutrition also suggest that boys are more likely to be malnourished than girls. The results for 2003 confirm that boys appear to be at a relative disadvantage compared to girls in nutrition in Kenya. This conclusion is robust to findings from other studies for Africa cited above.

Table 1.4a: Nutritional Indicators by Age Group, 1998-2003 (%): Full Sample

	1998					**2003**				
Grouped Z-scores	**Grouped child age in months**									
	0-6	6-12	12-24	24-35	All	0-6	6-12	12-24	24-35	All
Height for Age[a]										
Z score <= -2	7.5	17.7	42.0	37.9	31.1	7.4	15.8	44.1	36.5	30.3
-2 < Z-score <=-1	17.2	25.1	28.6	27.3	25.8	19.7	27.3	27.5	29.4	26.7
-1 < Z-score <=0	33.3	30.7	15.9	17.6	21.7	24.7	29.5	17.4	20.7	22.0
0 < Z-score <=1	23.9	15.4	8.7	9.5	12.5	32.0	19.7	7.0	7.6	13.7
1 < Z-score <= 2	10.7	7.0	1.2	3.8	4.5	10.6	5.3	2.6	3.4	4.6
Z score > 2	7.4	4.1	3.6	4.0	4.4	5.7	2.5	1.5	2.5	2.7
Weight for Height[b]										
Z score <= -2	5.2	7.8	9.7	4.9	7.1	3.9	6.1	9.8	5.5	6.8
-2 < Z-score <=-1	8.5	23.9	22.7	23.5	21.0	7.2	16.7	20.9	19.3	17.4
-1 < Z-score <=0	21.1	29.5	31.2	38.3	31.7	20.1	33.9	31.6	37.6	32.0
0 < Z-score <=1	30.7	22.6	23.3	25.6	25.1	32.6	26.9	24.3	29.4	27.7
1 < Z-score <= 2	21.2	11.7	8.5	5.7	10.1	22.5	10.3	9.7	6.2	10.9
Z score > 2	13.3	4.5	4.7	2.0	5.1	13.8	6.1	3.7	2.0	5.3
Weight for Age[c]										
Z score <= -2	2.3	15.2	27.4	28.4	21.8	2.4	15.2	27.6	25.4	20.4
-2 < Z-score <=-1	9.2	32.5	35.5	31.8	29.8	7.6	26.0	35.1	34.4	28.6
-1 < Z-score <=0	26.7	29.7	23.0	24.8	25.3	24.6	32.2	23.7	23.4	25.4
0 < Z-score <=1	31.8	15.0	8.9	9.3	13.6	35.7	15.9	9.2	12.2	15.7
1 < Z-score <= 2	18.9	5.3	3.1	3.7	6.1	22.3	7.6	3.4	3.1	7.2
Z score > 2	11.1	2.4	2.1	2.0	3.5	7.4	3.1	1.0	1.6	2.7
N	440	520	1013	941	2914	484	574	1006	893	2956

[a] Low height for age Z-score indicates chronic under nutrition
[b] Low weight for height Z-score indicates acute under nutrition
[c] Low weight for age Z-score indicates underweight

From tables 1.4a and 1.4b, it is apparent that for z scores less than –2, the highest level of malnutrition is observed for children aged 12-24 months irrespective of whether they are boys and girls. Beyond age 24 months, malnutrition declines. In other words, for both years, the distribution of children below –2 z scores by age group follows an inverted `U' shape. This is again consistent with previous studies and our earlier conclusions from table 1.3.

Table 1.4b: Nutritional Indicators by Age and Gender, 1998-2003 (%)

	1998					**2003**				
Grouped Z-scores	***Grouped child age in months***									
	0-6	6-12	12-24	24-35	All	0-6	6-12	12-24	24-35	All
Male Sub-sample										
Height for Age[a]										
Z score <= -2	6.9	21.5	47.1	39.3	33.8	9.2	19.5	49.1	38.2	33.6
-2 < Z-score <=-1	20.6	21.9	26.1	26.6	24.7	19.1	27.4	28.3	28.7	26.8
-1 < Z-score <=0	32.5	32.3	15.3	16.8	21.5	27.7	27.2	14.6	20.9	21.1
0 < Z-score <=1	21.5	13.9	6.8	10.2	11.5	28.3	19.0	4.9	6.1	11.8
1 < Z-score <= 2	10.5	4.8	1.4	3.3	4.1	9.5	4.8	2.1	4.2	4.4
Z score > 2	7.9	5.7	3.2	3.7	4.5	6.2	2.1	1.0	1.9	2.4
Weight for Height[b]										
Z score <= -2	5.9	8.7	9.5	5.0	7.3	3.7	7.6	10.8	6.5	7.7
-2 < Z-score <=-1	8.1	24.8	23.0	24.9	21.6	8.2	20.8	19.8	18.9	17.9
-1 < Z-score <=0	16.5	29.8	33.5	37.4	31.4	18.5	29.4	32.7	36.5	30.9
0 < Z-score <=1	31.8	22.2	24.2	24.5	25.1	33.2	28.7	23.7	31.5	28.6
1 < Z-score <= 2	20.9	11.0	5.9	6.5	9.3	24.0	9.1	10.0	4.3	10.4
Z score > 2	16.8	3.6	4.0	1.8	5.2	12.3	4.4	3.1	2.3	4.6
N	228	257	502	472	1460	240	283	504	451	1478
Female Sub-sample[a]										
Height for Age										
Z score <= -2	8.1	13.9	36.8	36.4	28.3	5.5	12.2	39.0	34.8	26.9
-2 < Z-score <=-1	13.3	28.4	31.1	28.1	27.0	20.3	27.1	26.7	30.1	26.7
-1 < Z-score <=0	34.2	29.0	16.5	18.4	22.0	21.7	31.8	20.3	20.5	22.9
0 < Z-score <=1	26.6	16.9	10.7	8.7	13.5	35.7	20.4	9.0	9.1	15.7
1 < Z-score <= 2	11.0	9.3	0.9	4.2	5.0	11.7	5.7	3.0	2.5	4.8
Z score > 2	6.9	2.5	3.9	4.3	4.2	5.1	2.8	2.0	3.0	3.0
Weight for Height[b]										
Z score <= -2	4.4	6.9	9.9	4.8	6.9	4.2	4.5	8.8	4.5	5.9
-2 < Z-score <=-1	8.8	23.0	22.4	22.0	20.4	6.1	12.7	22.0	19.7	16.8
-1 < Z-score <=0	26.3	29.3	28.8	39.3	31.9	21.6	38.2	30.5	38.7	33.0
0 < Z-score <=1	29.5	23.1	22.5	26.8	25.0	31.9	25.1	25.0	27.3	26.8
1 < Z-score <= 2	21.6	12.4	11.2	5.0	10.9	21.0	11.5	9.4	8.2	11.4
Z score > 2	9.4	5.4	5.3	2.2	4.9	15.2	7.9	4.3	1.7	6.0
N	211	263	511	468	1454	244	291	501	441	1478

[a] Low height for age Z-score indicates chronic under nutrition
[b] Low weight for height Z-score indicates acute under nutrition
[c] Low weight for age Z-score indicates underweight

Table 1.5 confirms our earlier results (in table 1.2) that malnutrition is higher in rural than in urban areas for both years, with 33% of all rural children suffering from chronic under nutrition in 1998, compared to 31% in 2003. Though the percentage of rural children with chronic malnutrition fell by 2% between the two years, the percentage of urban children with chronic under nutrition increased by 2%. Coast province has the largest percentage of malnourished children in the two years, though the percentage fell by 3% in 2003. Nairobi reported the lowest percentage. That urban children are less likely to be stunted or wasted than rural children may reflect differences in sanitation and access to health care, as well as possible self-selection of parents into urban areas (Alderman, 1990). The results in this table are consistent with sample characteristics presented in table 1. Another highlight from Table 1.5 is that male children are more likely to suffer chronic malnutrition than girls, which supports our earlier findings on the gender distribution of the indicators of children's nutritional status.

Levels of malnutrition by asset index quintiles were ranked using the household data for all interviewed women. The results are presented in table 1.6. The results show that under nutrition declined linearly with assets. This is however not observed for the urban sample for 1998, probably due to a relatively small sample. Though the lack of linearity of the nutritional indicators by asset index quintiles for urban areas is surprising, this finding is not uncommon in the literature (see for instance Alderman 1990 and Sahn, 1990). The data shows that there was a notable improvement in the percentage of children with chronic and acute malnutrition in 2003 for the poorest 40% of the population (i.e. the lowest two quintiles). The general implication of the results of this table is the need for targeting poor households in order to reduce malnutrition.

To assess the impact of availability of health care on children's nutritional status, we generate a vector of community level variables as proxies[1]. We experiment with five variables, namely: the proportion of children who were fully immunized; the proportion of children who had at least one immunization vaccine; the share of children whose mothers had access to modern contraceptive methods; the proportion of mothers who delivered in a modern facility, and the percentage of mothers delivered by modern birth attendants such as a doctor or a nurse.

[1] Individual level variables such as whether a child is fully immunized or not or whether a mother has access to modern contraception are arguably endogenous because they depend on among other factors household characteristics. To make these variables exogenous, we find the cluster means or local community means of each of these variables.

Table 1.5: Nutritional Indicators by Region and Gender

Province	1998			2003		
	Percentage with chronic malnutrition	Percentage with acute malnutrition	N	Percentage with chronic malnutrition	Percentage with acute malnutrition	N
Male Sub-sample						
Nairobi	31.61	7.02	57	22.13	5.21	131
Central	27.44	5.74	113	32.30	4.59	181
Coast	37.13	4.65	224	35.70	6.10	197
Eastern	34.72	6.81	196	35.22	5.56	190
Nyanza	27.91	11.20	240	31.51	4.17	194
Rift Valley	35.40	6.67	432	34.88	12.11	313
Western	39.92	5.49	198	34.98	7.98	191
Urban	23.88	4.72	215	27.06	4.67	375
Rural	35.58	7.80	1245	34.74	8.24	1103
Female Sub-sample						
Nairobi	16.67	5.56	36	13.84	4.12	137
Central	25.78	5.93	121	26.70	4.56	192
Coast	36.17	6.75	222	32.95	7.05	168
Eastern	31.67	4.86	209	28.24	4.37	177
Nyanza	27.33	9.17	251	28.96	2.48	192
Rift Valley	26.79	7.05	390	27.69	7.53	290
Western	26.15	6.27	225	24.09	6.50	231
Urban	20.79	5.67	205	20.25	4.87	364
Rural	29.28	7.03	1249	28.10	6.02	1114
Full Sample						
Nairobi	25.81	6.45	93	17.99	4.66	268
Central	26.83	5.84	234	29.51	4.57	373
Coast	37.93	5.62	446	34.42	6.54	365
Eastern	32.99	5.80	405	31.87	4.98	367
Nyanza	26.91	10.19	491	30.25	3.34	386
Rift Valley	31.58	6.84	822	31.42	9.90	422
Western	32.63	5.89	423	28.91	7.15	172
Urban	22.42	5.17	420	23.80	4.76	739
Rural	32.49	7.42	2494	31.42	7.13	2217

Table 1.6: Nutritional Indicators by Asset Index Quintile

Quintiles	1998			2003		
	Rural Areas					
	Percentage with chronic malnutrition	Percentage with acute malnutrition	N	Percentage with chronic malnutrition	Percentage with acute malnutrition	N
Rural Sample						
Quintile 1	43.37	6.98	564	35.42	10.47	610
Quintile 2	36.38	8.60	533	34.08	7.06	591
Quintile 3	29.55	8.72	664	30.53	6.33	497
Quintile 4	25.98	6.18	507	28.04	4.72	373
Quintile 5	16.34	5.04	207	16.16	3.72	140
Urban Sample						
Quintile 1	43.06	5.06	13	52.17	13.43	48
Quintile 2	17.24	14.18	27	34.53	9.93	33
Quintile 3	21.49	7.24	42	29.76	4.05	78
Quintile 4	31.32	4.86	94	22.24	3.68	182
Quintile 5	19.11	4.13	242	19.92	4.11	394
Full Sample						
Quintile 1	42.488	6.76	577	36.12	10.59	658
Quintile 2	35.378	8.89	560	34.10	7.17	624
Quintile 3	28.977	8.62	706	30.46	6.13	575
Quintile 4	27.047	5.92	601	26.75	4.49	555
Quintile 5	17.978	4.50	449	18.66	3.98	534

The sample characteristics for the community variables for the two years are presented in Table 1.7. For each of these variables, we calculated (and present) the non-self cluster means to adjust for design effects in the survey. Like most of the earlier descriptive statistics, the table once again indicates robustness and comparability of the two data sets. For instance, only 24 and 25 percent of mothers reported to have used modern contraception in 1998 and 2003 respectively. The rest were reported to have used other methods. However, the percentage was much higher in urban areas at almost 40% in the two years, compared to about 20% in rural areas. Only about 40% of all the children had been fully immunized in both urban and rural areas in the two years. As expected the percentage of women giving birth in modern facilities and assisted by trained personnel in urban areas is almost twice as much as that in rural areas. For each of the community variables, we calculated the non-self cluster means to adjust for design effects.

We also estimated non-self cluster means for proportion of households with access to piped water, with toilet facilities, with traditional floor (earth, mud, dung or sand) and roof. These variables can be seen as measures of the environmental/sanitation quality of the residence of the child and are therefore expected to affect child nutritional status. Once again, the results are robust across regions for the two years. As expected, only a small proportion of households have access to piped water in rural areas compare to urban areas. Somehow, there seem to be marked differences in the proportions between 1998 and 2003, more so for the urban sample. The rural urban differences across the years conform to expectations. For instance, 94% of all urban households have corrugated iron roofs compared to only 60% in rural areas. The same case applies to toilet facilities while as expected, only a small proportion (20%) of urban dwellers have a traditional floor, compared to over 80% in rural areas.

In addition to these variables, we attempted to map onto the DHS data district level variables for health and schooling institutions, in order to analyze the impact of institutions on children's nutritional status. In particular, for 1998, we mapped information on the number of hospital, health centers and dispensaries per capita, number of schools, teachers and pupil-teacher ratios. The corresponding information is not yet available for 2003. However, in our regression analysis, the institutional variables were either all insignificant or with the unexpected signs, irrespective of whether they are introduced into the model jointly or one at a time. For this reason, we dropped them out of the analysis. The descriptive statistics for these variables are not presented here because they will appear in another section of our report.

The descriptive analyses presented above suggest some relationship between nutritional indicators and a vector of groups of variables, namely: child characteristics, household characteristics and community level characteristics. However, descriptive analysis alone cannot be relied on to establish the existence or otherwise of causation between variables. To establish the nature and strength of the impact of these variables on child nutritional status, we resort to econometric analysis. The results are presented in the next section.

Table 1.7: Community and Environmental Variables: Non-Self Cluster Adjusted Means for Proportion of Sample by Characteristic

	1998			2003		
Variable/characteristic	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**
Rural Sample						
Access to modern contraception methods	0.21	0.22	2476	0.22	0.21	2214
Fully vaccinated	0.41	0.23	2476	0.40	0.20	2214
At least one vaccination	0.93	0.12	2476	0.91	0.14	2214
Delivery in modern facility	0.37	0.28	2476	0.33	0.25	2214
Delivery assisted by trained medical personnel	0.38	0.27	2476	0.34	0.26	2214
Piped water	0.15	0.28	2476	0.08	0.21	2214
Toilet facility	0.77	0.32	2476	0.72	0.36	2214
Traditional floor	0.81	0.26	2476	0.81	0.25	2214
Corrugated roof	0.57	0.34	2476	0.63	0.33	2214
Urban Sample						
Access to modern contraception methods	0.40	0.26	411	0.37	0.22	735
Fully vaccinated	0.40	0.20	411	0.40	0.19	735
At least one vaccination	0.98	0.05	411	0.95	0.10	735
Delivery in modern facility	0.68	0.27	411	0.70	0.24	735
Delivery assisted by trained medical personnel	0.69	0.25	411	0.72	0.22	735
Piped water	0.77	0.29	411	0.48	0.41	735
Toilet facility	0.95	0.17	411	0.92	0.21	735
Traditional floor	0.23	0.31	411	0.22	0.32	735
Corrugated roof	0.94	0.16	411	0.94	0.18	735
Full Sample						
Access to modern contraception methods	0.24	0.24	2887	0.25	0.22	2949
Fully vaccinated	0.41	0.23	2887	0.40	0.20	2949
At least one vaccination	0.94	0.11	2887	0.92	0.13	2949
Delivery in modern facility	0.42	0.30	2887	0.40	0.29	2949
Delivery assisted by trained medical personnel	0.43	0.29	2887	0.41	0.29	2949
Piped water	0.26	0.36	2887	0.15	0.30	2949
Toilet facility	0.80	0.31	2887	0.76	0.35	2949
Traditional floor	0.71	0.34	2887	0.70	0.35	2949
Corrugated roof	0.63	0.35	2887	0.69	0.33	2949

1.4 Preliminary Regression Results

Introduction

We concentrate our regression analysis on explaining chronic and acute malnutrition as measured by height for age and weight for height scores respectively. To derive the empirical results, we use survey regressions rather than ordinary least squares methods in order to control for sample design used in the data collection procedure. This is because our DHS data collection procedures did not use purely random sampling methods. Survey regression takes care of three important sample characteristics: sampling weights, clustering and stratification. Failure to include sampling weights gives estimators that are biased and affect standard error of the estimates. Further, because of the sampling design, observations in a cluster are not independent and using OLS will give very small standard errors. Accounting for clustering is therefore necessary to adjust the standard errors for design effects. In our DHS, different groups of clusters are sampled separately. Since sampling is done independently across strata, the resulting standard errors will be smaller than normal. Therefore, survey regression produces the correct standard errors in the presence of different sampling weights, clustering and stratification (Stata Corp, 1999).

Before discussing the regression results, we wish to note here that the nutritional status of a child is a function of two main inputs, food and health care. The common practice in the literature is to proxy food/nutrient intake by per capita household expenditure due to paucity of information on actual food/nutrient intakes. Likewise health inputs are generally difficult to measure and may be proxied by days of illness per child or whether a child caught a particular illness or not. Where such information is available, both per capita expenditure and illness have to be instrumented to make them endogenous. If this is not feasible, simple reduced forms of nutritional status models are estimated. We follow the latter approach due to difficulties of obtaining the relevant data for nutrient intake and health inputs as well as lack of appropriate instrumental variables to estimate a structural model.

Econometric Analysis

The estimated reduced form models explaining the determinants of child nutritional status are presented in tables 4.8 to 4.9. To save on space, we concentrate on results for chronic and acute malnutrition. The results for wasting are not presented but would be available form the authors upon request.

Chronic Malnutrition

Table 1.8 presents the results for chronic malnutrition for the two years. We present estimation results from two models. Model one consists of mother characteristics as

explanatory variables for nutritional status while model two includes the characteristics of the household heads as well. Since about 20% of mothers are also household heads, we include a dummy variable for mother being household head in model two. The results for rural and urban areas are presented in appendix II tables A4.1 and A4.2. Except for significance level of some variables, the results for rural and urban areas are generally consistent in terms of direction of the impact of different variables on nutritional status. The rural models however fit the data better than the urban model, probably due to larger degrees of freedom. All regional models have a poorer fit than the full sample across the nutritional indicators and years.

First we note that for all regressions, the explanatory power of the model is consistent with other studies on nutritional status, before suppressing the constant. That is, the R-squared values are quite low. However, without a constant the models for 1998 explain about 47% of the total variation in chronic malnutrition while the models for 2003 explain about 51%. The Chow tests as well as the test for joint significance of all variables for all models also confirm that the variables are jointly significant in explaining chronic and acute malnutrition.

The regression results for chronic and acute malnutrition by gender of child are presented in appendix II table A1.5 and A1.6. The results suggest that differences in determinants of child malnutrition across gender are much more pronounced in 2003 than in 1998, judging from the value of the R-squared. Other than for birth order, all child characteristics are important determinants of malnutrition across gender. Generally, the results are robust across gender for the two years except for some cases with reverse signs and differences in significance as was the case in our earlier results. Except for community variables for the girls sub-sample, all groups of variables exert a stronger impact on the nutritional status for 2003 than for 1998. The results for acute malnutrition give a less defined picture

Child Characteristics

The results suggest that all variables for child characteristics are important determinants of chronic nutrition, which is consistent with results of descriptive analysis. This is also confirmed by the test for joint significance of this group of variables. Only birth order has insignificant effects in all models. But as expected higher birth order is inversely related to the nutritional status of the child. Chronic malnutrition is also inversely related to the age of the child but improves at a later age, which is consistent with results of our descriptive analysis and with previous studies. This result is also supported by dummies for child age (not presented) which indicated that all child age groups relative to age 12-24 months have significant coefficients, but which clearly decline with age in terms of magnitudes and level of significance.

Table 1.8: Survey Regression Results for Chronic Malnutrition: 1998-2003; Full Sample (t-values in parenthesis)

	Model (1)		Model (2)	
	1998	2003	1998	2003
Variable by Category	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates
Child characteristics				
Age of child in months	-0.177 (-12.79***)	-0.182 (-14.18***)	-0.177 (-12.89***)	-0.182 (-14.05***)
Age of child in months squared	0.004 (9.81***)	0.004 (11.06***)	0.004 (9.85***)	0.004 (10.99***)
Birth Order	-0.025 (-0.91)	-0.027 (-0.92)	-0.027 (-1.00)	-0.030 (-1.02)
Male child dummy	-0.153 (-2.32***)	-0.229 (-4.05***)	-0.148 (-2.23***)	-0.231 (-4.05***)
Household characteristics				
Number of children 5 and under	-0.033 (-0.79)	-0.058 (-1.27)	-0.032 (-0.80)	-0.060 (-1.31)
Number of women aged 15-49 yrs	-0.131 (-2.59***)	0.067 (1.30)	-0.099 (-2.11**)	0.053 (1.10)
Mothers age	-0.040 (-0.90)	0.042 (1.08)	-0.039 (-0.84)	0.033 (0.91)
Mothers age squared	0.001 (1.14)	0.000 (-0.47)	0.001 (1.19)	0.000 (-0.38)
Mothers height	-0.030 (-2.62***)	-0.044 (-4.90***)	-0.026 (-2.43***)	-0.050 (-5.84***)
Mothers height squared	0.0002 (4.32***)	0.000 (7.07***)	0.000 (4.19***)	0.000 (7.71***)
Mothers years of primary education	0.006 (0.37)	0.019 (1.25)	0.014 (0.94)	0.012 (0.90)
Mothers years of post primary education	0.046 (1.89**)	0.049 (2.16**)	0.053 (2.15**)	0.057 (2.68***)
House hold heads years of primary education	0.014 (1.06)	-0.018 (-1.27)		
House hold heads years of post primary education	0.018 (0.81)	0.014 (1.17)		
Age of house hold head	0.012 (0.73)	-0.025 (-1.55)		
Age of house hold head squared	0.000 (-0.28)	0.000 (1.46)		
Mother is head dummy	0.082 (0.83)	-0.028 (-0.36)		
Asset index	0.414 (4.12***)	0.255 (2.79***)	0.413 (4.42***)	0.246 (2.7***)
Asset index squared	-0.109 (-2.62***)	-0.032 (-0.84)	-0.106 (-2.6)	-0.025 (-0.66)
Ethnicity dummies relative to Luo, Luyhia, Kisii				
Kalenjin tribe	0.060 (0.64)	0.050 (0.52)	0.047 (0.51)	0.071 (0.72)
Kikuyu, Meru, Kamba, Embu tribe	-0.013 (-0.14)	-0.002 (-0.03)	-0.012 (-0.13)	-0.005 (-0.06)
Other tribe	0.019 (0.13)	0.285 (2.28**)	0.025 (0.17***)	0.286 (2.27***)

Religion relative to Christian				
Muslim	0.189 (0.98)	-0.053 (-0.34)	0.212 (1.08)	-0.062 (-0.40)
Other religion	-0.066 (-0.25)	-0.203 (-1.12)	-0.055 (-0.2)	-0.206 (-1.13)
Community variables				
Child is fully vaccinated	0.193 (1.09)	-0.217 (-1.23)	0.201 (1.13)	-0.236 (-1.32)
Delivery in modern facility	0.373 (2.95***)	0.340 (2.18**)	0.357 (2.86***)	0.348 (2.23**)
Rural area dummy	-0.050 (-0.40)	0.250 (2.45***)	-0.015 (-0.12)	0.242 (2.36***)
No. of Observations	2830	2747	2836	2747
R-Squared	0.4696	0.5154	0.4681	0.5144
Test statistics ***Chow test for significance***				
All variables	65.57 (0.000)	73.91 (0.0000)	80.67 (0.000)	87.35 (0.0000)
Child characteristics	66.93 (0.000)	95.82 (0.0000)	68.39 (0.000)	96.52 (0.0000)
Household characteristics	8.25 (0.000)	11.57 (0.0000)	10.65 (0.000)	16.07 (0.0000)
Religion dummies	0.18 (0.9066)	0.63 (0.5331)	0.67 (0.5136)	0.65 (0.5230)
Ethnicity dummies	0.57 (0.5631)	1.95 (0.1209)	0.13 (0.9416)	2.02 (0.1106)
Community variables	5.71 (0.0035)	2.87 (0.0580)	5.52 (0.0043)	3.08 (0.0471)
Regional dummies	0.16 (0.6869)	5.99 (0.0149)	0.02 (0.9024)	5.59 (0.0186)

*,**, ***, significant at 10%, 5% and 1% levels respectively

Male children are clearly more likely to be malnourished than female children which is also consistent with some studies in the literature (see for instance Sahn and Alderman, 1997). Other studies however suggest that though the coefficients for male dummies are negative, they are often insignificant implying absence of gender bias in nutritional status (Webb and Block, 2004, Ssewanyana, 2003, Strauss, 1990, Sahn, 1990).

Household Characteristics

Household characteristic variables include number of children less than 5 years old, number of adult women, mothers' characteristics, household head characteristics and the household asset index variable. The results suggest that household composition and mother's age are not important determinants of chronic malnutrition, though mother's ages is positive and significant when the quadratic term is not included. Household head age variables also turn out to be insignificant in all models. Results for mother's height are consistent with findings in the literature and suggest a U shaped relationship with chronic malnutrition. This implies that genetics play an important role in affecting the

stature of children (Sahn, 1994). Maternal education is positively related to nutritional outcomes. Primary education turn out to be insignificant in all models, but post primary education is significant implying the importance of human capital investments in improving children's nutritional status. Where included, education of the household head is either negative or insignificant, implying that father's education may not be a significant determinant of a child's nutritional status. These results again are consistent with some of the studies cited above (e.g. Webb, 2004; Sahn and Alderman, 1997; Alderman, 1990; see also Sahn and Stifel, 2002).

Asset variables are important in all models and portray a U shaped relationship with nutritional status. The results imply that nutrition improves at a decreasing rate with assets. Assets seem to have been more important for nutrition in 1998 than in 2003. Our finding support Sahn and Stifel (2003), who show that the asset index is a valid predictor of child nutrition. Like for child characteristics, household characteristics are also jointly significant at all conventional levels of testing.

Ethnicity and Religion

Ethnicity and religion do not seem to be important determinants of chronic malnutrition, though the results suggest that relative to the Luo, Luhya and Kisii tribes, other minor tribes are likely to have higher levels of malnutrition, except for the Kikuyu, Meru, Kamba and Embu tribe group.

Community Variables

We first experimented regressions with four main community variables, namely the proportion of children whose mothers had access to modern contraception, delivered in modern facilities rather than at home, assisted to deliver by trained medical personnel, and proportion of children who had been fully immunized. Due to collinearity of the variables, we finally settled for only two variables, proportion of children fully immunized and proportion of women who delivered in modern facilities. The results suggest that the later, a proxy for availability of medical facilities, improve the nutritional status of children. Vaccination does not seem to have a direct impact on nutritional status. Probably, since immunization in most cases is free, the mothers may not necessarily be able to provide the right nutrients for their children, irrespective of whether the children have been immunized or not. Community variables are jointly significant at all conventional levels in 1998, but only significant at 5% in 2003. The environmental/sanitation determinants: proportion of households with piped water, proportion with toilet facilities, proportion with traditional floor and proportion with corrugated iron roof turn out to be insignificant and are therefore dropped from the regression analysis.

Surprisingly, the rural dummy is positive and significant for 2003 implying that rural children are likely to have better nutrition status than urban children. This is inconsistent with our descriptive analysis. However, the rural dummies for 1998 are negative and insignificant. Furthermore, the test for significance confirms the insignificance of the rural dummy in 1998, but significance of the same at the 1% level of significance in 2003.

Current/Acute Malnutrition

The econometric results for the model of current or acute malnutrition as measured by *whz* scores are presented in Table 1.9. Like for chronic malnutrition, the regional (rural and urban) models are presented in appendix II tables A1.3 and A1.4. The results differ with those of long term malnutrition in several aspects. In the first place the models portray much poorer fits with the 1998 models explaining only about 12% of the total variation in current malnutrition and the 2003 models only 14%. The explanatory power is even much lower when we include the constant. This is however consistent with the literature.

In both years assets are not important determinants of current nutrition, though important for long term nutritional status. The impact of mature females turns out to be positive but only important for 2003. The impact of mother's height is reversed to give an inverted U-shaped relationship and the impact is only significant for 2003. Signs for primary years of education or mothers and head of household are also reversed for 2003.

Immunization is important for the 1998 sample but not for the 2003 sample. Comparing the two survey years, results for current malnutrition are somewhat quite different. Other than the overall fit of the model, household characteristics seem to be more important in 2003 than in 1998. For instance, number of mature females, mother's height, and age of household head are more important determinants of current malnutrition than in 1998. Male children are evidently likely to be more malnourished in 2003. The results also differ for ethnic dummies where relative to the Luo group, all other tribes are likely to have lower levels of *whz* scores in 2003. In 1998, all ethnic dummies are positive but only significant for the Kikuyu group. Muslim are likely to have lower nutritional scores relative to Christians in 1998, but the coefficient is weakly significant.

Table 1.9: Survey Regression Results for Acute Malnutrition: 1998-2003; Full Sample (t-values in parenthesis)

	Model (1)		Model (2)	
	1998	2003	1998	2003
Variable by Category	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates
Child characteristics				
Age of child in Months	-0.088 (-7.38***)	-0.114 (-10.62***)	-0.089 (-7.48***)	-0.116 (-10.75***)
Age of child in Months Squared	0.002 (6.15***)	0.003 (9.17***)	0.002 (6.2***)	0.003 (9.32***)
Birth Order	-0.008 (-0.34)	-0.007 (-0.32)	-0.007 (-0.3)	-0.012 (-0.58)
Male child dummy	-0.061 (-1.14)	-0.114 (-2.21***)	-0.062 (-1.14)	-0.112 (-2.17***)
Household characteristics				
Number of children 5 and under	-0.022 (-0.74)	-0.031 (-0.90)	-0.026 (-0.88)	-0.025 (-0.73)
Number of women aged 15-49 yrs	0.005 (0.12)	0.081 (2.00**)	0.018 (0.46)	0.056 (1.51)
Mothers age	0.010 (0.3)	-0.023 (-0.62)	0.004 (0.13)	-0.029 (-0.8)
Mothers age squared	0.000 (-0.19)	0.001 (1.14)	0.000 (-0.02)	0.001 (1.18)
Mothers height	-0.004 (-0.51)	0.019 (2.49***)	-0.002 (-0.21)	0.015 (1.99**)
Mothers height squared	0.000 (0.56)	-0.0001 (-1.93**)	0.00001 (0.33)	0.000 (-1.55)
Mothers years of primary education	0.027 (1.98**)	-0.001 (-0.06)	0.023 (1.82**)	0.009 (0.75)
Mothers years of post primary education	0.029 (1.18)	0.037 (2.1**)	0.039 (1.67*)	0.040 (2.24**)
House hold heads years of primary education	-0.016 (-1.42)	0.018 (1.18)		
House hold heads years of post primary education	0.020 (1.05)	0.002 (0.23)		
Age of house hold head	0.009 (0.64)	-0.026 (-2.04**)		
Age of house hold head squared	0.000 (-0.7)	0.000 (1.87**)		
Mother is head dummy	-0.061 (-0.75)	-0.036 (-0.47)		
Asset index	0.082 (1.04)	0.131 (1.55)	0.096 (1.25)	0.136 (1.63*)
Asset index squared	0.040 (1.1)	-0.030 (-0.82)	0.038 (1.08)	-0.031 (-0.85)
Ethnicity dummies relative to Luo, Luyhia, Kisii				
Kalenjin tribe	0.022 (0.31)	-0.255 (-2.68***)	0.030 (0.43)	-0.263 (-2.79***)
Kikuyu, Meru, Kamba, Embu tribe	0.129 (1.69*)	-0.081 (-1.16)	0.118 (1.54)	-0.093 (-1.32)
Other tribe	0.010 (0.08)	-0.437 (-3.43***)	0.000 (0.00)	-0.446 (-3.50***)

Religion relative to Christian				
Muslim	-0.256 (-1.6*)	0.012 (0.08)	-0.246 (-1.54)	-0.006 (-0.04)
Other religion	-0.126 (-0.95)	-0.099 (-0.64)	-0.103 (-0.78)	-0.113 (-0.73)
Community variables				
Child is fully vaccinated	0.293 (2.27***)	-0.016 (-0.09)	0.307 (2.37***)	-0.002 (-0.01)
Delivery in modern facility	0.227 (1.8**)	0.240 (1.81**)	0.237 (1.86**)	0.241 (1.80**)
Rural area dummy	0.042 (0.46)	-0.103 (-1.14)	0.050 (0.54)	-0.112 (-1.25)
No. of observations	2845	2750	2851	2750
R-Squared	0.1201	0.1369	0.1191	0.1344
Test statistics ***Chow test for significance***				
All variables	12.91 (0.0000)	11.57 (0.0000)	15.35 (0.0000)	13.85 (0.0000)
Child characteristics	19.35 (0.0000)	38.43 (0.0000)	20.19 (0.0000)	38.89 (0.0000)
Household characteristics	2.18 (0.0082)	4.42 (0.0000)	3.17 (0.0006)	5.45 (0.0000)
Religion dummies	1.45 (0.2357)	0.23 (0.7966)	1.27 (0.2816)	0.27 (0.7631)
Ethnicity dummies	1.01 (0.3901)	5.25 (0.0015)	0.85 (0.4687)	5.52 (0.0010)
Community variables	4.46 (0.0121)	1.66 (0.1922)	4.75 (0.0091)	1.65 (0.1915)
Regional dummies	0.21 (0.6467)	1.30 (0.2544)	0.29 (0.5873)	1.55 (0.2133)

*,**, ***, significant at 10%, 5% and 1% levels respectively

Both community variables are positive and significant in 1998, but only the place of delivery is important for 2003. Rural dummies have different signs but are both insignificant. The differences between the two survey years in terms of the determinants of current malnutrition are further portrayed by the differences in joint significance of groups of variables. For instance, ethnicity dummies are jointly significant for 2003 and not 1998, while the reverse is the case for community variables. All other groups of variables are either significant or otherwise, at the same or different levels.

1.5. Preliminary Conclusions

This sub-paper investigates the determinants of child nutritional status in Kenya for the period 1998-2003, using demographic household survey data. We investigate the impact of child characteristics, household characteristics and community characteristics on both chronic and acute malnutrition. For community variables, we estimate non-self cluster means to endogenize community characteristics. We employ both descriptive statistics and survey regression techniques to explain the determinant of child nutritional status.

Descriptive analysis shows that the 1998 and 2003 datasets are robust across all variables in spite of differences in sample sizes, and therefore, child nutritional status and its determinants can be compared across the two periods. The descriptive statistics imply that though the distribution of mean 'Z'scores across regions is not consistent in the two years, there is evidence of regional disparities in child nutritional status.

The descriptive statistics also suggest that boys are more likely to suffer chronic and acute under nutrition as well as being underweight than girls, while children from female headed households are likely to be more malnourished than children from male headed households. Further, rural children are likely to suffer more malnutrition than urban children. Maternal education is positively correlated to child nutritional status.

The preliminary regression results support the descriptive statistics. In particular, we find child characteristics to be important determinants of nutritional status, while male children are more likely to be malnourished than female children. We do not uncover any important effect of household composition and mother's age on malnutrition. Mother's height display a U shaped relationship with malnutrition. Maternal education is important, but paternal education does not seem to matter. Another highlight is that nutrition improves at a decreasing rate with assets, which is also consistent with descriptive statistics. However, assets seem to have been more important for nutritional status in 1998 than in 2003. Though community variables are jointly significant in explaining child nutritional status, only delivery in a modern facility is individually significant in explaining malnutrition.

Future Work

To complete this sub-paper the remaining tasks include:

- To pool the 1998 and 2003 DHS dataset together to estimate pooled regressions
- To carry out joint significance tests for the pooled regression results
- Decompose differences in nutritional status into explained and unexplained components. The first refers to that component explainable by child, household and community characteristics, while the second component is that explainable by say policy failure

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Appendix II

Table A1.1: Survey Regression Results for Chronic Malnutrition: 1998-2003; Rural Sample (t-values in parenthesis)

	Model (1)		Model (2)	
	1998	2003	1998	2003
Variable by Category	**Parameter Estimates**	**Parameter Estimates**	**Parameter Estimates**	**Parameter Estimates**
Child characteristics				
Age of child in months	-0.180 (-12.76***)	-0.188 (-13.08**)	-0.181 (-12.98***)	-0.186 (-13.07***)
Age of child in months squared	0.004 (9.75***)	0.004 (10.25***)	0.004 (9.86***)	0.004 (10.21***)
Birth Order	-0.131 (-1.99**)	-0.200 (-3.25***)	-0.009 (-0.31)	-0.054 (-1.71
Male child dummy	-0.006 (-0.22)	-0.054 (-1.75*)	-0.123 (-1.85**)	-0.201 (-3.21***)
Household characteristics				
Number of children 5 and under	-0.038 (-0.83)	-0.043 (-0.92)	-0.037 (-0.84)	-0.049 (-1.03)
Number of women aged 15-49 yrs	-0.100 (-1.78*)	0.093 (1.59**)	-0.071 (-1.36)	0.069 (1.25)
Mothers age	-0.028 (-0.58)	0.037 (0.91)	-0.030 (-0.61)	0.037 (0.95)
Mothers age squared	0.001 (0.81)	0.0001 (-0.12)	0.001 (0.90)	-0.0001 (-0.20)
Mothers height	-0.034 (-2.78***)	-0.0404 (-4.08***)	-0.030 (-2.63***)	-0.047 (-5.43***)
Mothers height squared	0.0001 (4.35***)	0.0001 (6.25***)	0.0002 (4.24***)	0.0003 (7.23***)
Mothers years of primary education	0.005 (0.28)	0.0182 (1.09)	0.013 (0.86)	0.006 (0.39)
Mothers years of post primary education	0.069 (2.43***)	0.042 (1.4)	0.091 (3.29***)	0.044 (1.50)
House hold heads years of primary education	0.011 (0.83)	-0.028 (-1.9**)		
House hold heads years of post primary education	0.045 (1.99**)	0.003 (0.22)		
Age of house hold head	0.007 (0.41)	-0.021 (-1.24)		
Age of house hold head squared	0.0001 (-0.04)	0.000 (1.17)		
Mother is head dummy	0.026 (0.26)	-0.010 (-0.13)		
Asset index	0.380 (3.31***)	0.279 (2.67***)	0.414 (3.87***)	0.255 (2.50***)
Asset index squared	-0.050 (-0.62)	-0.059 (-0.77)	-0.060 (-0.73)	-0.042 (-0.56)

Ethnicity dummies relative to Luo, Luyhia, Kisii				
Kalenjin tribe	0.096 (1.01)	-0.005 (-0.05)	0.093 (0.98)	0.019 (0.17)
Kikuyu, Meru, Kamba, Embu tribe	0.047 (0.46)	-0.056 (-0.56)	0.048 (0.47)	-0.053 (-0.53)
Other tribe	0.047 (0.32)	0.190 (1.41)	0.057 (0.39)	0.194 (1.41)
Religion relative to Christian				
Muslim	-0.137 (-0.56)	-0.245 (-1.39)	-0.127 (-0.50)	-0.246 (-1.35)
Other religion	0.061 (0.21)	-0.197 (-0.96)	0.069 (0.23)	-0.186 (-0.90)
Community variables				
Child is fully vaccinated	0.142 (0.8)	-0.167 (-0.81)	0.153 (0.85)	-0.192 (-0.93)
Delivery in modern facility	0.357 (2.72***)	0.384 (2.30***)	0.338 (2.61***)	0.375 (2.23**)
No. of observations	2427	2039	2433	2039
R-Squared	0.5120	0.5372	0.5100	0.5360
Test statistics ***Chow test for significance***				
All variables	70.72 (0.0000)	64.81 (0.0000)	87.57 (0.0000)	77.74 (0.0000)
Child characteristics	65.52 (0.0000)	80.09 (0.0000)	67.81 (0.0000)	80.33 (0.0000)
Household characteristics	9.44 (0.0000)	8.57 (0.0000)	11.37 (0.0000)	11.82 (0.0000)
Religion dummies	0.21 (0.8138)	1.23 (0.2955)	0.17 (0.8406)	1.13 (0.3246)
Ethnicity dummies	0.36 (0.7840)	1.01 (0.3911)	0.34 (0.7938)	1.00 (0.3938)
Community variables	4.43 (0.0125)	2.78 (0.0643)	4.19 (0.0159)	2.71 (0.0689)

*,**, ***, significant at 10%, 5% and 1% levels respectively

Table A1.2: Survey Regression Results for Chronic Malnutrition: 1998-2003; Urban Sample (t-values in parenthesis)

	Model (1)		Model (2)	
	1998	2003	1998	2003
Variable by Category	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates
Child characteristics				
Age of child in months	-0.171 (-4.07***)	-0.151 (-5.64***)	-0.168 (-3.91***)	-0.159 (-5.52***)
Age of child in months squared	0.003 (3.07***)	0.003 (4.52***)	0.003 (2.92***)	0.004 (4.44***)
Birth Order	-0.222 (-1.12)	-0.296 (-2.25**)	-0.165 (-1.86**)	0.051 (0.68)
Male child dummy	-0.155 (-1.81**)	0.070 (1.01)	-0.237 (-1.18)	-0.323 (-2.30**)
Household characteristics				
Number of children 5 and under	0.037 (0.33)	-0.099 (-0.84)	0.023 (0.22)	-0.102 (-0.85)
Number of women aged 15-49 yrs	-0.234 (-2.02**)	-0.010 (-0.09)	-0.176 (-1.57)	-0.005 (-0.05)
Mothers age	-0.073 (-0.56)	0.151 (1.26)	-0.047 (-0.37)	0.104 (0.95)
Mothers age squared	0.002 (0.68)	-0.003 (-1.24)	0.001 (0.59)	-0.002 (-1.05)
Mothers height	-0.020 (-0.69)	-0.046 (-2.31**)	-0.014 (-0.54)	-0.052 (-2.09**)
Mothers height squared	0.0002 (1.30)	0.0002 (2.9***)	0.0001 (1.19)	0.0003 (2.72***)
Mothers years of primary education	0.024 (0.54)	-0.024 (-0.73)	0.018 (0.43)	0.022 (0.62)
Mothers years of post primary education	-0.026 (-0.56)	0.053 (1.51)	-0.060 (-1.14)	0.090 (3.12)
House hold heads years of primary education	0.018 (0.41)	0.059 (1.21)		
House hold heads years of post primary education	-0.067 (-1.20)	0.064 (2.54***)		
Age of house hold head	0.026 (0.40)	-0.060 (-1.36)		
Age of house hold head squared	-0.0002 (-0.22)	0.001 (1.23)		
Mother is head dummy	0.406 (1.39)	-0.073 (-0.36)		
Asset index	0.407 (2.06**)	0.224 (1.48)	0.344 (1.80**)	0.244 (1.55)
Asset index squared	-0.072 (-1.21)	-0.022 (-0.38)	-0.058 (-0.94)	-0.018 (-0.28)
Ethnicity dummies relative to Luo, Luyhia, Kisii				
Kalenjin tribe	-0.648 (-1.89**)	0.061 (0.2)	-0.643 (-2.20**)	0.174 (0.65)
Kikuyu, Meru, Kamba, Embu tribe	-0.323 (-1.43)	0.094 (0.65)	-0.310 (-1.40)	0.108 (0.74)
Other tribe	-0.003 (-0.01)	0.533 (1.98**)	-0.004 (-0.01)	0.488 (1.84**)

Religion relative to Christian				
Muslim	0.351 (1.10)	0.262 (0.85)	0.410 (1.25)	0.218 (0.75)
Other religion	-0.972 (-3.09***)	-0.289 (-0.8)	-1.098 (-3.71***)	-0.331 (-0.89)
Community variables				
Child is fully vaccinated	0.720 (1.33)	-0.419 (-1.19)	0.730 (1.33)	-0.327 (-0.86)
Delivery in modern facility	0.368 (0.89)	0.077 (0.22)	0.304 (0.78)	0.075 (0.21)
No. of observations	402	708	403	708
R-Squared	0.2926	0.4472	0.2849	0.4347
Test statistics ***Chow test for significance***				
All variables	7.81 (0.0000)	17.51 (0.0000)	9.89 (0.0000)	20.52 (0.0000)
Child characteristics	8.65 (0.0000)	18.56 (0.0000)	8.43 (0.0000)	18.97 (0.0000)
Household characteristics	0.92 (0.5387)	4.52 (0.0000)	1.30 (0.2470)	4.79 (0.0000)
Religion dummies	8.08 (0.0007)	1.21 (0.3018)	10.86 (0.0001)	1.23 (0.2984)
Ethnicity dummies	1.61 (0.1936)	1.71 (0.1694)	1.87 (0.1415)	1.71 (0.1677)
Community variables	1.44 (0.2445)	0.73 (0.4850)	1.28 (0.2829)	0.38 (0.6829)

*,**, ***, significant at 10%, 5% and 1% levels respectively

Table A1.3: Survey Regression Results for Acute Malnutrition: 1998-2003; Rural Sample (t-values in parenthesis)

	Model (1)		Model (2)	
	1998	2003	1998	2003
Variable by Category	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates
Child Characteristics				
Age of child in Months	-0.095 (-7.30***)	-0.120 (-9.85***)	-0.096 (-7.42***)	-0.122 (-10.03***)
Age of child in Months Squared	0.002 (6.12***)	0.003 (8.63***)	0.002 (6.19***)	0.003 (8.83***)
Birth Order	-0.085 (-1.48)	-0.131 (-2.28***)	-0.015 (-0.59)	-0.016 (-0.68)
Male child dummy	-0.014 (-0.57)	-0.008 (-0.35)	-0.089 (-1.53)	-0.126 (-2.18***)
Number of children 5 and under	-0.020 (-0.63)	-0.013 (-0.33)	-0.028 (-0.87)	-0.003 (-0.08)
Number of women aged 15-49 yrs	0.000 (-0.01)	0.080 (1.71***)	0.017 (0.40)	0.043 (1.02)
Mothers age	0.012 (0.31)	-0.015 (-0.36)	0.004 (0.11)	-0.024 (-0.59)
Mothers age squared	-0.0001 (-0.22)	0.001 (0.95)	0.00001 (0.02)	0.001 (1.00)
Mothers height	-0.003 (-0.3)	0.020 (2.28***)	0.001 (0.11)	0.015 (1.70*)
Mothers height squared	0.0001 (0.4)	-0.0001 (-1.89***)	0.00003 (0.10)	-0.0001 (-1.46)
Mothers years of primary education	0.026 (1.76*)	-0.010 (-0.63)	0.020 (1.50)	0.004 (0.26)
Mothers years of post primary education	0.019 (0.69)	0.053 (2.36***)	0.033 (1.30)	0.055 (2.46***)
House hold heads years of primary education	-0.021 (-1.71***)	0.025 (1.56***)		
House hold heads years of post primary education	0.027 (1.23)	0.000 (0.04)		
Age of house hold head	0.011 (0.69)	-0.037 (-2.43***)		
Age of house hold head squared	-0.0001 (-0.72)	0.0004 (2.26**)		
Mother is head dummy	-0.020 (-0.24)	0.171 (1.83**)		
Asset index	0.126 (1.35)	-0.080 (-1.21)	0.141 (1.49)	0.174 (1.92**)
Asset index squared	0.056 (0.76)	-0.069 (-0.79)	0.055 (0.75)	-0.077 (-1.18)
Ethnicity dummies relative to Luo, Luyhia, Kisii				
Kalenjin tribe	0.077 (1.07)	-0.234 (-2.28**)	0.088 (1.24)	-0.247 (-2.44***)
Kikuyu, Meru, Kamba, Embu tribe	0.200 (2.45***)	-0.094 (-1.16)	0.188 (2.29***)	-0.113 (-1.40)
Other tribe	0.114 (0.83)	-0.380 (-2.66***)	0.103 (0.75)	-0.395 (-2.75***)

Religion relative to Christian				
Muslim	-0.339 (-1.55*)	0.058 (0.32)	-0.318 (-1.46)	0.041 (0.23)
Other religion	-0.221 (-1.55*)	-0.160 (-0.87)	-0.195 (-1.36)	-0.181 (-0.98)
Community variables				
Child is fully vaccinated	0.246 (1.78*)	-0.024 (-0.11)	0.261 (1.88**)	-0.009 (-0.04)
Delivery in modern facility	0.152 (1.08)	0.295 (2.02**)	0.160 (1.13)	0.301 (2.05**)
No. of Observations	2438	2040	2444	2040
R-Squared	0.1329	0.1474	0.1313	0.1424
Test statistics ***Chow test for significance***				
All variables	13.03 (0.0000)	9.38 (0.0000)	15.57 (0.0000)	11.04 (0.0000)
Child characteristics	19.60 (0.0000)	32.44 (0.0000)	20.73 (0.0000)	32.86 (0.0000)
Household characteristics	2.18 (0.0082)	3.57 (0.0000)	2.45 (0.0077)	4.32 (0.0000)
Religion dummies	1.98 (0.1398)	0.53 (0.5893)	1.62 (0.1998)	0.60 (0.5488)
Ethnicity dummies	2.06 (0.1049)	3.32 (0.0206)	1.86 (0.1358)	3.62 (0.0139)
Community variables	2.34 (0.0974)	2.06 (0.1298)	2.55 (0.0796)	2.14 (0.1202)

*,**, ***, significant at 10%, 5% and 1% levels respectively

Table A1.4: Survey Regression Results for Acute Malnutrition: 1998-2003; Urban Sample (t-values in parenthesis)

	Model (1)		Model (2)	
	1998	2003	1998	2003
Variable by Category	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates
Child characteristics				
Age of child in months	-0.051 (-1.82**)	-0.079 (-4.02***)	-0.051 (-1.81*)	-0.079 (-3.97***)
Age of child in months squared	0.001 (1.49)	0.002 (3.05***)	0.001 (1.46)	0.001 (3.02***)
Birth Order	0.055 (0.4)	-0.029 (-0.25)	0.049 (0.75)	-0.008 (-0.13)
Male child dummy	0.042 (0.65)	0.004 (0.07)	0.057 (0.42)	-0.025 (-0.22)
Household characteristics				
Number of children 5 and under	-0.058 (-0.73)	-0.148 (-2.5***)	-0.050 (-0.64)	-0.136 (-2.24**)
Number of women aged 15-49 yrs	0.029 (0.32)	0.125 (1.95**)	-0.005 (-0.05)	0.139 (2.08**)
Mothers age	-0.054 (-0.50)	-0.022 (-0.34)	-0.051 (-0.48)	-0.027 (-0.4)
Mothers age squared	0.001 (0.54)	0.0002 (0.22)	0.001 (0.50)	0.001 (0.47)
Mothers height	0.005 (0.27)	0.0093 (0.63)	0.004 (0.22)	0.011 (0.71)
Mothers height squared	-0.0002 (-0.25)	-0.00002 (-0.25)	-0.00002 (-0.23)	-0.00002 (-0.35)
Mothers years of primary education	0.016 (0.45)	0.083 (2.58***)	0.023 (0.68)	0.038 (1.89**)
Mothers years of post primary education	0.089 (1.65*)	-0.022 (-0.74)	0.084 (1.57*)	-0.008 (-0.24)
House hold heads years of primary education	0.009 (0.29)	-0.082 (-2.01**)		
House hold heads years of post primary education	-0.019 (-0.45)	0.018 (0.78)		
Age of house hold head	0.003 (0.1)	0.017 (0.73)		
Age of house hold head squared	-0.0001 (-0.43)	-0.0001 (-0.68)		
Mother is head dummy	-0.277 (-1.05)	0.198 (1.22)		
Asset index	-0.075 (-0.53)	0.013 (0.07)	-0.058 (-0.43)	-0.028 (-0.15)
Asset index squared	0.075 (1.47)	0.045 (0.58)	0.064 (1.32)	0.058 (0.78)
Ethnicity dummies relative to Luo, Luyhia, Kisii				
Kalenjin tribe	-0.431 (-1.41)	-0.521 (-2.12**)	-0.494 (-1.66*)	-0.513 (-2.14***)
Kikuyu, Meru, Kamba, Embu tribe	-0.166 (-0.86)	-0.019 (-0.14)	-0.163 (-0.83)	-0.046 (-0.33)
Other tribe	-0.427 (-2.00**)	-0.670 (-2.82***)	-0.417 (-1.93**)	-0.708 (-2.99***)

Religion relative to Christian				
Muslim	0.039 (0.18)	0.014 (0.05)	-0.017 (-0.08)	0.102 (0.38)
Other religion	0.291 (0.98)	0.154 (0.68)	0.307 (1.06)	0.158 (0.70)
Community variables				
Child is fully vaccinated	0.289 (0.85)	0.030 (0.09)	0.306 (0.89)	-0.077 (-0.22)
Delivery in modern facility	0.515 (1.73*)	-0.088 (-0.32)	0.571 (2.00**)	-0.011 (-0.04)
No. of Observations	407	710	407	710
R-Squared	0.1095	0.1524	0.1042	0.1415
Test statistics ***Chow test for significance***				
All variables	3.44 (0.0001)	5.14 (0.0000)	4.61 (0.0000)	6.25 (0.0000)
Child characteristics	1.12 (0.3515)	6.18 (0.0002)	1.61 (0.3335)	6.10 (0.0000)
Household characteristics	1.42 (0.1698)	2.85 (0.0011)	1.40 (0.1985)	3.83 (0.0002)
Religion dummies	0.47 (0.6253)	0.24 (0.7884)	0.60 (0.5539)	0.35 (0.7075)
Ethnicity dummies	1.82 (0.1516)	4.42 (0.0055)	1.99 (0.1229)	4.74 (0.0035)
Community variables	1.44 (0.2445)	0.05 (0.9483)	2.69 (0.0741)	0.03 (0.9731)

*,**, ***, significant at 10%, 5% and 1% levels respectively

Table A1.5 : Survey Regression Results for Chronic Malnutrition by Gender of the Child: 1998-2003; (t-values in parenthesis)

	Model (1)				Model (2)			
	Boys		Girls		Boys		Girls	
	1998	2003	1998	2003	1998	2003	1998	2003
Variable by category	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates
Child characteristics								
Age of child in months	-0.176 (-9.65***)	-0.199 (-12.35***)	-0.176 (-9.40***)	-0.165 (-9.31***)	-0.176 (-9.55***)	-0.198 (-12.18***)	-0.177 (-9.57***)	-0.166 (-9.37***)
Age of child in months squared	0.004 (7.19***)	0.004 (10.10***)	0.004 (7.23***)	0.003 (7.01***)	0.004 (7.08***)	0.004 (9.93***)	0.004 (7.35***)	0.003 (7.07***)
Birth Order	-0.045 (-1.15)	-0.090 (-2.51***)	0.00004 (0.0002)	0.037 (0.90)	-0.052 (-1.31)	-0.095 (-2.65***)	-0.003 (-0.09)	0.037 (0.89)
Household characteristics								
Number of children 5 and under	-0.021 (-0.39)	0.044 (0.74)	-0.046 (-0.93)	-0.152 (-2.70***)	-0.017 (-0.32)	0.040 (0.65)	-0.046 (-0.95)	-0.158 (-2.87***)
Number of women aged 15-49 yrs	-0.113 (-1.56)	0.091 (1.34)	-0.162 (-2.37***)	0.029 (0.41)	-0.066 (-0.96)	0.042 (0.66)	-0.142 (-2.23**)	0.056 (0.87)
Mothers age	0.004 (0.06)	0.032 (0.61)	-0.094 (-1.58)	0.039 (0.81)	0.0263 (0.36)	0.033 (0.65)	-0.110 (-1.86**)	0.026 (0.57)
Mothers age squared	0.0002 (0.13)	0.0002 (0.19)	0.002 (1.75*)	-0.001 (-0.80)	0.00001 (0.00)	0.0001 (0.11)	0.002 (2.00**)	0.000 (-0.62)
Mothers height	-0.045 (-2.59***)	-0.047 (-3.96***)	-0.015 (-1.10)	-0.044 (-3.80***)	-0.0374 (-2.32)	-0.058 (-5.06***)	-0.016 (-1.24)	-0.0440 (-4.16***)
Mothers height squared	0.0003 (3.63***)	0.0003 (5.63***)	0.0002 (2.87***)	0.0002 (5.50***)	0.0001 (3.38***)	0.0003 (6.41***)	0.0002 (3.02***)	0.0003 (5.78***)
Mothers years of primary education	-0.006 (-0.27)	0.012 (0.63)	0.023 (0.97)	0.024 (1.11)	0.013 (0.62)	0.003 (0.17)	0.017 (0.78)	0.021 (1.04)
Mothers years of post primary education	0.026 (0.68)	0.038 (1.38)	0.066 (2.22***)	0.068 (1.94***)	0.030 (0.79)	0.046 (1.74)	0.073 (2.37***)	0.076 (2.35***)
House hold heads years of primary education	0.042 (2.26**)	-0.027 (-1.25)	-0.018 (-0.96)	-0.010 (-0.48)				
House hold heads years of post primary education	0.018 (0.55)	0.010 (0.69)	0.018 (0.72)	0.017 (0.88)				

Age of house hold head	0.036 (1.57)	-0.036 (-1.71*)	-0.013 (-0.54)	-0.007 (-0.31)				
Age of house hold head squared	-0.0003 (-1.1)	0.0003 (1.48)	0.0002 (0.73)	0.0001 (0.37)				
Mother is head dummy	0.171 (1.19)	0.054 (0.42)	-0.0003 (0.00)	-0.075 (-0.62)				
Asset index	0.456 (3.23***)	-0.014 (-0.11)	0.378 (2.83***)	0.513 (4.30***)	0.454 (3.35***)	-0.034 (-0.27)	0.374 (2.95***)	0.515 (4.30***)
Asset index squared	-0.143 (-2.75***)	0.074 (1.27)	-0.071 (-1.00)	-0.134 (-2.94***)	-0.141 (-2.71***)	0.087 (1.49)	-0.068 (-0.98)	-0.130 (-2.84***)
Ethnicity dummies relative to Luo, Luyhia, Kisii								
Kalenjin tribe	0.051 (0.45)	-0.018 (-0.14)	0.066 (0.46)	0.122 (0.96)	0.006 (0.05)	0.012 (0.10)	0.091 (0.62)	0.1415 (1.10)
Kikuyu, Meru, Kamba, Embu tribe	-0.061 (-0.47)	0.036 (0.31)	0.028 (0.23)	-0.017 (-0.15)	-0.061 (-0.48)	0.020 (0.17)	0.038 (0.33)	-0.016 (-0.14)
Other tribe	-0.034 (-0.14)	0.260 (1.71*)	0.091 (0.56)	0.297 (1.66*)	-0.023 (-0.09)	0.266 (1.77*)	0.080 (0.49)	0.298 (1.68*)
Religion relative to Christian								
Muslim	0.124 (0.42)	0.086 (0.46)	0.213 (0.94)	-0.208 (-0.89)	0.157 (0.51)	0.071 (0.38)	0.239 (1.05)	-0.212 (-0.90)
Other religion	-0.233 (-0.76)	-0.482 (-2.52***)	0.050 (0.16)	0.205 (0.73)	-0.222 (-0.70)	-0.484 (-2.54***)	0.111 (0.34)	0.203 (0.72)
Community variables								
Child is fully vaccinated	0.220 (0.94)	-0.026 (-0.11)	0.170 (0.71)	-0.421 (-1.82***)	0.223 (0.93)	-0.050 (-0.22)	0.173 (0.73)	-0.421 (-1.82*)
Delivery in modern facility	0.294 (1.55)	0.479 (2.60***)	0.441 (2.31***)	0.159 (0.78)	0.281 (1.45)	0.469 (2.53***)	0.443 (2.34***)	0.189 (0.92)
Rural area dummy	-0.072 (-0.41)	0.238 (1.70*)	-0.023 (-0.12)	0.218 (1.62*)	-0.011 (-0.07)	0.233 (1.65*)	-0.007 (-0.04)	0.233 (1.76*)
No. of Observations	1417	1380	1413	1367	1420	1380	1416	1367
R-Squared	0.4783	0.5563	0.4675	0.4872	0.4720	0.5532	0.4677	0.4861
Test statistics ***Chow test for significance***								
All variables	44.25 (0.0000)	58.53 (0.0000)	37.34 (0.0000)	36.10 (0.0000)	53.72 (0.0000)	70.18 (0.0000)	44.55 (0.0000)	40.93 (0.0000)

Child characteristics	51.66 (0.0000)	70.98 (0.0000)	48.46 (0.0000)	53.50 (0.0000)	51.80 (0.0000)	70.69 (0.0000)	50.26 (0.0000)	54.38 (0.0000)
Household characteristics	4.58 (0.0000)	6.96 (0.0000)	5.78 (0.0000)	6.36 (0.0000)	4.70 (0.0000)	9.78 (0.0000)	7.70 (0.0000)	8.77 (0.0000)
Religion dummies	0.47 (0.6280)	3.49 (0.0315)	0.44 (0.6426)	0.80 (0.4521)	0.46 (0.6323)	3.47 (0.0322)	0.56 (0.5741)	0.80 (0.4512)
Ethnicity dummies	0.25 (0.8583)	1.02 (0.3820)	0.15 (0.9291)	1.41 (0.2408)	0.11 (0.9546)	1.08 (0. 3596)	0.18 (0.9087)	1.52 (0.2091)
Community variables	1.76 (0.6794)	3.38 (0.0352)	3.60 (0.0281)	1.86 (0.1572)	1.59 (0.2052)	3.19 (0.0424)	3.72 (0.0249)	1.93 (0.1462)
Regional dummies	0.17 (0.6794)	2.88 (0.0905)	0.01 (0.9039)	2.62 (0.1064)	0.001 (0.9463)	2.73 (0.0991)	0.001 (0.9710)	3.09 (0.0798)

*,**, ***, significant at 10%, 5% and 1% levels respectively

Table A1.6: Survey Regression Results for Acute Malnutrition by Gender of the Child: 1998-2003; (t-values in parenthesis)

	Model (1)				Model (2)			
	Boys		Girls		Boys		Girls	
	1998	2003	1998	2003	1998	2003	1998	2003
Variable by Category	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates	Parameter Estimates
Child characteristics								
Age of child in months	-0.113 (-6.43***)	-0.113 (-7.63***)	-0.064 (-4.15***)	-0.112 (-7.44***)	-0.114 (-6.45***)	-0.117 (-7.81***)	-0.063 (-4.13***)	-0.113 (-7.56***)
Age of child in months squared	0.003 (5.72***)	0.003 (6.78***)	0.001 (3.01***)	0.002 (6.18***)	0.003 (5.70***)	0.003 (6.94***)	0.001 (2.97***)	0.002 (6.31***)
Birth Order	-0.006 (-0.19)	-0.022 (-0.76)	-0.0003 (-0.01)	0.007 (0.26)	-0.009 (-0.31)	-0.029 (-1.01)	0.001 (0.04)	0.003 (0.1)
Household characteristics								
Number of children 5 and under	-0.003 (-0.07)	0.014 (0.29)	-0.031 (-0.74)	-0.073 (-1.81**)	-0.005 (-0.12)	0.023 (0.46)	-0.036 (-0.89)	-0.072 (-1.75*)
Number of women aged 15-49 yrs	0.043 (0.70)	0.086 (1.40)	-0.045 (-0.86)	0.064 (1.22)	0.059 (1.08)	0.039 (0.72)	-0.038 (-0.80)	0.065 (1.37)
Mothers age	0.042 (0.83)	-0.065 (-1.41)	-0.036 (-0.77)	0.013 (0.25)	0.036 (0.70)	-0.075 (-1.59*)	-0.038 (-0.82)	0.012 (0.23)
Mothers age squared	-0.001 (-0.70)	0.002 (2.09**)	0.001 (0.74)	-0.0001 (-0.16)	0.0005 (-0.53)	0.002 (2.04**)	0.001 (0.73)	-0.0001 (-0.14)
Mothers height	-0.008 (-0.79)	0.025 (2.46***)	0.002 (0.23)	0.011 (0.99)	-0.006 (-0.54)	0.018 (1.80*)	0.003 (0.33)	0.011 (1.01)
Mothers height squared	0.00002 (0.48)	-0.0001 (-1.85**)	0.00001 (0.22)	-0.00003 (-0.70)	0.00001 (0.28)	-0.0001 (-1.38)	0.00001 (0.14)	-0.00003 (-0.71)
Mothers years of primary education	0.028 (1.43)	0.020 (1.04)	0.030 (1.68*)	-0.023 (-1.25)	0.027 (1.49)	0.031 (1.98**)	0.021 (1.28)	-0.011 (-0.59)
Mothers years of post primary education	0.021 (0.64)	0.044 (1.90**)	0.042 (1.34)	0.037 (1.41)	0.050 (1.64*)	0.048 (2.06***)	0.032 (1.08)	0.035 (1.38)
House hold heads years of primary education	-0.014 (-0.98)	0.019 (0.94)	-0.017 (-1.05)	0.023 (1.14)				

House hold heads years of post primary education	0.054 (2.15**)	0.004 (0.31)	-0.020 (-0.76)	-0.0001 (-0.01)				
Age of house hold head	0.008 (0.48)	-0.040 (-2.39***)	0.006 (0.28)	-0.008 (-0.39)				
Age of house hold head squared	-0.0001 (-0.41)	0.0004 (2.14**)	-0.0001 (-0.46)	0.0001 (0.41)				
Mother is head dummy	-0.021 (-0.19)	-0.172 (-1.75*)	-0.131 (-1.12)	0.094 (0.85)				
Asset index	-0.120 (-1.20)	-0.009 (-0.08)	0.279 (2.92***)	0.239 (2.18**)	-0.085 (-0.84)	-0.001 (-0.01)	0.263 (2.80***)	0.241 (2.27**)
Asset index squared	0.156 (4.24***)	0.048 (1.05)	-0.082 (-2.14**)	-0.090 (-1.75*)	0.151 (4.00***)	0.050 (1.11)	-0.079 (-2.01**)	-0.094 (-1.86**)
Ethnicity dummies relative to Luo, Luyhia, Kisii								
Kalenjin tribe	-0.048 (-0.55)	-0.175 (-1.39)	0.126 (1.13)	-0.322 (-2.72***)	-0.040 (-0.46)	-0.180 (-1.45)	0.137 (1.25)	-0.341 (-2.91***)
Kikuyu, Meru, Kamba, Embu tribe	0.077 (0.73)	-0.023 (-0.23)	0.187 (1.83**)	-0.117 (-1.14)	0.059 (0.57)	-0.055 (-0.55)	0.182 (1.74*)	-0.115 (-1.13)
Other tribe	-0.012 (-0.06)	-0.473 (-3.09***)	0.040 (0.30)	-0.395 (-2.21**)	-0.012 (-0.06)	-0.482 (-3.04***)	0.027 (0.20)	-0.397 (-2.26**)
Religion relative to Christian								
Muslim	-0.213 (-0.88)	0.075 (0.40)	-0.275 (-1.38)	-0.039 (-0.21)	-0.196 (-0.82)	0.037 (0.20)	-0.275 (-1.38)	-0.048 (-0.27)
Other religion	-0.152 (-0.84)	-0.060 (-0.25)	-0.114 (-0.50)	-0.121 (-0.75)	-0.135 (-0.74)	-0.095 (-0.38)	-0.095 (-0.41)	-0.118 (-0.74)
Community variables								
Child is fully vaccinated	0.466 (2.53	-0.002 (-0.01)	0.150 (0.81)	-0.102 (-0.43)	0.473 (2.59***)	0.034 (0.16)	0.149 (0.80)	-0.086 (-0.37)
Delivery in modern facility	0.202 (1.09)	0.214 (1.23)	0.246 (1.49)	0.268 (1.48)	0.205 (1.10)	0.225 (1.29)	0.272 (1.63*)	0.262 (1.44)
Rural area dummy	-0.047 (-0.35)	-0.166 (-1.49)	0.140 (1.09)	-0.053 (-0.40)	-0.021 (-0.16)	-0.170 (-1.58*)	0.128 (0.97)	-0.058 (-0.45)
No. of Observations	1426	1382	1418	1368	1429	1382	1422	1368
R-Squared	0.1626	0.1696	0.1024	0.1223	0.1589	0.1629	0.1003	0.1203

Test statistics **Chow test for significance**								
All variables	12.16 (0.0000)	10.80 (0.0000)	5.67 (0.0000)	6.27 (0.0000)	14.06 (0.0000)	11.58 (0.0000)	6.65 (0.0000)	7.68 (0.0000)
Child characteristics	15.56 (0.0000)	23.21 (0.0000)	10.84 (0.0000)	26.90 (0.0000)	15.65 (0.0000)	24.41 (0.0000)	11.01 (0.0000)	27.10 (0.0000)
Household characteristics	4.60 (0.0000)	4.07 (0.0000)	1.92 (0.0227)	2.86 (0.0004)	5.52 (0.0000)	4.83 (0.0000)	2.09 (0.0242)	3.61 (0.0001)
Religion dummies	0.55 (0.5779)	0.13 (0.13)	0.97 (0.3789)	0.28 (0.7543)	0.45 (0.6375)	0.11 (0.8923)	0.96 (0.3827)	0.29 (0.7503)
Ethnicity dummies	0.42 (0.7380)	3.59 (0.0140)	1.28 (0.2804)	3.47 (0.0163)	0.28 (0.8379)	3.31 (0.0204)	1.28 (0.2799)	3.90 (0.0092)
Community variables	4.12 (0.0168)	0.77 (0.4628)	1.58 (0.2070)	1.10 (0.3337)	4.22 (0.0152)	0.90 (0.4084)	1.78 (0.1695)	1.05 (0.3524)
Regional dummies	0.12 (0.7259)	2.23 (0.1364)	1.18 (0.2777)	0.16 (0.6925)	0.03 (0.8699)	2.49 (0.1155)	0.94 (0.3326)	0.20 (0.6558)

*,**, ***, significant at 10%, 5% and 1% levels respectively