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Anthropometric Parameters of Under-Five Years Old Children with Different Dietary Habits in Ukambani Region : A Study in Eastern Rural Kenya

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ANTHROPOMETRIC PARAMETERS OF UNDER-FIVE YEARS OLD CHILDREN WITH DIFFERENT DIETARY HABITS IN UKAMBANI REGION: A STUDY IN EASTERN RURAL KENYA

By

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Each person whose signature appears below certifies that this dissertation, in his/her opinion, is adequate in the scope and quality as a dissertation for the degree of Doctor of Public Health.

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ABSTRACT

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The objective of this descriptive cross sectional study was to assess dietary intake and nutritional status of children under-five years in two rural sites of Eastern Kenya where the staple cereals may differ. A modified rapid, knowledge, practice and coverage (KPC) questionnaire and a 24-hr dietary recall form were used to collect the data. A total of 403 households were surveyed from four randomly selected divisions. This yielded 629 surrogate 24-hr dietary recalls of children < 5 years with 314 from Mwingi district and 315 from Makueni district (49 % boys and 51 % girls).

Statistical analysis was done using SPSS and SAS. Comparison of means was done using *t*- test and chi square was used for proportions. The 24-hr recalls were analyzed using the NDS-R 2008. Height, weight and age were used to compute the malnutrition indices (Z-scores) using EPI INFO 2000.

Daily energy intake (mean ± SD) for all the children was 1056 ± 553 Kcal. Daily energy intake 1130 ± 595 Kcal in MW children was 15% higher compared to MA children (983 ± 499 Kcal, p = 0.002). Boys had a 12% higher daily energy intake than girls ($p = 0.005$). Grains contributed 62-68 % of total energy intake in both districts. The contribution to total energy from grains was 27 % higher in MW children ($p = 0.0001$). There were gender and geographical differences in diets of children in Ukambani region with the most prominent perhaps being the type and amount of cereal intake.

Girls had higher malnutrition prevalence rates (height-for-age; HAZ = 51.7%, weight-for-age; WAZ = 32.1% and weight-for-height; WHZ = 4.6%) than boys (height-for-age 35.9%, weight-for-age 14.6% and weight-for-height 1.2%). Boys had more favorable mean Z score indices (HAZ = -1.33, WAZ = -0.60 and WHZ = 0.25) than girls (HAZ = -2.02, WAZ = -1.37 and WHZ = -0.10). Regardless of geographical location malnutrition in both boys and girls was related to age. Further research is needed to establish the determinants of malnutrition at household level that might be causing gender disparity in nutritional status in Ukambani region of Mwingi and Makueni.

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CHAPTER 1

INTRODUCTION

A. Statement of the Problem

Although there has been improvement in nutritional status in many parts of the developing world, it is unfortunate that under-nutrition in the developing world is still a main factor associated with poverty (Kwena et al., 2005; Fosto, 2006). Under-nutrition is exacerbated by diseases, poverty, hostile climates, political instability, etc. Causes of under-nutrition can range from lack of access to healthy food to gender discrimination.

Sub-Sahara is not on track to achieving a single Millennium Development Goals (MDGs). In sub-Sahara Africa, about 35% of pre-school children are stunted and 29% underweight (World Bank, 2006). In Eastern Africa, the corresponding figures are 48.1% stunted and 35.9% underweight (Fosto, 2006; Leenstra et al., 2005). Chronic malnutrition is stunting the growth of Kenyan children. Thirty percent of children under 5 years in Kenya are stunted, 24% are underweight, 6% are wasted and one in five children in Kenya is underweight (KDHS, 2003). One out of every nine children in Kenya die before cerebrating their fifth birthday (Kenya Demographic Health Survey [KDHS], 2003).

Kenya's long term goal of food sufficiency remains unmet. Kenya has a population of about 38 million growing at a rate of 3% and 10% are classified as food insecure. On January 09, 2009 the government declared a food emergency stating that about 10 million Kenyans (25% of the population) are now or will soon be at risk of food shortage (USDA, 2009). There is also growing evidence that the world climate is changing gradually hence more of the world is likely to be in drought. Future climatic changes will affect water supplies and food production.

Most of Kenyan agriculture is rain fed. Eastern province, in which Mwingi and Makueni districts are located, is dry most of the time. For over 50 years now Makueni district has used maize as its staple cereal, however, increased drought in the area may not be conducive to supporting maize as a staple cereal (Mwingi Development Plan, 2002-2008). Mwingi district, mainly relies on pearl millet for its staple cereal because rain is not enough most of the time to support maize production. Pearl millet was domesticated as a food crop in the tropical region of East Africa about 4000 years ago (Robert, 2002). Pearl millet is considered more efficient in utilization of soil moisture and has a higher level of heat tolerance than sorghum and maize, two common grains consumed in this area (Rathi, Kawatra, and Sehgal, 2003).

Apart from the assumption that most of the children's energy come from cereal, we lack region scientific specific dietary description in children < 5 years in Ukambani region of Eastern Africa. In Kenya, a few rural regional studies have been done on the nutritional status of <5 children. However, most of them have been done in western part of Kenya and to the best of my knowledge only one of those describes the < 5 children dietary intake (Bloss et al., 2004; Kwena et al.; 2005; Macharia et al., 2004, Macharia et al., 2005). Dietary assessment studies can provide valuable data to guide in policy making, planning at national and regional level, designing and evaluation of programs and prioritizing. Thus, this study was designed to describe the dietary intake and nutritional status of under five children in two sites: Mwingi, a pearl millet growing area, and Makueni, a maize growing area in Ukambani region, Eastern Kenya.

B. Purpose of the Study

The purpose of this study was to assess dietary intake and nutritional status of children under-five years in two rural sites of Eastern Kenya where the staple cereals may differ.

C. Research Questions

This study tried to answer the following main questions:

1. What are the commonly consumed foods by children less than five years in rural Eastern Kenya?

2. What is the total daily energy and nutrients intake among under-five children in rural Eastern Kenya?

3. What are the rates of malnutrition among under-five year old children in the surveyed areas of Mwingi and Makueni districts in rural Kenya?

D. Definition of Terms

1. Stunting

Stunting (height-for-age) is slowing of skeletal growth and stature, which can be defined as the end result of a reduced rate of linear growth. It is found in countries where economic conditions are poor. It uses the height-for-age index and it results from chronic under-nutrition (Gibson, 2005). Stunting is also defined as -2 standard deviations (-2SDs) or more below the reference median on height-for-age. A child whose height-for-age is less than –2SDs is considered stunted (NCHS, 2000).

2. Underweight

Underweight (weight-for-age) is an index of acute malnutrition, which begins as early as six months of a child's age. It encompasses both stunting and wasting and it is used widely to assess protein-energy malnutrition. A child whose weight -for-age is less than –2SDs is considered underweight (Gibson, 2005; NCHS, 2000).

3. Wasting

Wasting (weight-for-height) is a sensitive index of current nutritional status. It results from inadequate nutrition over a shorter period and it develops very rapidly. It can be reversed quickly with appropriate intervention (Gibson, 2005). Wasting is defined as being –2SDs below the reference median. A child whose weight-for-height is less than –2SDs is classified as wasted (Gibson, 2005; NCHS, 2000).

E. Significance to Nutrition

Although genetics and disease contribute considerably to the development of individuals, diet has been shown to play a major role (Pawloski et al., 2004). Malnutrition (protein-energy malnutrition and micronutrient deficiencies) continues to afflict the developing countries (Muller and Krawinkel, 2005). Mothers require having knowledge and services allied to nutrition, reproductive health, family planning, and general health.

A number of studies conducted in the developing world in different settings ascertain that children enter the middle childhood already undernourished –already stunted and underweight (Friedman et al., 2005; Unpublished data). Therefore, the results of this intended study enabled the researchers to ascertain if there were differences in nutritional status in under-five year old children of Mwingi and Makueni Districts of Ukambani region. These two districts have different dietary habits. Mwingi district uses pearl millet mainly as its staple cereal while Makueni uses maize mainly.

We hypothesized that those children from Mwingi district would be better nourished because of better availability of their main energy food cereal, pearl millet. Pearl millet is a drought resistant cereal indigenous to Ukambani region, so when maize fails in most areas of Ukambani it is possible that Mwingi district continues to have better supply of pearl millet for their staple food. This could translate to better food availability in Mwingi district as compared to Makueni district. It was also assumed that if boys and girls children were cared for equally their anthropometric status should average the same. Differences in the growth between boys and girls above those dictated by biology can be attributed to inequalities in diet and health.

The results of this study may be used to support nutritional intervention programs and to inform agricultural and nutrition policy in Eastern Kenya.

CHAPTER 2

LITERATURE REVIEW

A. Introduction

Nutrition in developing countries is typically characterized by lack of sufficient food and variety in food choices (Pawloski et al., 2004). Africa is the only continent where the prevalence of malnutrition continues to be high, with little or no evidence of any improvement in nutritional status (Labadarios, 2005). Although there has been a drop by 14 % of under-nutrition in the developing world, this has not been the case, however, in Eastern Africa. Instead, stunting has increased by 2%, contributing to the 48% current stunting levels in children. This region has the highest levels of stunting on the continent of Africa (Bloss, Wainaina, and Bailey, 2004). Malnutrition is associated with over half of all deaths of children worldwide (World Bank, 2006).

Studies from different settings in the developing world show that children enter middle-childhood with nutritional status shortfalls resulting in stunting and wasting accrued from infancy (Friendman et al., 2005). In sub-Sahara Africa, stunting among the under-five ranges from 20% to 40%. Among adults, especially the pregnant women, micronutrient deficiencies are the most common. Global projected estimates for underweight in 2015 indicate that approximately 33% (43.3 million) of the world's underweight children will live on the continent of Africa (Labadarios, 2005). Sub-Sahara is not on track to achieve a single Millennium Development Goal (World Bank, 2006).

In Kenya 30% of children under-five years are stunted, 24% are underweight, and 6% are wasted (KDHS, 2003; UNICEF, 2007). Stunting indicates chronic malnutrition and wasting is a sign of severe malnutrition. One in five Kenyan children is underweight with stunting, or wasting; underweight is common in rural and among families of lower socioeconomic status (KDHS, 2003). The definition of malnutrition in this review is children less than –2SD Z-scores for height-for-age (stunting), weight-for-age (underweight), and weight -for- height (wasting) (Pelletier and Frongillo, 2003). Nationally, infant mortality is 77 deaths per 1,000 live births and under-five mortality is 115 deaths per 1,000 live births. In Eastern province infant mortality is 56 deaths per 1,000 live births and under-five mortality is 84 deaths per 1,000 live births (KDHS, 2003). In general, higher levels of education are associated with lower mortality rates. This may be possible because education exposes the mother to information about better nutrition, use of contraceptives to space children, and improved knowledge about childhood illness and treatment (KDHS, 2003).

1. Climate Change and Agricultural Output Practices

Most of Kenyan agriculture is rain fed. With the current changes in climate it is evident that people who reside in the arid and semi-arid parts of the country may not be able to depend on maize as their staple food as before. Eastern province in which Mwingi and Makueni districts are located is dry most of the time.

Mwingi district is hot and dry most of the year. Maximum annual temperature ranges between 26^0C and 34^0C and the minimum annual temperature ranges between 14^0C and 22^0C. The district has two rainy seasons the long rains (March to May) and the short rains (October to December). The rainfall ranges between 400 mm and 800 mm, but it is erratic. The short rains are more reliable than the long rains (Mwingi Development Plan, 2002-2008). Makueni experiences two rain seasons: the long rains (March/April) and the short rains (November/December). The lower parts of the district experience high temperatures, which result in high evaporation. Generally, the district experiences high temperatures during the daytime and low temperatures at nights. The rainfall ranges between 400 mm in the lower parts and 1200 mm in the hilly areas. The rainfall is erratic (Makueni District Development Plan, 2002-2008).

Mwingi district mainly relies on pearl millet for its staple cereal grain because rain is not enough most of the time to support maize production. Close to over 50 years now Makueni district has used maize as its staple cereal grain. Increased drought, however, may not be conducive to continue the cultivation of maize as a staple cereal (Mwingi District Development Plan, 2002-2008).

Pearl millet is considered more efficient in utilization of soil moisture and it has a high level of heat tolerance than sorghum and maize (Rathi, Kawatra, and Sehgal, 2003). Therefore, there was need to describe the diets and to assess the nutritional status of children living in these two sites where the staple cereal may differ. This was in an attempt to establish if children who are fed with pearl millet mainly as their staple food are well nourished because this might be the way to go with the current climatic changes that do not seem to support good maize yields in arid and semi-arid regions (ASALS).

This literature review discusses nutritive value of pearl millet, nutritional requirements of children, measures of nutritional status, determinants of under-nutrition, and consequences of under-nutrition.

B. Pearl Millet

Pearl millet is among the best drought resistant crops grown in arid and semi-arid parts of the world. It can grow in infertile lands where other crops like maize and sorghum will fail to survive. It is less vulnerable to pests; hence, it can be grown without the use of expensive pesticides (Rathi, Kawatra, and Sehgal, 2003). Currently, pearl millet is the world's sixth most important cereal grain. Pearl millet was domesticated as a food crop in the tropical region of East Africa about 4000 years ago. Now an estimated 64 million acres of pearl millet are being grown in Africa and India for human consumption. This acreage is equivalent to the total United States corn (maize) crop (Robert, 2002). See appendix F and G for pictures of pearl millet crop and grain. The stalks for pearl millet are used for fodder, thatching, fuel and beddings (Mwingi District Agricultural Office, 2007)

1. Nutritive Value of Pearl Millet

The nutritive value of pearl millet (specifically protein, fat and mineral contents) compares well with or is superior to other grain cereals (Rathi, Kawatra, and Sehgal, 2003; Ejeta, Hassen, and Mertz, 1987). Comparatively, pearl millet is high in proteins and its amino acid balance is good. Specifically, it is high in lysine, methionine and cystine. Compared to sorghum it contains two-fold methionine. In fact, slightly over 1/10 of the whole grain is protein. Pearl millet is high in fat and 4% of this fat content is α-linolenic acid. Pearl millet is comparable to wheat in iron and zinc contents (Varriano-Marston and Hoseney, 1980). The starch in pearl millet is hydrolyzed more slowly than that of sorghum by pancreatic amylase. This may have some implications in management of diabetes. Studies are needed to explore this further. Pearl millet is very bland and this blandness makes it well suited for people who are sick and having difficult in keeping food down. This could be explored further for use in clinical nutrition too.

Table 1. Nutritive Value of Pearl Millet Compared to Other Cereal Grains (100gms)

	Pearl millet	Maize	Sorghum	Finger millet	Rice	Wheat
Energy (kcal)	361	362	339	328	358	349
Water	12.4%	20-32%	8-16%	13%	-	-
CHO	67.1%	68%	68-74%	72%	79.9%	74.1%
Protein	11.6%	6-15%	8-15%	8%	6.2%	12.3%
Fat	5.3%	5%	2-5%	1.3%	0.6%	1.5%

Hulse J. et al., 1980
Food and Nutrition Center Tanzania Food Composition Tables, 2007

Basahy (1996), in an amino acid analysis of pearl millet identified at least 17 amino acids that included most of the essential amino acids. Leucine was the highest, whereas isoleucine and valine were within range as compared to other cereal grains, and threonine, lysine and sulphur containing amino acids were lower comparatively. This good amino acid balance suggests that pearl millet is a nutritious and a well digestible source of calories and protein for humans.

Table 2. Amino Acid Composition of Millet and Maize

Analysis	Pearl Millet	Maize
Protein %	11.7	9.06
Amino acids, g/100g of protein		
Aspartic acid	8.7	6.7
Threonine	4.2	3.8
Serine	5.3	5.3
Glutamic acid	22.1	22.5
Glysine	3.2	3.6
Alanine	8.8	8.6
Cystine	1.2	1.9
Valine	6.0	5.2
Methionine	2.3	2.3
Isoleucine	4.4	3.7
Leucine	11.5	15.2
Tryptophan	-	0.6
Tyrosine	2.4	3.9
Phenylalanine	5.6	5.5
Histidine	2.4	3.1
Lysine	2.8	2.4
Ammonia	1.3	1.2
Arginine	3.9	3.7
Proline	6.8	10.8
Total	**102.3**	**108.8**

Ejeta, Hassen & Mertz, 1987

Pearl millet is a good source of the following major minerals phosphorus, calcium, potassium, magnesium and sodium. It is also a good source of the following minor minerals iron, zinc, manganese and copper (Basahy, 1996; FAO, 1995; Abdalla, El Tinaya, and Mohamed, 2007; Varriano-Marston and Hoseney, 1980). Pearl millet is rich in B vitamins especially B_6, niacin and folacin. Since it contains no gluten it could be a suitable cereal for people with celiac disease.

Table 3. Mineral Content of Pearl Millet as Compared to Other Grain Cereals (mg %)

Grain	P	Mg	Ca	Fe	Zn	Cu	Mn
Pearl Millet	**379**	137	46	**8.0**	3.1	1.06	1.15
Maize	270	-	-	4.0	-	-	-
Finger Millet	320	137	398	3.9	2.3	0.47	5.49
Sorghum	352	171	15	4.2	2.5	0.44	1.15

FAO, 1995
Food and Nutrition Center Tanzania Food Composition Tables, 2007

C. Nutritional Requirements of Children

Normal infants and young children require at least twice as much of energy per kilogram weight as do adults. That is about 80 kcal to 100 kcal versus 30 kcal to 40 kcal / kg/ day. This higher need reflects children's higher resting metabolic rate and special needs for growth and development. Protein needs are also higher in children (Shils, Shike, Ross, Caballero, and Cousins, 2006). Thus, intervention programs have focused on increasing the protein and energy intake of children. Currently, intervention programs with micronutrients are being tested. Results of these interventions showed improved growth in children, better school performance and reduction in high prevalence of vitamin B_{12}. However, more research is needed on this approach (Grillenberger et al., 2003; Siekmann et al., 2003).

Following are Food Agricultural Organization (FAO) and World Health Organization (WHO) recommendations for under-five year old children for macronutrients: Acceptable Macronutrients Distribution Ranges (AMDR)
1-3 years : CHO 45-65%, protein 5-20%, Fat 30-40%, 4-5 years: CHO 45 -65%, protein 10 -30%, Fat 25 -35% (Gibson, 2005). A study conducted in Uganda found

energy deficits in children between 12-35 months (Bridge, Kipp, Raine, and Kondelule, 2006).

D. Measures of Nutritional Status

Nutritional assessment methods utilize measurement of food and nutrient intake and evaluation of nutrition-related health indicators (Lee and Nieman, 2006). Nutritional assessment methods can determine individual or group nutritional status. Such assessments can serve as a basis for identifying needs and goals and planning personal health care and community programs to meet the identified goals (Worthington-Roberts and William, 2000). Nutritional assessment interprets data from dietary, biochemical, anthropometric, and clinical measures (Gibson, 2005). Because of the multiple causes and different ways in which deficiencies of various nutrients manifest, no one method of assessing nutritional status is completely satisfactory (Guthrie, 1989). Four main nutritional assessment methods are common: dietary, anthropometrics, laboratory (biochemical), and clinical methods (Gibson, 2005).

*1. **Nutritional Assessment Methods***

a. *Dietary Assessment Methods* The dietary assessment methods include diet history, 24-hr diet recall, food records, and food frequency questionnaires (Lee & Nieman, 2006). In diet history a subject keeps a comprehensive record of the usual food intake over a relatively long period of time. This method includes a history of related living situations and other personal, psychological, and economic problems and drug use (Gibson, 2005).

In 24-hr diet recall, individuals respond to recall questions asked by a trained interviewer on specific food items eaten during the previous day, with descriptions of the nature and amount of each. This method is sufficient for group assessment but is not good for an individual assessment (Gibson, 2005). This method also serves as the gold standard to validate food frequency questionnaire (Walter, 1998). One major advantage is its use in low literacy populations like in rural settings. Two studies one conducted in Uganda and another in Makueni report using 24 -hr recalls for dietary data collection (Bridge, 2006; Macharia et al., 2005).

A food record is done by taking a three-to-seven day food records and this has been shown to give sufficient data (Gibson, 2005). Lastly, food frequency questionnaires provide information about an individual's food intake over an extended period of time. They also supply useful data when studying a group's disease risk incidence (Lee and Nieman, 2006).

b. Anthropometric Method The Anthropometric methods include measurements of height, weight, circumference, diameter, or length of various parts of the body (Lee and Nieman, 2006). Gibson (2005) defines anthropometry as the measurement of the variations of the physical dimensions and gross composition of the human body at different age levels and degrees of nutrition. Anthropometric methods have a number of advantages including simplicity, safety, precision and use of inexpensive equipment. Despite these advantages, a major limitation is that it is not sufficiently sensitive to detect disturbances in nutritional status over short periods of time (Gibson, 2005). Anthropometry is the most common method used to monitor growth in developing countries (Jelliffe and Jelliffe, 1989). Three indices are usually computed from age, height and weight measurements: Height-for-age, weight-for-age, and height-for-age.

The indicator for height-for-age is stunting (short stature). It is defined as height-for-age more than two standard deviations (-2SD) below the median of the National Center for Health Statistics (NCHS) (NCHS, 200O). Stunting means failure to grow adequately in height in relation to age. It reflects past or chronic under-nutrition resulting from inadequate food intake over a long period of time or repeated episodes of illness, particularly diarrhea (WHO, 1995; Gibson, 2005).

The indicator for weight-for-age is underweight (lightness). It is defined as weight-for-age more than two standard deviations (-2SD) below the median of the NCHS reference population. Weight-for- age is a composite indicator that reflects either chronic or acute malnutrition status or both (WHO, 1995; Gibson, 2005).

In anthropometrics, the indicator used for weight-for-height is wasting (thinness). It is defined as weight-for-height more than two standard deviations (-2SD) below the median of the NCHS reference population. Wasting represents a failure to gain weight adequately in relation to height and reflects recent or acute under-nutrition (WHO, 1995; Gibson, 2005).

The body mass index (BMI) measures adiposity because it is an excellent measure of adiposity in young adult and middle-aged population. In some circumstances it is better than percent body fat (Walter, 1998).

c. *Clinical Measurements* Clinically, malnutrition can be diagnosed by looking at the clinical symptoms of malnutrition. These include bloated abdomen and swelling in other parts of the body, changes in skin and hair such as brittle and spooned nails, dry and scaly skin, hair loss and change of hair color. Sunken temples and visible wasting are very easy to see in malnourished individuals (Shetty, 2006). In a study conducted among hospitalized children in rural Kenya, Berkley et al. (2005) used severe wasting as a predictor of subsequent inpatient death in under-5 year old children. Clinicians were instructed to look for muscle loss, manifested as wasting of the gluteal area and as the presence of a bony prominence over the chest wall. Mid upper arm circumference (MUAC), which is a simple and low cost method of assessing malnutrition in children was also used to predict malnutrition.

d. Biochemical Measurements Apart from a specific example like iron deficiency anemia, biochemical measurements alone cannot be used to measure under nutrition. One main reason is that they become abnormal only in advanced under-nutrition (Shetty, 2006). Iron-deficiency anemia (IDA) is a common nutritional deficiency in children and mothers. Anemia can be defined as decreased amount of hemoglobin concentration and red blood cells in the blood stream. Several factors can cause anemia; namely, insufficient iron in the diet, poor absorption of iron by the body, ongoing blood loss (most commonly from menstruation or from gradual blood loss in the intestinal tract), and periods of rapid growth. Children are at a higher risk of IDA because of their increased needs during their rapid growth periods, and particularly since their dietary iron intake is insufficient to make up for these increased needs. Some measures of anemia include hemoglobin concentration or hematocrit, serum ferritin, and serum transferrin receptor (sTfR). Transferrin receptor is an index of iron deficiency anemia and pre-anemic iron-deficient erythropoiesis in whole blood (Shell-Duncan and McDade, 2004).

E. Determinants of Under-nutrition in Children

Malnutrition is a violation of a child's human right. The immediate determinants are child's dietary intake and health. These two are influenced directly by three underlying factors at household level: namely; food security, adequate care for mothers and children, and a proper health environment. These in turn are influenced by two basic determinants. One, the potential resources available to a country and two, host of political, cultural, and social factors that affect their utilization (Smith & Haddad, 2000). Figure 1 presents a summary of determinants of malnutrition.

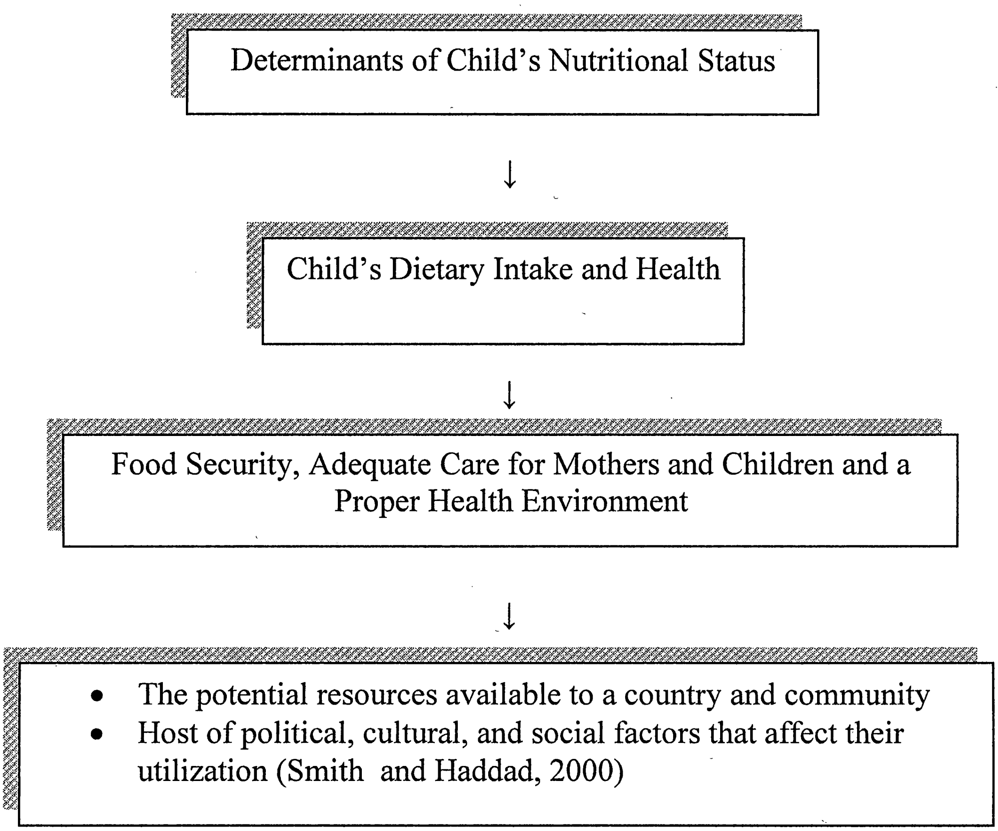

Figure 1. Summary of Determinants of a Child's Nutritional Status

1. Food Security

A poor diet results from family food shortage, inadequate care of children and women, an unhealthy environment and poor health services (Burgess, 1994). Agriculture in most developing countries including Kenya is weather dependent. Only about 16% of the 576,000 square kilometers of the Kenyan land mass receives adequate and dependable rainfall. Most of the landmass in Kenya falls under the arid and semi-arid areas. Land tenure in Kenya is divided into three types, namely, communal land, government trust land and private land. Not having a piece of land to farm is a common reason given in food security surveys as a cause of malnutrition (KDHS, 2003). Food insecurity is a huge cause of malnutrition in most parts of Kenya and it has multiple causes.

2. ***Education Levels***

Another possible cause of malnutrition includes low levels of education in the community. Despite the extraordinary expansion of education in the postcolonial period, Africa remains the most under-educated continent in the world. Of particular relevance to childhood malnutrition is the high rate of illiteracy among women. In sub-Sahara Africa, 62% of women are illiterate (World Bank, 2006; UNESCO, 2006). In Kenya 21% males and 30% females are illiterate (UNESCO, 2006). While academic knowledge might not always translate into nutritional knowledge, academic educational levels do translate into social economic status, and social economic status is a determinant of nutritional status.

3. ***Diseases***

HIV/AIDS, which has almost become a synonym for sub-Sahara Africa, is a major determinant of malnutrition. The epidemic that is usually accompanied by morbidity and mortality rates among children and the younger section of the adult population in turn exacerbates food insecurity. HIV decreases the available agricultural labor force and decreases food production. It also affects the purchasing power by killing or grounding the working class who provide for the means to buy the food if not the food by their toil and labor (Labadarios, 2005).

Kenya, a tropical country, is in a malarial zone; malaria is a major cause of morbidity and mortality in children (Nyakeriga, Troye-Blomberg, Chemtai, Marsh, and Williams, 2004). Nutritional inadequacies that result in stunting for Kenyan children also impair host immunity (Verhoef, West, Veenemas, Beguin, and Kok, 2002). Malaria, diarrhea and acute respiratory infection (ARI) are the major killers among the diseases of childhood (KDHS, 1998). The nutritional status of the children who survive these diseases may be compromised. Malaria causes children to lose appetite. Under-nutrition can affect development of an effective immune system (Siekman et al., 2003).

4. Poverty

The prevalence of malnutrition and stunting among children is a measure of the existing socioeconomic status in a given country (Labadarios, 2005). Malnutrition adds to the economic burden that developing countries face. Endemic poverty and lack of basic resources as shown by poor education, lack of employment and lack of basic resources for nutritional well being, form the basis for poor nutritional status in children (KDHS, 2003).

F. Consequences of Under-nutrition in Children

While nutritional needs vary throughout the life cycle, they are more intense during infancy and adolescence. Adolescence ranks number two after infancy as a time of greatest nutritional need (Pawloski, Moore, Lumbi, and Rondriguez, 2004). Nutritional status is a vital indicator of the general wellbeing and linear development of an individual (Friedman et al., 2005). Growth retardation is costly physiologically and economically (Leenstra et al., 2005).

Nutrient deficiencies can affect intellectual development in children, limit physical growth and increase child mortality. Currently, infant mortality rate in Kenya is 77 while the under five-mortality rate is 115 (KDHS, 2003). Nutritional deficiencies in children limit their ability to learn and to develop; temporary hunger during the school day hampers children's ability to concentrate (Tangwireyi and Greiner, 1994). Mukundi (2003), in a study in western Kenya, reports that nutritional stress could significantly affect school achievement. In this study of 851 children, prevalence of nutritional stress was high and most children fell below the reference, the NCHS mean on height-for-age (H/A) and weight-for-age (W/A). Malnutrition retards children's physical and cognitive development and increases susceptibility to disease.

Chronic malnutrition during the first few months of life, or intrauterine growth retardation, may decrease the number of brain cells and result in an abnormally low head circumference (Gibson, 2005). Malnutrition greatly increases the risk of morbidity, which is correspondingly high in sub-Sahara Africa. It also causes delay in school enrollment due to illness or the perception of parents and teachers that the child might not be ready for school (World Bank, 2006). Malnutrition affects human performance, physical growth, cognitive development, reproduction, and physical work capacity. It is also a risk for several adult-onset chronic diseases (KDHS, 2003; Pelletier and Frongillo, 2003). In addition, malnutrition is a risk for infection (Labadarios, 2005).

G. Conclusions

The most widespread nutrition disorder in developing countries among children is under-nutrition due to inadequate caloric intake, protein and macronutrients referred to as protein energy malnutrition (PEM). The prevalence of stunting, underweight, and wasting is decreasing in most areas of the world, but, in most of Africa, stunting is increasing (World Bank, 2006). East Africa has the highest prevalence of under-nutrition south of Sahara, standing at 48%. Currently, chronic malnutrition is stunting the growth of Kenyan children with 30% children stunted, 24% children underweight, and 6% children wasted.

Due to the climatic changes which are taking place in most parts of the world today (Kenya included), there is a need to establish if the traditional cereals such as pearl millet are sufficient in supporting the nutritional status of under-five children. Pearl millet is a drought resistant cereal, which was replaced by maize in most parts of Ukambani region about 30-50 years ago. Since agriculture in Kenya is mostly rain fed with the drought spells experienced in the semi-arid and arid regions like Ukambani, maize alone may not be a reliable cereal any more to support the nutritional needs of people residing in these areas.

Therefore, this study assessed the dietary intake and nutritional status of children under-5 years from Mwingi and Makueni districts. Mwingi district people still depend on pearl millet for their staple cereal while Makueni district people mainly use maize as their staple cereal.

CHAPTER 3

METHODS

A. Overview of Study Design and Participants

This study employed a cross-sectional research design, which examines associations at a single point in time (Margetts and Nelson, 1997; Hulley et al., 2001). A sample of 629 under 5-year-old children was drawn from four randomly selected locations in Mwingi and Makueni districts in Eastern rural Kenya. A total of 16 villages were surveyed.

Included were all the households with under-five year old children. Households whose mothers were not present at the homestead at the time of data collection were excluded, since data was only collected from the biological mother of the children. Data was collected from 403 households (mothers) 201 and 202 from Mwingi and Makueni respectively. This yielded 629 children with 314 from Mwingi and 315 from Makueni districts.

We assessed the dietary intake and nutritional status of children under-five years in two rural sites of Eastern Kenya where the staple cereals may differ.

B. Location of Research Project

The republic of Kenya is about 600,000 square kilometers, a third of which is arid and it stretches from the coast of East Africa to the western highlands. Kenya has a population of 32 million people of which 2.5 million live with HIV/AIDS and half of the population lives below the poverty line.

Kenya is divided into 8 provinces: Central, Coast, Eastern, Nairobi, North

Eastern, Nyanza, Rift valley and Western (see appendix E). The provinces are further divided into districts, divisions, locations, sub-locations and villages. This study was conducted in Eastern province in two districts of Ukambani region: Mwingi and Makueni (see appendix E). Eastern province has 13 districts in total (Mwingi Development Plan, 2002-2008; Makueni Development Plan, 2002-2008). The Ukambani region is approximately 45,000 km^2. One-fifth (some 6,300 km^2) of this area, lies within Tsavo National Park and is therefore unavailable for use by the Akamba.

Ukambani region has four main sub regions namely, Kitui, Mwingi, Machakos and Makueni (Mwingi Development Plan, 2002-2008; Makueni Development Plan, 2002-2008). Makueni district was cut off from Machakos district in 1992 and it boarders Kajiado district in the west, Taita taveta district to the south, Kitui district to the East, and Machakos district to the north.

Makueni district has 17 administrative divisions and a population of 839,155 people. It is lightly populated except for Mbooni, Kilungu and Tulimani divisions, which have fairly high population densities. A large part of the district has arid climate (Makueni District Bureau of Statistics Office, 2007)

Mwingi district has a population of about 303,828 as per 1999 census. It is divided into 10 divisions and the driest divisions are Nguni, Kyuso, Tseikuru, Nuu, Mui and Ngomeni. The drier areas experience severe droughts that in turn lead to frequent famines and livestock losses. The general climate of the entire district is hot and dry for the greater part of the year. Mwingi district is a homogeneous district inhabited mainly by the Akamba people (Mwingi Development Plan, 2002-2008).

Rural residents report frequent crop failures and water shortages, and food relief has become a permanent feature of rural life in most parts of Ukambani region. A community leader in a semi-arid part of Kitui District, for example, classified 51% of the years from 1947 to 1979 as "bad" or "very bad" famine years (Kasperson, Kasperson and Turner II, 1995).

More than 95% of the population in Ukambani region is Akamba and approximately 85% of all Kamba speakers reside in Ukambani region. Historically, the Akamba are a group of homogenous people who share a common ancestral origin hence a common genetic pool. Interestingly, it is also one of the tribes, that has not intermarried much in Kenya with other tribes hence has maintained its tribal purity (Kasperson, Kasperson and Turner II, 1995).

C. Research Team

The research team was composed of a lead researcher (Dr.PH candidate at Loma Linda University, USA) and 4 research assistants. I being the lead researcher trained the team in data collection for two weeks and led the team to the field. As the lead researcher I put the project together, managed the whole project, developed data collection instruments, collected data at the field, liaised with government administration, supervised data collection and all activities that pertained to the research project. A research coordinator (PhD, senior lecturer, Baraton University, Kenya) coordinated the research activities, helped in procurement of research equipment and supplies, took care of security issues, equipment maintenance and care, was involved in data collection, verification of data records at the field, coded and filed questionnaires, drove and maintained the research vehicles, and any other duties assigned to him by the lead researcher. The third research assistant (Bachelor of science in Biomedical biology) was involved in data collection, data recording, care of specimens, data verification and filing, care of research equipment and maintenance and any other duties assigned to her by the lead researcher. The fourth research assistant (a trained secretary) was involved in data collection (weight and height), baby-sitting at the field while mothers were interviewed, giving children sweets as part of creating rapport just before they were assessed, cooking and any other duties assigned by the lead researcher. The last research assistant (high school graduate) helped with catering and housekeeping. She was taken into the field once in a while. At every village visited a village elder welcomed us and took us from homestead to homestead for data collection.

D. Sample Size and Village Selection

A sample of 629 under - 5 year olds was drawn from four randomly selected locations in Mwingi and Makueni districts. This sample was drawn on the assumption of an 80% power, two-tailed alpha (0.05), no matching of any variables and that we were to detect a 10% difference in malnutrition in the two groups (Margetts and Nelson, 1997).

Table 4. Sample Size

	Group 1	**Group 2**
10% difference in prevalence (20% malnutrition in group 1, 30% malnutrition in group 2)	313	313

Joseph L. Fleiss (2nd ed., 1981, John Wiley & Sons, NY), chapter 3, Table A3.

Table 5 presents the 16 villages chosen for data collection. An effort was made to choose villages which were similar. The choices were done depending on the village's accessibility to the outside world as measured by infrastructure (see appendix H). I, the lead researcher, the research coordinator and the respective village elders did this assessment and scoring. Specific infrastructure which was looked at included: availability or presence of a shopping center, schools, churches, cell phone coverage, radio usage, news papers, market days, *jua kali* industries, clinic/dispensaries, public transport and rural electrification.

Table 5. Villages Chosen for Data Collection

Mwingi District	Division	Makueni District	Division
More remote		**More remote**	
Kangilw'a	Mui	Athi	Kithuki
Kamulewa	Mui	Matheani	Kithuki
Kyandani	Mui	Kalelo	Kithuki
Kwamung'atu	Mui	Kasoka	Kithuki
Yumbu	Mui	Mutikati	Kithuki
Remote		**Remote**	
Katakaweni	Mwingi central	Musingini	Kalawa
Kyunduani	Mwingi central	Kikome	Kalawa
Katiliku	Mwingi central	Mumbuni	Kalawa

E. Variables

Data collected included demographics, anthropometrics, biomedical, clinical manifestations of malnutrition, and dietary habits. The variables age, weight and height were used to compute the following dependent variables: - stunting (height-for-age) underweight (weight -for-age) wasting (height-for-weight) for the children and body mass index (for the mothers). The hemoglobin levels and transferrin receptor were used as measures for anemia prevalence among the children. Clinical manifestations of malnutrition in the children were collected and documented under wasting, dry skin, brown hair and edema. These dependent variables (Cone and Foster, 2006) were the measures of nutritional status of children. The independent variables (Cone and Foster, 2006) in this study were location, social economic status (SES), Kcalories, gender, age, type of cereal, # of siblings, mother's age, family structure, smoking (father), drinking (father) and tobacco (mother). The SES variables were identified according to Kaufman and Oakes (2006).

Table 6. Summary of Variables in this Study

	Variable	**Unit (Label)**	**Type**
Dependent Variables	Stunting	0,1	Dichotomous
	Underweight	0,1	Dichotomous
	Anemia	0,1	Dichotomous
Independent variables	Location	0,1	Dichotomous
	SES	Numeric	Continuous
	Kcalories	Numeric	Continuous
	Gender	0,1	Dichotomous
	Age	Numeric	Continuous
	Type of cereal	0,1	Dichotomous
	# of siblings	Numeric	Continuous
	Mothers age	Numeric	Continuous
	Family structure	1,2,3	
	Smoking (father)	0,1	Dichotomous
	Drinking (father)	0,1	Dichotomous
	Tobacco (mother)	0,1	Dichotomous

F. Procedures and Data Collection

1. Procedures

With the help of the district officers, chiefs, sub-chiefs, division nutrition officers, division agricultural extension officers, community leaders, school headmasters and church leaders, we passed information about this research project to the people in the community by order from the district commissioner's office. We then purposely visited these sites to interact with the community members at different occasions like worship, fundraising drives, community work, market days, chief's meetings etc. This helped to create rapport and it was very helpful for the research team to familiarize with the terrain in these communities.

After this initial contact with the community the research team was ready for data collection in these research sites. A data collection instrument was used to collect data (see appendix B). The instrument included a mother and child section that was a modified rapid, knowledge, practice and coverage (KPC) survey questionnaire, a 24-hr recall section and a very brief 17-item food frequency questionnaire (FFQ).

The entire data instrument was piloted in December 2007 and necessary revisions were done. One main revision that was done was reordering the questions to flow in a certain way and deletion of redundant questions. Questions that were unclear were also reworded for clarity. The pilot also was very helpful in determining the approximate time needed to interview one mother and her child/children and was established to be about 30 to 45 minutes. Time taken to walk from one homestead to the next was also determined and it was between 20 to 35 minutes.

Before data collection a consent statement was verbally read in Kikamba language to the parents and a verbal consent was requested for (see appendix L). This was done this way because most mothers could not read or write and those who could read a little could not conceptualize because of the high levels of illiteracy in this region. The mother consented for her child/children. On consenting, with the help of the mother data was collected from their children and the mothers too.

Data collected included demographics, anthropometrics, biomedical, clinical manifestations of malnutrition, and dietary habits.

Age for the children was recorded as reported by the mother and it was verified by comparing the reported age with the child's maternal and child health clinic (MCH) cards. Where there was discrepancy between the reported age and the age on the MCH card the later prevailed. In two cases where mothers could not remember the birth dates of their children and did not have the MCH cards the lead researcher allowed them to inquire from the other members of the family. One inquired from a sister-in-law and the other from her mother-in-law. Age for the mothers was recorded as reported by the mothers. In a few cases where mothers could remember the year and not the date and month, the 15th of June was used as their birthday and month.

For each participant child and mother, the lead researcher or a trained research assistant took weight and height (see appendix G for protocol). For children older than two years of age and mothers weight was taken using an electronic floor scale (Troni-x) while height was taken using a stadiometer as described by Lee and Nieman (2006). Height was measured to the nearest 0.1 cm and weight was measured to the nearest 0.1 kg (Leenstra et al., 2005). For children less than two years old, length was measured using a recumbent length board (Crown) and weight was measured using an infant beam balance (Crown) (Gibson, 2005) (see appendix G for protocol). The beam balance was calibrated accordingly.

A trained research assistant cleaned each participant's finger with alcohol wipes, and then a finger prick was done to collect blood. A hypolet automatic pricking device (Auto-Lancet) and sterile hypoguard disposable lancets (Techlite) were used to make the prick. Hemocontrol microcuvettes (EKF- Diagnostic) were used to collect the blood and a hemocontrol analyzer (EKF- Diagnostic) was used to measure hemoglobin levels. Hemoglobin was measured in g/dl. Whole blood was applied on a standardized filter paper (Whatman). It was dried at room temperature over night, stored at 4^{o} Celsius for the entire period of data collection, transported to the USA, stored at 4^{o} Celsius and later analyzed for transferrin receptor (Shell-Duncan and McDade, 2004; McDade and Shell-Duncan, 2002).

Clinical manifestations of malnutrition in the children were observed and documented as wasting, brown hair, dry skin and edema. Also diseases suffered within one month prior to data collection were documented. Hospital visitations and hospitalization encountered one month prior to data collection were documented too.

The lead researcher collected the dietary habits using 24-hour dietary recall and a brief 17-item FFQ (see appendix B). Each mother of the participating child or children was interviewed once for a 24-hr dietary recall on behalf of her child or children. During the first phase of the study the 24-hr diet recalls were done without aid. The mother reported what food and how much of it she had fed the child and the researcher estimated the portion sizes. During the second phase we used water and a measuring device to estimate the portion sizes. The mother was requested to avail the utensil(s) used to feed the child. We filled the utensil with water equivalent to the amount of food consumed by the child as shown by the mother. The water was then transferred into a graduated cup and measured for the exact amount (see appendix I).

2. Data Collection in the Field

Data collection for this study took place in two phases for a period of 22 weeks at different seasons of the year (see appendix A). These two phases can be described as pre-harvest and post-harvest seasons. Ukambani region has two main rain cycles (seasons) the long and the short rain (see appendix M). Phase 1 of this study was from January to March 2008. There was a delay in data collection for about three weeks in January because of the post election violence that broke in Kenya immediately after the announcement of presidential election results in December 2007. The conflict was bad enough to warrant the government to put the internally displaced people into isolated camps for safety (see appendix J). Phase 2 of this study took place in June to September 2008.

G. Data Entry and Quality Control

We entered data from the mother child questionnaire section using a data management entry frame (tool) developed by a data manager in access program. The data was entered every day early morning before leaving for the field. Ten percent random sample verification was done on the data entry and out of the sample only one case of gender was recorded wrong and it was corrected.

The 24-hr dietary recall interviews were entered using the NDS-R 2008 (The Nutrition Coordinating Center, Minneapolis). The 24-hr diet recalls were analyzed under two main categories namely food groups and nutrients. Food schemes were used to create these two categories of analysis. We created recipes for foods not found in the NDS-R database. The mothers provided some of the recipes during the 24-hr recall interviews and the rest were generated using one of the author's (MN) prior knowledge of having grown and socialized in this region. Also we developed and tested porridge recipes with flour imported from Kenya in the nutrition department kitchen at Loma Linda University in order to obtain exact ratios (by weight) of grain (millet, maize, or sorghum) and water to produce porridge of light, medium, thick or *ugali* consistency. A random 10% of the 24-hr dietary recall interviews (entries) were selected for quality control. For quality control recipes beyond the range of nutrient tolerance (gram weight >500 and energy > 400 per serving) were flagged, checked for accuracy, and then corrected as necessary. Food scheme codes were developed and entered using NDS-R and statistical analysis software (SAS) codes were run to produce data analysis files (SAS version 9.2 Institute Inc., Cary, NC, USA) (see appendix K for food schemes).

H. Data Analysis

Statistical Package for the Social Sciences (SPSS) for windows version 15.0 (Field, 2005) and SAS version 9.2 (SAS Institute Inc., Cary, NC, USA) were used to analyze data. EPINUT program in EPI INFO 2000 was used to calculate Z-*scores* using the anthropometrical data (Leenstra et al., 2005). These were developed by Center of Disease Control (CDC) and were adopted by World Health Organization in 1998. These computations were used to evaluate the prevalence of stunting and underweight among the children, using as reference standards the National Center for Health Statistics (Leenstra et al., 2005; Gibson, 2005; Mukudi, 2003).

Data from the 24-hr recalls was used: to establish if the children frequently used pearl millet or maize as their staple cereal among other foods; to calculate the energy consumption, gram weight and specific nutrient intake of these children. It was also used to describe the diets of children <5 years in Ukambani region. This description was done using specific foods groups' contribution to gram weight and energy.

A descriptive analysis of the sample was done. Between groups comparisons were made with *t*-test and chi-square (χ^2) tests. Height, weight and age variables were used to compute malnutrition indices: stunting, under weight and wasting. Proportion differences were determined using χ^2. The cut point -2SD was used for the classification of stunting, under weight and wasting while -3SD was used for severe stunting, severe underweight and severe wasting (Gibson, 2005).

The data was compared to carefully selected reference standards. According to Whitney and Rofles (2007) anthropometric measures such as height and weight taken on an individual should be compared with standards specific for sex and age or with previous measures on the same individual. In this study they were compared with developing countries' reference anthropometric standards agreed upon by World Health Organization (WHO, 1995).

I. Research Ethics

Approval to conduct this research was sought from the government of Kenya ministry of higher education and a research permit was issued. Approval was also sought from Loma Linda University Institutional Review Board (IRB) and an approval certificate was issued. Verbal informed consent was obtained from the mother before the data collection could take place. This was done in line with the three ethical principles that guide research namely; respect for persons, beneficence and justice.

Respect for humans expects that informed consent be obtained from participants by the investigator and beneficence demands a scientifically sound research design with acceptable risks in relation to possible benefits. Finally, justice requires fair distribution of research benefits and burdens in the population being studied (Hulley et al., 2001).

Therefore, in this study participation was voluntary and informed consent was sought from the mother. The records were coded with ID and information was kept confidential and was destroyed once the study was over. Close monitoring was done to make sure that no risk was incurred during the data collection period. Random sampling was done to give each subject an equal chance of being selected.

CHAPTER 4

FIRST PUBLISHABLE PAPER

DIETARY PATTERNS OF CHILDREN < 5 YEARS OLD IN MWINGI AND MAKUENI DISTRICTS OF UKAMBANI REGION, EASTERN KENYA

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Abstract

A cross -sectional study was conducted in the Ukambani region of Eastern Kenya to describe dietary patterns of children < 5 years of age. The purpose of the study was to provide region specific data on dietary patterns of children living in Mwingi (MW) a pearl millet growing region and Makueni (MA) a maize growing region. A modified rapid, knowledge, practice and coverage (KPC) questionnaire and a 24-hr dietary recall were used to collect the data. A total of 403 households (201 –MW, 202 -MA) were surveyed from four randomly selected divisions of MW and MA districts. This yielded 629 surrogate 24-hr dietary recalls of children < 5 years with 314 from MW district and 315 from MA district (49% boys and 51% girls). Intake of nutrients and food groups were compared between the two districts using *t*- test. On average, grains contributed 62-68 percent of total energy intake in both districts. Mean daily energy intake (mean ±SD) for all the children was 1056 ±553 Kcal. Daily energy intake (1130 ± 595 Kcal) in MW children was 15% higher compared to MA children (983 ± 499 Kcal, p = 0.002). Boys had a 12% higher daily energy intake than girls (p= 0.005). The contribution to total energy from grains was 27% higher in MW children (p = 0.0001) and breast milk contribution to total energy intake was 50% less in MW children (p < 0.001). Consumption of fruits and vegetables was significantly lower in MW children (p<0.0001). Intakes of carbohydrate, protein and iron were higher in MW children and vitamin A intake was lower. Fat intake was the same in both districts for these children. We observed gender and geographical differences in diets of children in Ukambani region, with the most prominent perhaps being the type and amount of cereal intake.

Key words: Ukambani, Kenya, under-fives, dietary patterns, pearl millet

Introduction

Chronic under-nutrition in developing countries continues to be a major cause of morbidity and mortality among children, the most vulnerable segment of the population. One major cause is difficulties in food availability in most developing nations [1, 2]. Assessing food consumption patterns in different areas in developing nations can be very helpful in identifying these locations; documenting the type and severity of the food unavailability; describing the causes of malnutrition and understanding practices that might contribute to food unavailability [1]. Dietary assessment surveys can also provide very valuable data to guide in policy making, planning at national and regional levels, prioritizing, designing, and evaluation of programs [1].

Although many studies have been undertaken on the nutritional status of children under five years in Kenya very few have described their dietary habits [3-5]. There is a paucity of data on studies describing dietary habits of the under five children especially at regional levels.

This report describes the dietary patterns of children under five years in Ukambani region in Kenya: Mwingi and Makueni. These two districts have different staple cereals, as Mwingi uses a traditional cereal pearl millet, while Makueni uses maize. This research hypothesized that cultivation and consumption of the traditional grain, pearl millet, as opposed to maize, results in improved food availability and better nourishment for children.

Methodology and Design

Study Area and Population

This was a descriptive study of the diets of children < 5 years old living in rural districts of Mwingi and Makueni in Ukambani region, Eastern part of Kenya. The study population was predominantly of the Akamba ethnic group who live in the semi-arid Eastern province of Kenya [6]. Out of the 4 districts in Ukambani region we selected two districts which represented maize or pearl millet. We then randomly selected 4 divisions, and within the divisions a total of 16 villages were selected. These villages were classified as remote or more remote based on a 14- item scale assessing a village's accessibility to the outside world, using infrastructure. All the households in these villages were visited and were eligible for data collection.

All households with under-5-year-old children were included. Households whose mothers were not present at the homestead at the time of data collection were excluded, since data was only collected from the biological mother of the children. Data was collected from 403 households (mothers), 201 and 202 from Mwingi and Makueni, respectively. This yielded 629 children with 314 from Mwingi and 315 from Makueni districts

Data Collection Procedure

The research team consisted of a leader (MN) and four trained research assistants. Data collection proceeded after permission was granted from the district commissioner's office. At the village level the team was led by a village elder from house to house during the home visitations. Data was collected in two phases: January to March 2008, and June to September 2008 from the four randomly selected locations in

Mwingi and Makueni.

The data collection instruments included a mother and child section that was a modified rapid, knowledge, practice and coverage (KPC) survey questionnaire, and a 24-hr dietary recall of the mother on the child's intake. A consent statement was read verbally to the parents in Kikamba (vernacular) and a verbal informed consent was obtained from the biological mother before proceeding with the dietary assessment interview. Age for the children was recorded as reported by the mother, and then verified with the maternal and child health (MCH) cards. Where there was discrepancy the age on the MCH card prevailed.

Children who were exclusively breastfed and were ≤ 6 months were estimated to take an average of 25 oz (750ml) of breast milk per day. Therefore, estimating that the babies were fed 6 times within 24 hours, an average of ½ cup of breast milk was estimated for every feed in the 24-hr recall record. After introduction of solid foods, the milk was adjusted accordingly to accommodate the use of solid foods [5, 7, 8].

The 24 hr Diet Recall Data

Dietary intake of each child was assessed by a single face to face 24 hr dietary recall interview from the mother. The 24-hr dietary recall interviews were entered using the NDS-R 2008 (The Nutrition Coordinating Center, Minneapolis, MN). We created recipes for foods not found in the NDS-R database. The mothers provided some of the recipes during the 24-hr recall interviews and the rest were generated using one of the author's (MN) prior knowledge of having grown and socialized in this region. Also we developed and tested porridge recipes with flour imported from Kenya in the nutrition department kitchen at Loma Linda University in order to obtain exact ratios (by weight) of grain (millet, maize, or sorghum) and water to produce porridge of light, medium, thick or *ugali* consistency. A random 10% of the 24-hr dietary recall interviews (entries) were selected for quality control. Recipes beyond the range of nutrient tolerance (gram weight >500 and energy >400 per serving) were flagged, checked for accuracy, and then corrected as necessary.

Data Analysis

The 24-hr diet recalls were analyzed in terms of nutrients and food groups. For food group analyzes, individual components or ingredients were aggregated into 8 food groups: grains, legumes, fruits/vegetables, breast milk, milk, meat/eggs, fat and miscellaneous. The nutritional data was normalized using log transformations where appropriate, and differences for consumption between age, gender or geographic categories were assessed using independents sample t-tests and chi square, with significance assumed at an alpha of 0.05. Descriptive results are reported as mean ±standard deviation (SD), unless otherwise indicated. All statistical analysis was done using SAS version 9.2 (Institute Inc, Cary, NC, USA) and SPSS [9].

This research had approval from Kenya Government Ministry of Higher Education and Loma Linda University Institutional Review Board.

Results

We obtained 629 24-hr surrogate dietary recalls from 403 mothers. Of the 629 children, 306 (49%) were boys and 323 (51%) were girls. The average age for the interviewed mothers was 30 ± 7 yrs and the mean age for the children was 26.5 ± 17 months. Table 1 presents the distribution of the children by age and gender categories of each district. Children from the two districts (Mwingi and Makueni) were stratified into

20 age category and gender strata, which happened to be very similar in distribution, except for the oldest age category of Makueni where the number of girls was double the boys. There was a progressive decrease of the number of children as age increased in both districts.

Table 2 presents mean daily energy intake according to age, gender and categories of the two districts. Mean energy intake for these children was 1056 ± 553 Kcal. Boys were reported to have higher total energy intake in almost all age categories, overall and in the two districts. As age increased, daily energy intake for the children increased steadily in both districts except for age category 49-60 months where there was a major drop. Mwingi children had a 15% higher mean energy intake (1130 ± 595 Kcal, p = 0.002) than Makueni children (983 ± 499 Kcal). Overall, boys had a 12% higher mean energy intake (1120 ± 568 Kcal) than girls (996 ± 533 Kcal, p= 0.005).

Figures 1, 2 and 3 show the contribution of food groups to daily average energy intake in the study population and by district. Overall, grains contributed about 62-68% of the total energy intake of the children in both districts combined. The contribution of grains to daily energy intake was 27% higher (p= 0.0001) in Mwingi compared to Makueni children. Breast milk's contribution to daily energy intake was 50% higher in Makueni children (p <0.001). Fruits and vegetables consumption was 178 % higher in MA children than MW children (p< 0.0001). The rest of the food groups were not significantly different in both districts.

The contribution of breast milk to the daily energy intake of these children tapered off at around 18-24 months in both districts. Mothers of Mwingi district introduced complementary foods to their children earlier in the first six months. Mothers in Makueni sustained breastfeeding longer than the mothers in Mwingi. The average total length for breast feeding, as reported by the mothers, was 21.3 ± 8 months for both districts. The same average was 20.4 ± 7.3 months for Mwingi mothers and 22.1±8.6 months for Makueni mothers (Data not shown).

Table 3 presents comparison of nutrients intake to recommended daily intake (RDI) in children ≥18 months. Children aged ≥18-36 months had deficits in energy, fat and iron while those aged 37-60 months had deficits in energy and fat in both districts combined. Children 37-60 months in Mwingi, however, did not have a deficit in iron. For children ≥18-36 months, Mwingi children had 18% higher intakes of carbohydrates, 28% of protein intake and 32% of iron and for age category 37- 60 months Mwingi also had higher intakes of energy (6%), protein (6%) and iron (21%). Mwingi children had lower intakes of vitamin A for both age categories 66% (≥18-36 months) and 24 % (36-60 months) (Data not shown).

Discussions

On stratification there was a progressive decrease in the numbers of the children as ages increased. Energy intake increased with age except for the age category 49-60 months where there was a major drop. Energy intake in boys was 12% higher than girls. There were marked differences in breastfeeding practices in the two districts. Mwingi district had higher intake of grains, carbohydrates, protein and iron compared to children from Makueni.

The observed decrease in the numbers of children with age represents an attrition rate of about 42-50%. It is unlikely that these decreases are due to increased mobility in the older children. The National Kenya Demographic Health Survey (KDHS) for 2003 reports the national under-five mortality rate as 115 deaths per 1,000 live births and infant mortality rate as 77 deaths per 1,000 births. At this rate it means that one out of every nine children born in Kenya die before attaining their fifth birthday [10]. It could be possible that these children are malnourished, get sick and die from diseases as they get older.

Daily energy intake consumption increased steadily in all the age categories except for age category 49-60 months where there was a sharp decline. It is unlikely that this was due to computation error, underreporting on the side of the respondent, or due to unstable estimate. Data was checked for error. The reporting method was the same for all the age categories and the standard deviation for the cell with the smallest sample size was not very large. It is possible that these children consumed less energy, or the children became independent and the mother had no correct record of what they ate. Boys consistently had higher energy intakes than girls. It could be true that the boys were served more than the girls or mothers over reported due to expected traditional practices. If it is so, that they are served more, then, malnutrition indices (mean Z scores) should be lower in girls and malnutrition prevalence should be higher in girls.

During the first year of life there was a dramatic drop in breast feeding in the study population. In both districts breast milk tapered off and ceased to be a major contributor of energy to under-five children at about 18months. However, mothers in Makueni district seemed to sustain breastfeeding just a little longer than mothers in Mwingi district. Between 18- 24 months most mothers had stopped breast feeding completely. This is in support of a study conducted at Kathonzweni in Makueni that reports that most mothers stopped breastfeeding between 12-18 months because they will have conceived [4]. A study in Machakos reports that breast feeding was practiced until 18-24 months [8]. Another study conducted in western Kenya indicates that breastfeeding was sustained until at least the latter part of the second year for most children in a location in Busia district [11]. The average length children were breast fed in both Mwingi and Makueni was 21.3 months. In Mwingi district the average was 20.4 months while in Makueni the average was 22.1 months. Therefore, there is concurrence between the reported length of breastfeeding from the mothers and the actual data collected showing breast milk contribution to daily energy intake. The 2003 KDHS reports at the national level the duration for breastfeeding as 20 months in the rural areas and 19 months in urban areas. At the provincial level, Eastern province had the longest reported breast feeding period 25 months [5]. Therefore, this study supports the period between 18-24 months as a good cut point for breast feeding in studies looking at nutritional status of under five children. This is so because breast milk is protective of malnutrition.

In both districts most children were introduced to other foods between the ages of 0-6 months. These other foods specifically were milk (cow's and goat's milk) and grain porridges of different consistencies. Mwingi district mothers tended to introduce these foods a little earlier than Makueni district mothers. Results from the Kenya Demographic Health Survey indicate that half of all the children between two to three months are given complementary foods [5]. In addition, children under six months receive the following complementary foods: milk other than breast milk (36%), food made from grains (28%), and fruits and vegetables (23%) [5].

Mwingi children compared to those from Makueni consistently had higher energy consumption among all the age categories except at age 49-60 months, where energy was higher. This is due to the boys in this category, who had higher energy intake than their counter parts in Mwingi. Overall, Mwingi district children had 15% significantly higher energy consumption than Makueni children.

In this study population, grains contributed about 62-68% of the total daily energy intake followed by milk (19%) and legumes (8.3%). Compared to Makueni, consumption in Mwingi was 26% higher for grains and 43% higher for legumes. In Makueni, however, consumption was 50% higher for breast milk and 178% for fruits and vegetables. The higher percentage in grain consumption in Mwingi children could be due to the growing and consumption of the traditional grain pearl millet. Pearl millet is a traditional grain that is indigenous to Ukambani region and was the main staple cereal 50 years ago before the introduction of maize. It is considered more efficient in utilization of soil moisture and has a higher level of heat tolerance than sorghum and maize [12], thus it is able to withstand drought conditions. Cultivation and consumption of this traditional grain pearl millet which has better nutritive value than maize and sorghum may result in better nourishment of children in arid lands like Ukambani region.

The high consumption of cereals by Mwingi district children corresponds to nutrients intake as well. For children ≥18 months Mwingi children had higher intakes of carbohydrates, protein and iron while Makueni children had higher intakes of vitamin A. Fat intake was the same in both districts. Overall, these children had deficits in energy, fat and iron. Mwingi had no deficit in iron for age category 37-60 months. This could be due to consumption of higher amounts of legumes which are a good source of iron and pearl millet which is high in iron than maize and is comparable to wheat in iron and zinc contents [13]. Children met their recommended daily intake for protein and vitamin A [14]. It is important to note that the protein is mainly derived from grains and legumes. Therefore, it is important for this community to keep a good supply of legumes and grains.

It has been reported that Kenyan children in general have inadequate intakes of energy, fat and micronutrients such as iron, zinc and calcium among the many [15]. A study in Uganda reports energy deficits in children between 12- 35 months [16]. Meat and eggs consumption was on the lower side in this study. The same was observed in a study in Kathonzweni Makueni district [4]. Since most homes had domestic animals ranging from chicken to cows parents could be encouraged to incorporate these animal foods into their children's diet. This is because animal source foods supply high–quality protein and readily digestible protein and energy. They are also a dense and efficient source of readily available micronutrients [17].

Conclusions

Boys consistently consumed more energy than girls in this Eastern Kenyan population. The major contributor of energy in children of this region was grains. Overall, Mwingi district children had higher energy intakes than Makueni district children. Children in this region did not meet their recommended daily intakes for energy, fats and iron. There were marked differences in breastfeeding practices in the two districts in that Makueni mothers sustained breastfeeding a little longer than Mwingi mothers, while mothers in Mwingi introduced complementary foods earlier in the first six months of the children's life. Overall, children in Mwingi had higher nutritional intake compared to Makueni children. Further research is needed to establish if the cultivation and consumption of the traditional cereal pearl millet along side with the other cereals may result in better nourishment of children in arid and semi-arid lands like Ukambani region.

Acknowledgements

We wish to thank the Federico Foundation Switzerland for funding this project and the research team for invaluable assistance during the fieldwork.

Table 1. Distribution (n) of Ukambani Study Population.

Age CAT in Months	All	Mwingi		Makueni	
		Girls	Boys	Girls	Boys
0-12	173	47	41	46	39
13-24	135	34	39	33	29
25-36	129	24	26	39	40
37-48	101	27	31	21	22
49-59	91	21	24	31	15
Totals	629	153	161	170	145

Table 2: Mean Daily Energy intake (Kcal) according to Age and Gender Categories.

Age in Months	Energy Intake in Kcal (Mean±SD) All n = 629	Girls n = 323	Boys n= 306
Both Districts Combined			
0-6	539±194	522±202	562±183
7-12	868±349	846±369	889±331
13-18	946±380	974±420	917±333
19-24	1164±661	1166±632	1163±697
25-36	1192±543	1063±509	1316±549
37-48	1365±607	1334±597	1393±620
49-60	1285±502	1171±505	1437±461
Total Average	**1056±553**	**996±533** [a]	**1120±568** [a]
Mwingi District			
0-6	596±236	549±261	682±153
7-12	929±343	960±317	907±373
13-18	1037±398	1063±429	1007±372
19-24	1199±715	1229±714	1178±730
25-36	1330±631	1281±617	1375±653
37-48	1437±636	1407±618	1463±660
49-60	1274±531	1252±621	1294±451
Total Average	**1130±595** [b]	**1086±599**	**1172±590**
Makueni District			
0-6	490±132	491±95	489±162
7-12	787±346	750±390	849±259
13-18	881±356	907±410	854±295
19-24	1074±507	1054±468	1105±606
25-36	1105±461	929±378	1277±475
37-48	1267±557	1238±570	1294±557
49-60	1296±477	1117±411	1667±387
Total Average	**983±499** [b]	**915±453** [c]	**1061±539** [c]
	[a] p = 0.005	[b] P = 0.002	[c] p = 0.032

P values refer to age adjusted t- test among means with the same superscript. [b] Additionally adjusted for gender

Table 3. Comparison of Nutrients Intake to Recommended Daily Intake (RDI)[a] in Ukambani Children

	Average Daily Intake	RDI	Balance
18-36 months			
Energy (Kcal)	1111	1500	(389)
Protein (g)	30.5	23	7.5
Fat (g)	17.7	35	(17.4)
Iron (mg)	10.9	13	(2.1)
Vitamin A (IU)	3216.6	1332	1895.7
37-60 months			
Energy (Kcal)	1328	1520	(192)
Protein (g)	40.8	26	14.8
Fat (g)	14.5	42	(27.5)
Iron (mg)	14.4	14	0.4
Vitamin A (IU)	3771.5	1332	2438.5

[a] Bridge, Kipp, Raine & Konde-Lule, 2006
RDI = Rrecommended Daily Intake

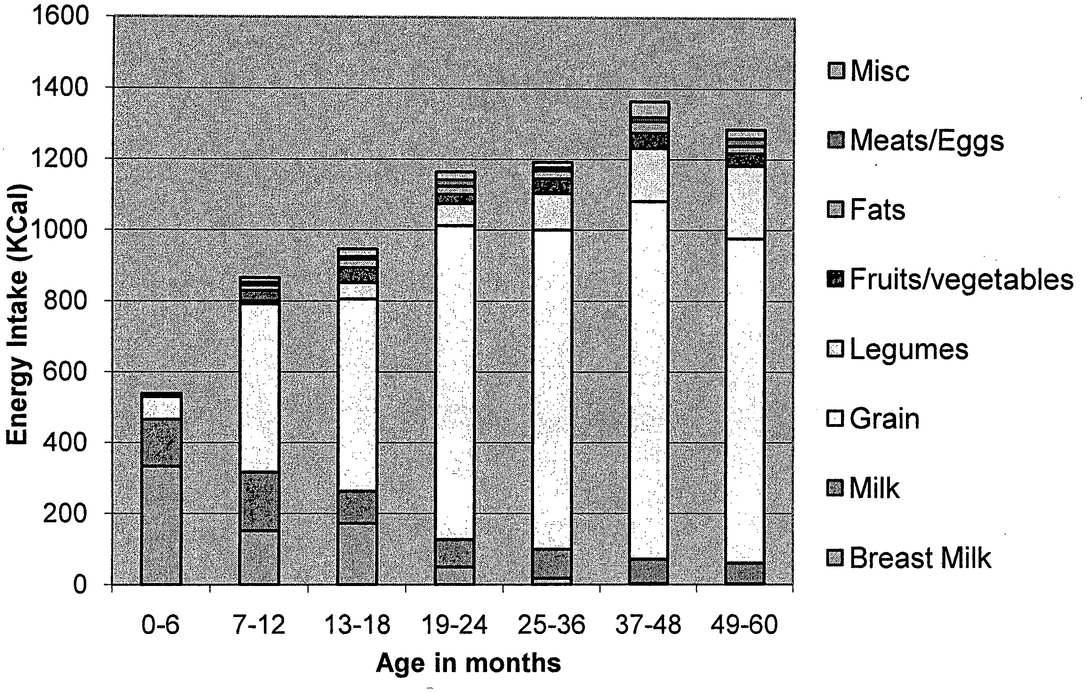

Figure 1. Contribution of Food Groups to Daily Average Energy Intake in Ukambani Children by Age.

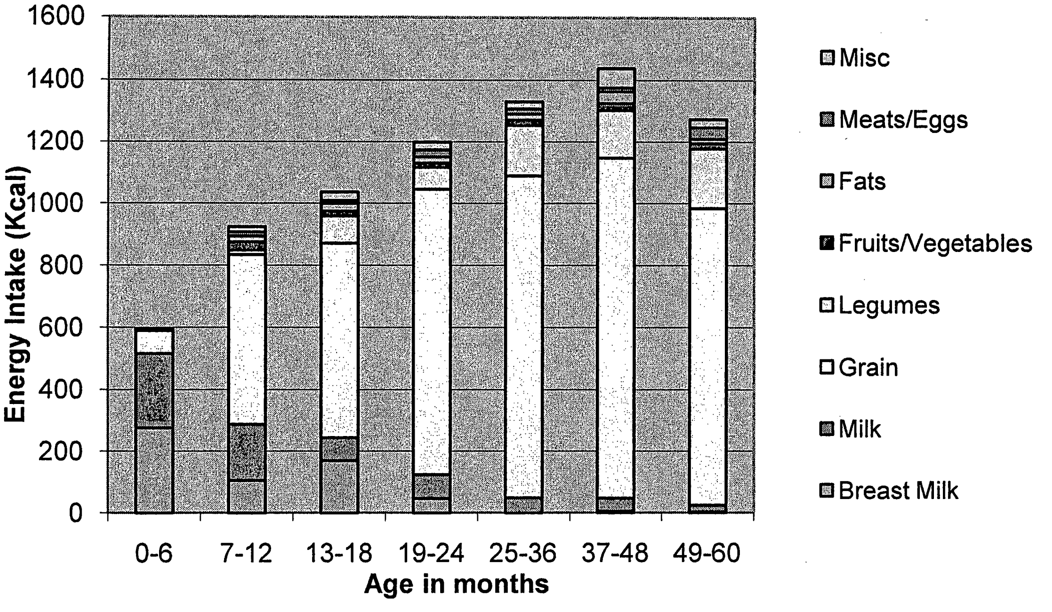

Figure 2. Contribution of Food Groups to Daily Average Energy Intake in Mwingi Children by Age.

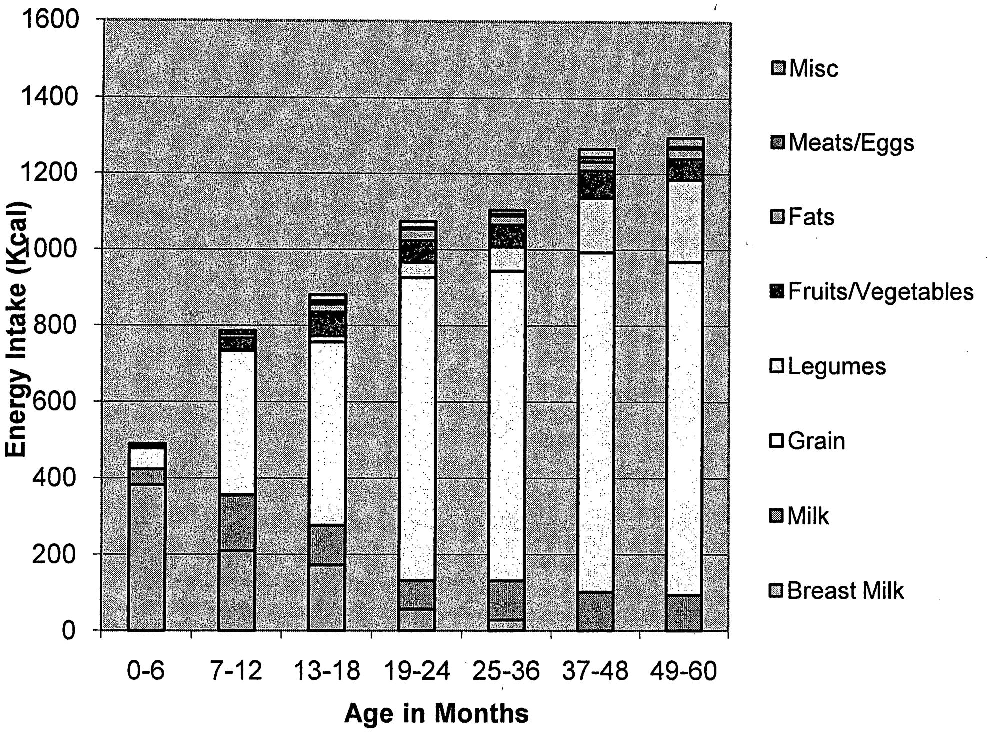

Figure 3. Contribution of Food Groups to Daily Average Energy Intake in Makueni Children by Age.

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CHAPTER 5

SECOND PUBLISHABLE PAPER

NUTRITIONAL STATUS OF UNDER-FIVE CHILDREN AND GENDER INEQUALITY IN UKAMBANI REGION, EASTERN KENYA

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Abstract and Key Words

Objective: The aim of this study was to assess nutritional status and gender inequality in under-five children of Ukambani region Eastern Kenya.

Design: A descriptive cross sectional study.

Settings: Mwingi and Makueni districts in Ukambani region of Eastern Kenya. Mwingi and Makueni are two rural districts in Eastern part of Kenya where grains are the main contributor of energy intake.

Subjects: Boys and girls aged 0-60 months (n= 629)

Results: Boys consistently had higher energy intakes than girls (p = 0.005). Girls had higher malnutrition prevalence (height-for-age; HAZ= 51.7%, weight-for-age; WAZ = 32.1% and weight-for-height; WHZ= 4.6%) than boys (height-for-age; HAZ, 35.9%, weight-for-age; WAZ = 14.6% and weight-for-height; WHZ= 1.2%). Boys had significantly higher weighted mean Z score indices (HAZ = -1.33, WAZ = -0.60 and WHZ = 0.25) than girls (HAZ = -2.02, WAZ = -1.37 and WHZ = -0.10).

Conclusions: Boys consistently had higher energy intakes than the girls and this translated into malnutrition indices. Regardless of gender malnutrition was related to age. There were major differences in malnutrition indices between the boys and girls. Boys had more favorable malnutrition indices than girls. Further research is needed to explore the possible determinants of malnutrition at household level to establish possible reasons for the reflected gender inequality in nutritional status of under-five children in Ukambani region, Eastern Kenya.

Key words: Stunting, Underweight, Ukambani, Gender, Nutritional assessment, Prevalence.

Introduction

Under-nutrition still continues to be a major public health concern in most developing nations and it is characterized by lack of sufficient food and variety in food choices. Gender inequalities may also contribute to under nutrition mainly in settings where the girl child is still considered less important than the boy child [1, 2]. Under-nutrition is exacerbated by diseases, poverty, hostile climates and lack of mothers or caretakers nutritional knowledge [3, 4]. In Eastern Africa stunting rates are 48% and they are the highest on African continent [5]. In Kenya 30% of under five children are stunted, 24% are underweight, and 6% are wasted [6].

After Kenya's independence in 1963, the government identified illiteracy, disease, ignorance and poverty as the main problems to be addressed in order to achieve sustainable national development. Since then a lot has been achieved (though not to full potential yet) through National Development Plans, Sectional Papers, Presidential Commissions and Task forces among others. However, like many other developing nations Kenya has been struggling with the challenges which are well known like the HIV burden and food insufficiency among others. Kenya's long term goal of food sufficiency remains unmet. Kenya has a population of about 38 million growing at a rate of 3% and 10% are classified as food insecure. On January 09, 2009 the government declared a food emergency stating that about 10 million Kenyans (25% of the population) are now or will soon be at risk of food shortage [7].

The main determinants of a child's nutritional status are the child's dietary intake and heath. These two are influenced directly by three underlying factors at the household level namely, food security, adequate care for mothers and children, and a proper health environment. These three are in turn influenced by two basic determinants. One, the potential resources available to a country and community, and two, host of political, cultural, and social factors that affect their utilization [8].

Stunting (shortness) is the indicator for height-for-age and it indicates chronic malnutrition (long-term deprivation). It also means failure to grow adequately in height in relation to age. Underweight (lightness), the indicator for weight-for-age reflects either chronic or acute malnutrition status or both. Wasting (thinness) is the indicator for weight-for-height and it represents failure to gain weight adequately in relation to height and it reflects recent or acute malnutrition. All these three indices are defined as height-for-age or weight-for-age, or weight-for-height more than two standard deviations (-2SD) below the median of the National Center for Health Statistics [5, 9, 10].

While several surveys [5, 6, 11-14] have reported on the nutritional status of under-five children in Kenya there is still a great need for region specific data in some regions like Ukambani area. It is assumed that if boys and girls were cared for equally their anthropometric status should be comparable. Differences in the growth between boys and girls above those dictated by biology, can be attributed to inequalities in diet and health

This data may be useful in designing intervention nutrition programs to mitigate the malnutrition problems in these regions to improve the health status of children. Therefore, the aim of this cross-sectional study is to add to the limited available regional specific scientific data on the nutritional status of children under-five years. We describe the results of a cross-sectional survey of the nutritional status of under-five children in Eastern Kenya stratified by gender.

Methodology and Design

Study Area and Population

This was a descriptive study that assessed the nutritional status of under-five year old children living in two sites where staple cereals may differ. Mwingi district uses pearl millet (a traditional cereal) mainly as its staple cereal while Makueni uses maize mainly. The study population was predominantly of the Akamba ethnic group and they reside in the semi-arid region of Eastern province of Kenya [15].

Out of the four main geographical regions of Ukambani we randomly selected two districts which were representative of maize (corn) or pearl millet. Four divisions were randomly selected from these two districts, and within the divisions a total of 16 villages were selected. An effort was made to choose villages which were similar. All the households in these villages were visited and were eligible for data collection. All the households with under-five children were included. Since data was collected only from the biological mother of the child, households whose mothers were not present at the homestead at the time of data collection were excluded. Four hundred and three households (mothers) - 201 and 202 from Mwingi and Makueni respectively were interviewed and these yielded 629 children: 314 from Mwingi and 315 respectively.

Data Collection Procedure

The research team consisted of a leader (MN) and four trained research assistants. Data collection proceeded after permission was granted from the district commissioner's office. At the village level the team was led by a village elder from house to house during the home visitations. Data was collected in two phases: January to March 2008, and June to September 2008 from the four randomly selected locations in

Mwingi and Makueni.

The data collection instruments included a mother and child section that was a modified rapid, knowledge, practice and coverage (KPC) survey questionnaire and a 24-hr dietary recall of the mother on the child's intake. The instrument was piloted and revised accordingly. A verbal consent was obtained from the biological mother after a consent statement had been read to her in Kikamba, the local language, before proceeding with data collection. Data collected included demographics, anthropometrics, biomedical, clinical manifestations of malnutrition, and dietary habits.

Age for the children was recorded as reported by the mother and verified with the maternal and child health (MCH) cards. Where there was discrepancy the age on the MCH card prevailed. Mother's age was recorded as reported by the mother.

Anthropometric Data

For each participant child the lead researcher assisted by a trained research assistant took weight and height. For children older than two years of age weight was taken using an electronic floor scale (Troni-x) while height was taken using a stadiometer [16]. Height was measured to the nearest 0.1 cm and weight was measured to the nearest 0.1 kg. For children less than two years old, length was measured using a recumbent length board (Crown) and weight was measured using an infant beam balance (Crown) [9]. The beam balance was calibrated accordingly.

Biomedical Data

We cleaned each participant's finger with alcohol wipes and then a finger prick was done to collect blood. A hypolet automatic pricking device (Auto-Lancet) and sterile hypo guard disposable lancets (Techlite) were used to make the prick.

Hemocontrol microcuvettes (EKF- Diagnostic) were used to collect the blood and a hemocontrol analyzer (EKF- Diagnostic) was used to measure hemoglobin levels. Hemoglobin was measured in g/dl.

Clinical Manifestations of Malnutrition

Clinical manifestations of malnutrition in the children were observed and documented as wasting, brown hair, dry skin and edema. Diseases suffered, and hospital visitations and hospitalization within one month prior to data collection were documented as well.

24 hr Diet Recall

During the first phase of the study the 24 hr diet recalls were done without any aid. The mother simply reported what food and how much of it she had fed the child and the researcher estimated the portion sizes. On the second phase the portion sizes were estimated using water and a measuring device. Mother availed the utensil used to feed the child and the researcher filled it with water equivalent to the amount of food given to the child. The water was then measured with a graduated device and measurements were recorded.

Data Analysis

The 24 hr diet recall interviews were entered and analyzed using NDS-R 2008 (The Nutrition Coordinating Center, Minneapolis, MN). The 24-hr diet recalls were analyzed under two main categories namely food groups and food nutrients (details given elsewhere). Statistical analysis was done using SPSS version 15.0 [17] and SAS version 9.2 (SAS Institute Inc, Cary, NC). Results are reported as mean ± standard deviation (SD) unless otherwise indicated. Descriptive analysis was done using student's *t* test for continuous variables and Fisher's Exact and Pearson chi square for categorical variables. Height, weight and age were used to compute the malnutrition indices (Z-scores) using EPI INFO 2000 [10].

This research was approved by Loma Linda University Institutional Review Board and Kenya government Ministry of Higher Education.

Results

Four hundred and three mothers were interviewed for 24-hr diet surrogate recalls and 629 diet recalls were conducted. Of the 629 children, 306 (49%) were boys and 323 (51%) were girls. The average age for the interviewed mothers was 30 ± 7 yrs and the mean age for the children was 26.5 ± 17 months. Table 1 presents the study sample by age and gender and selected demographic and health characteristics of the children. Children were stratified into 20 age and gender strata. There was a progressive decrease of the number of children as age increased. Boys had significantly higher body weight than girls and they were also significantly taller than girls. Boys were breast fed a little longer than the girls but this was not significantly different. Children's age and gender distribution was not significantly different. More boys were born at home than girls.

Girls had significantly higher hemoglobin levels than boys ($p = 0.001$). The boys had more diarrhea episodes than girls though not significantly different. Girls had significantly higher proportions of pneumonia, malaria, and measles compared to boys. More boys than girls had not been dewormed ($p < 0.0001$). Boys had significantly higher proportions of edema than girls ($p= 0.005$). Wasting and dry skin were significantly higher in girls than boys ($p < 0.0001$, $p = 0.017$). Brown hair was not significantly different.

Figures 1 a, and 1 b presents contribution of food groups to daily energy intake in children by gender. There was a consistent increase in energy as age increased for both boys and girls. However, the increase in boys was consistent while in girl it was not. The girls experienced drops in energy in age category 25 - 36 months and the 49 - 60 months. Overall, boys had higher energy intakes than girls. Mean ± SD daily energy intake for the children was 1056 ± 553 Kcal. Boys had a 12 % higher mean energy intake (1120 ± 568 Kcal) than girls (996 ± 533 Kcal, p = 0.005).

Figures 2 a, and 2 b presents the prevalence of both moderate and severe malnutrition among the children by gender. Prevalence of moderate malnutrition was higher in girls compared to boys as indicated by height-for-age, weight-for-age and weight-for-height prevalence percentages: 51.7%, 32.1% and 4.6 % respectively in girls and 35.9%, 14.6% and 1.2 % respectively in boys. Prevalence for severe malnutrition was higher in girls compared to boys as indicated by height-for-age (24.6%), weight-for-age (6.9 %) and weight-for-age (0.8%) in boys and height-for-age (16.3%) weight-for age (2.9 %) and weight-for-height (0.2% in girls.

Height-for-age indicators were significantly different with boys having higher mean Z-scores than girls in all age categories ($p < 0.001$). Weight-for-age mean Z-scores were also significantly different with boys having higher mean Z-scores than girls ($p < 0.001$). Only 4 age categories (7-12, 25-36, 37-48 and 49-60) had weight-for-height Z-score means significantly different with boys again having higher mean Z-scores compared to girls. Overall, boys significantly had higher (p = <0.001, p = 0.001, p = 0.001) mean Z-scores for height-for-age, weight-for-age and weight-for-height (-1.33, -0.60, 0.25 respectively) compared to girls (-2.02 HAZ, -1.37 WAZ and -0.10 WHZ).

Figure 3 represents the 3 anthropometric indicators (height-for-age, weight-for-age and weight-for-height) for all the children. As age increased malnutrition indices decreased with a downward acceleration, leveled at some point, converged to the reference and then dropped again. Weight-for-height Z-scores went below the median Z-score of the reference population slightly after children turned 18 months of age and remained below it until 40-60 months. Weight-for-age Z-scores crossed the median reference before the children turned 12 months. It continued dropping downward without a sign of converging back to the reference population. Height-for-age Z-scores crossed the reference line (Z-score 0) after six months of age. It continued to decrease with a downward acceleration and crossed the Z-score -2SD line for moderate malnutrition after 12 months. It converged back upwards and crossed the Z-score –2SD but never converged enough to cross the median reference line.

Figure 4 a, b and c represents a comparison of the 3 anthropometric indicators (height-for-age, weight-for-age, weight-for-height) by gender. Boys had higher Z-score means than girls for the three anthropometric indicators except for weight-for- height at age category 13-18 months where the girls had a higher Z-score mean than boys.

Discussion

There was a progressive decrease in the numbers of children with age. Energy intake increased for both boys and girls in all age categories except in girls at age 25-36 months and 49-60 months where there were major drops. Energy intake in boys was 12% higher than girls. Boys had more favorable malnutrition indices than girls. Malnutrition in both boys and girls was related to age.

The observed decreases in the number of children as age increased represents over

42 – 50 % attrition overall and within gender. Increased mobility in older children alone is unlikely to account for this progressive decrease. According to the 2003 Kenya Demographic Health Survey (KDHS), 1 out of every 9 children born in Kenya dies before attaining their fifth birthday. It could be possible that these children are malnourished, get sick and die from disease as they get older.

Boys were significantly taller than girls. Boys also were breast fed a little longer than the girls although this was not significant. Clinical indicators of malnutrition revealed that girls had heavier burden of ill-health than boys. For example, reported cases of malaria, fever, pneumonia and measles in the last one month prior to data collection were higher in girls than boys. Similarly, more girls had brown hair, dry skin and wasting. Inequality between the girl and the boy child can take many different forms. One of those could be neglect of health, nutrition and other interests of girls that influence survival [18]. Malnutrition is estimated to be associated with more than half of child deaths from major diseases such as malaria, diarrhea, pneumonia and measles [2]. According to Dey and Chaudhuri, 2008, the girl child in most cases is disadvantaged even before she is born and this goes on during her entire life.

Energy intake increased in all age categories for boys. Girls' energy intakes increased with age except at age 25-36 and 49-60 months, where there were major drops. In general, boys' energy intakes were higher than girls for all the age categories except age 13-18 months and 19-24 months. Our findings that the boys had higher energy intake than girls are revealed by the malnutrition indices in this study.

Both moderate and severe malnutrition prevalence were higher in girls than boys for all the anthropometric parameters. For height-for-age anthropometric indicator in all age categories boys had higher Z-scores than girls. This means that girls were more stunted than boys. This may explain why the boys in this study are slightly taller than the girls. Weight-for-age Z-score means were higher in boys than girls. This means that the girls were more underweight than the boys. Again this may explain why the boys are slightly heavier than the girls. Overall, compared to girls, boys had higher mean Z-scores for the three anthropometric indices. Boys in this study population were less stunted, less underweight, and less wasted than girls. Regardless of age and gender malnutrition in both boys and girls was related to age. Malnutrition indices were lowest around the time breast milk tapered off around 18-24 months.

A study conducted in India by Dey and Chaudhuri in 2008 in under five children revealed that 55.9%, 51.4% and 42.3% of the girls were underweight, stunted and wasted respectively compared to 46.6%, 40.5% and 35.3% of the boys. Underlying reasons for the differences could be that girls have less access to nutrition, physical and mental health care, and education. Girls are also known to enjoy fewer rights, opportunities and benefits of childhood. However, in a study conducted in Zambia among the Tonga, which is a matrilineal community, Gillet-Netting et al., reported that gender bias favored females. Preferential treatment in females was manifested in better nutritional status for females in larger (polygyamous) families [19]. This study reveals how events can take turns when women have an upper hand in life issues as in this matrilineal community.

The 2003 Kenya Demographic Health Survey reports higher Z-scores for height-for-age, weight-for-age and weight-for-height in boys (1.4, 1.0, and 0.3, respectively) compared to girls (1.1, 0.9, and 0.2, respectively) [6]. This concurs with the finding of this study that boys had higher Z-scores than girls. However, the same national survey reports lower malnutrition prevalence in girls (HAZ = 27.7%, WAZ = 4.8%, WHZ=17.7%) than boys (HAZ= 33%, WAZ= 6.4%, WHZ =22.0%).

So, the phenomenon revealed by the findings of this study that girls had lower Z- scores and higher malnutrition prevalence rates might not be a national problem. Therefore, there is need to conduct a study to ascertain if our findings from Makueni and Mwingi are the same in the entire Ukambani region. If this is a regional problem, then, it will warrant a second study to explore the determinants of malnutrition at the household level because these children live in a similar home environment. This is necessary because it is assumed that if boys and girls are cared for equally their anthropometric status should average the same. Something has to be done to correct this inequality in gender because malnutrition erodes human capital through poverty and hunger. Malnutrition affects the chances that a child will go to school, stay in school and perform well. In addition, this may delay the realization of the millennium development goals.

Two studies conducted in Bangladesh caution the use of anthropometrics to measure gender nutritional disparity because of the different conclusions drawn when the three known references are used, i.e. National Center for Health Statistics (NCHS /WHO, 1977), Center for Disease Control (CDC, 2000) and British growth references 1990 [20, 21]. For this study we have dietary data suggesting that girls had less energy intakes than boys and the anthropometric indices just confirmed that.

Since the causes of malnutrition are complex future research should look at these households closely to establish the determinants of malnutrition at the household level and the seemingly existing gender inequality in this society of Eastern Kenya.

Conclusions

The boy child consistently had higher energy intakes than the girl child and this translated into malnutrition indices. Regardless of gender malnutrition was related to age. Boys had more favorable malnutrition indices than girls. Low nutritional intake in children translated into malnutrition indices and rates.

Acknowledgements

We wish to thank the Federico Foundation Switzerland for funding this project and the research team for invaluable assistance during the fieldwork.

Table 1. Study Sample by Age, Gender, and Selected Demographic and Health Characteristics of Children in Eastern Kenya

Age category (Months)	All n	Girls n	Boys n
0-12	173	93	80
13-24	135	67	68
25-36	129	63	66
37-48	101	48	53
49-59	91	52	39
Totals	629	323	306

Demographic Characteristics				P value
Gender:		50.9%	49.1%	[†]NS
Age in months (Mean±SD)	26.4±17.4	26.1±17.6	26.4±17.1	[a] NS
Weight in Kg (Mean±SD)	10.6±3.55	10.2±3.0	10.9±3.9	[a] <0.0001
Height in cm (Mean±SD)	79.0±14.1	78.3±13.8	79.6±14.1	[a] 0.001
Length breast fed in months (M±SD)	21.3±8.0	20.6±7.4	21.1±7.9	NS
No vaccination card	38.8%	39.4%	38.2%	*NS
Child born at home	80.6%	78%	83.3%	*< 0.0001
Clinical Indicators of Malnutrition				
Hemoglobin in g/dl (Mean±SD)	9.8±1.6	9.8±1.7	9.7±1.5	[a]0.001
Diarrhea	11.8%	11.2%	12.5%	[†]NS
Malaria	31.4%	34.5%	28.1%	[†]<0.0001
Pneumonia	4.2%	5.7%	2.7%	[†]<0.0001
Measles	0.5%	0.7%	0.3%	[†]0.036
Fever	34.7%	36.0%	33.3%	[†]0.030
Not dewormed	79.3%	74.4%	83.9%	[†]<0.0001
Edema	2.2%	1.6%	2.7%	[†]0.005
Brown hair	8.8%	9.0%	8.5%	[†]NS
Dry skin	12.8%	13.8%	11.7%	[†]0.017
Wasting	17.9%	20.0%	15.8%	[†]<0.0001

[†] Pearson chi square *Fisher's exact test [a] *t* test

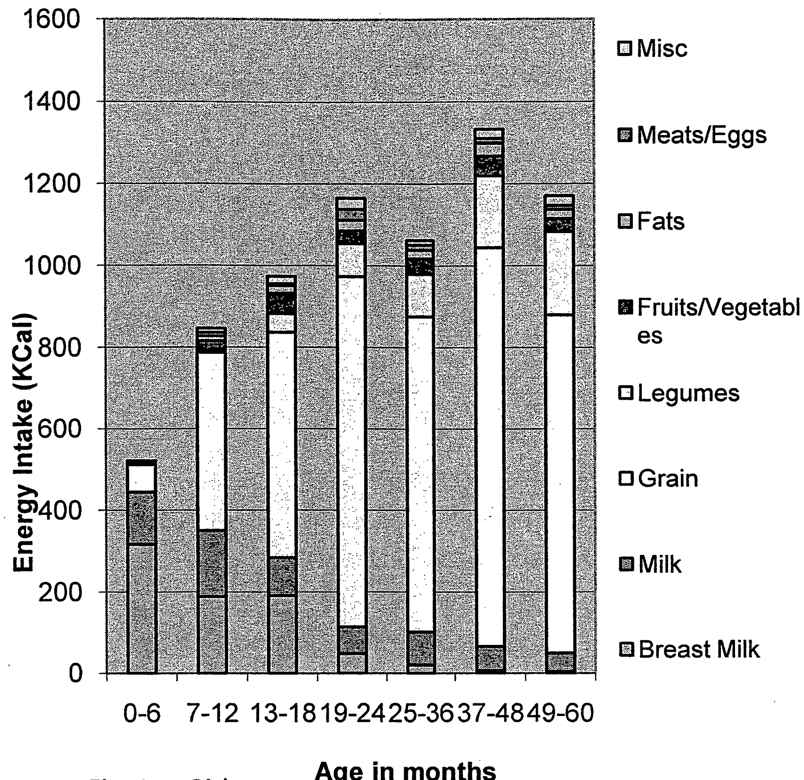

Fig. 1 a- Girls

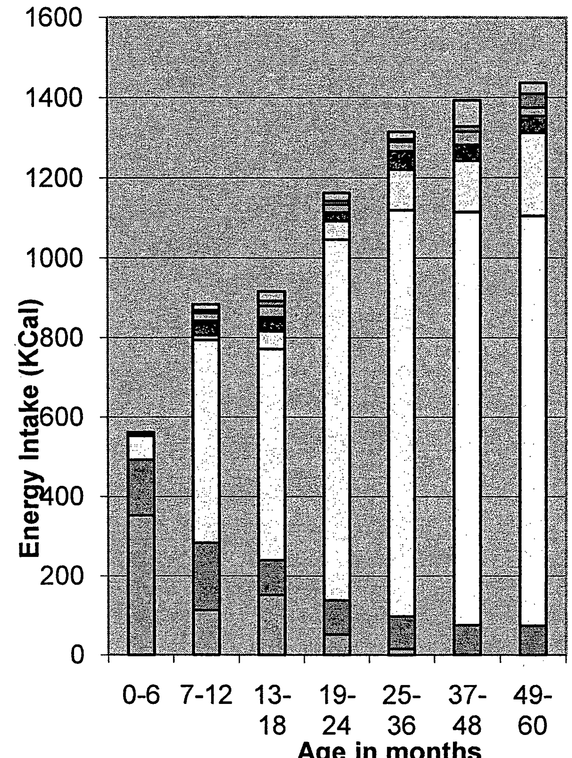

Fig. 1 b-Boys

Figure 1a and 1b. Contribution of Food Groups to Daily Energy Intake by Gender. (Figure a Girls and Figure b Boys).

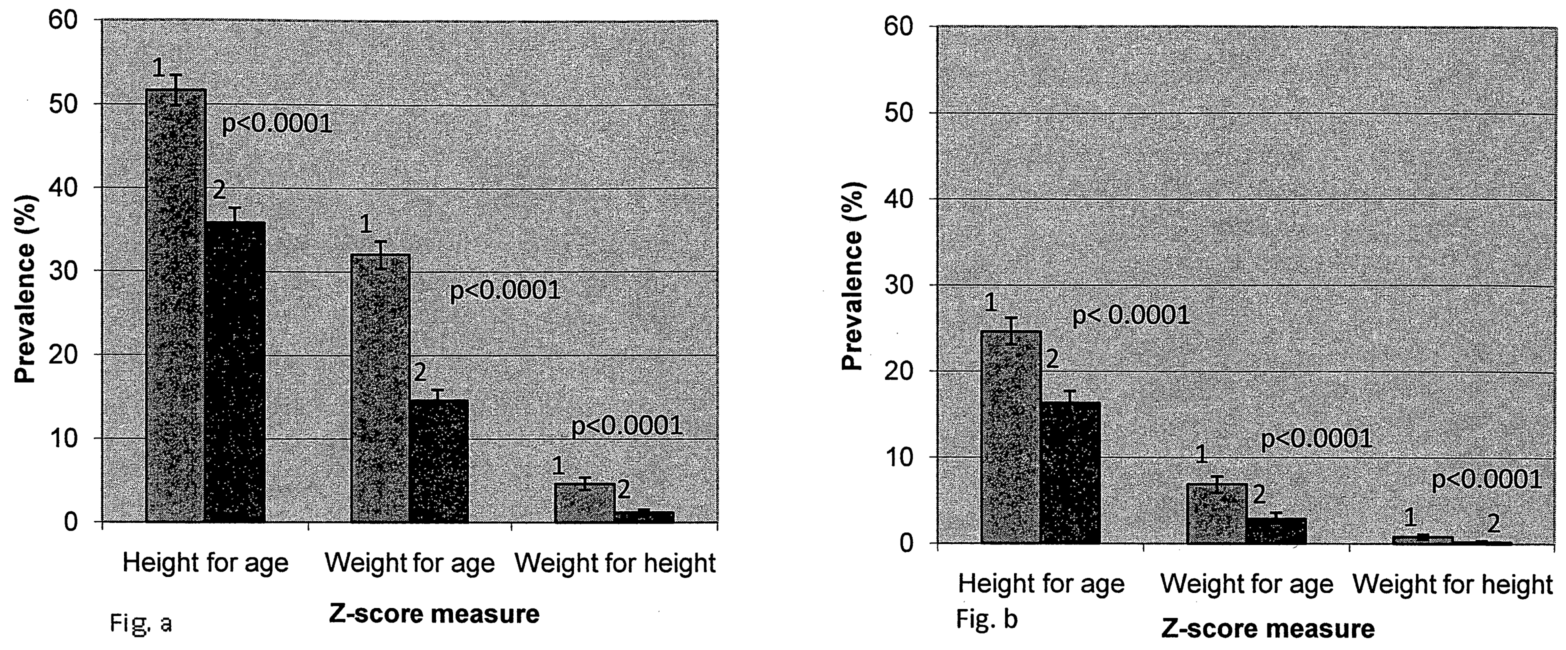

Figure 2 a and b. Moderate malnutrition (a) and Severe Malnutrition (b) in Under Five Children in Eastern Kenya.
1 - girls and 2- boys

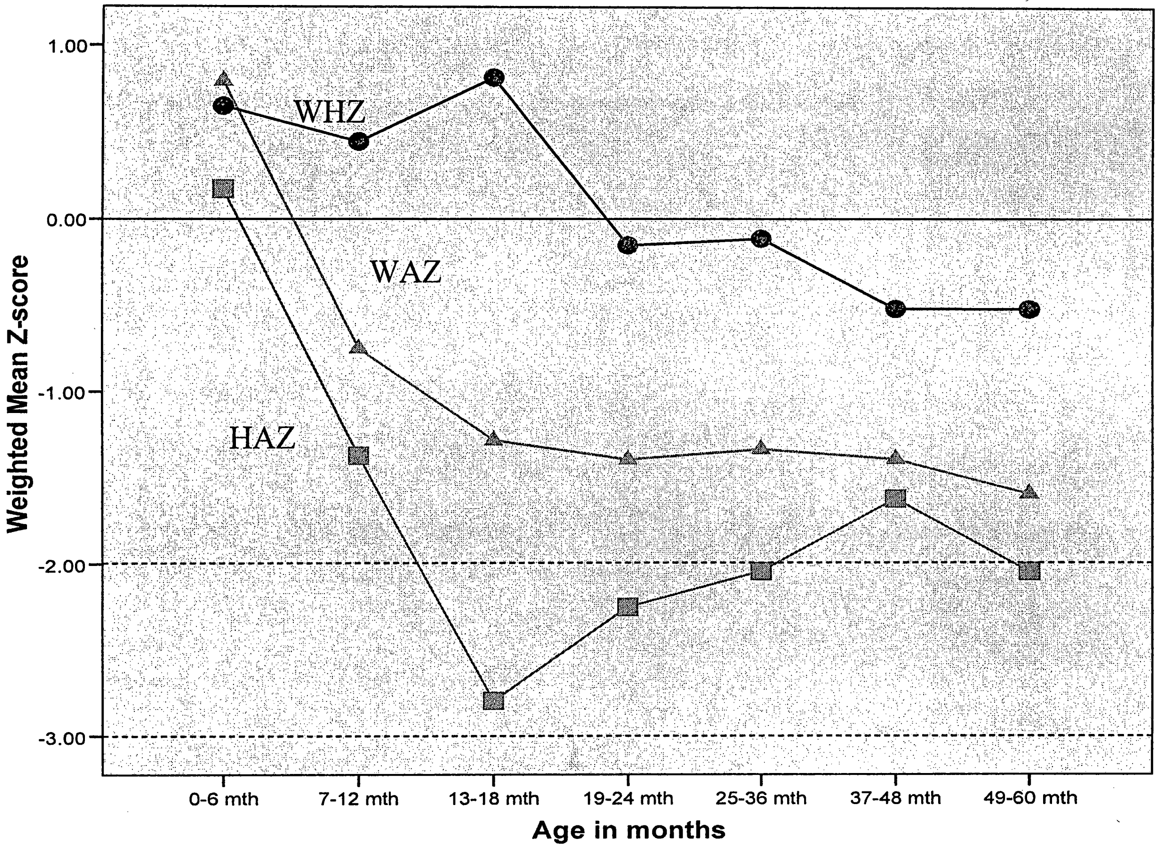

Figure 3. Mean Z Score Values for the 3 Anthropometric Indicators Height-for-Age (HAZ), Weight-for-Age (WAZ) and Weight-for-Height (WHZ) in Ukambani children n=629.

The Horizontal line at the Z-score value of 0 represents the median Z score of the reference population. Z score of -2 represents moderate malnutrition, and Z score of -3 represents severe malnutrition. The National Center for Health Statistics/World Organization reference was used to calculate the Z scores (NCHS, 2000). Cases were weighted by village size.

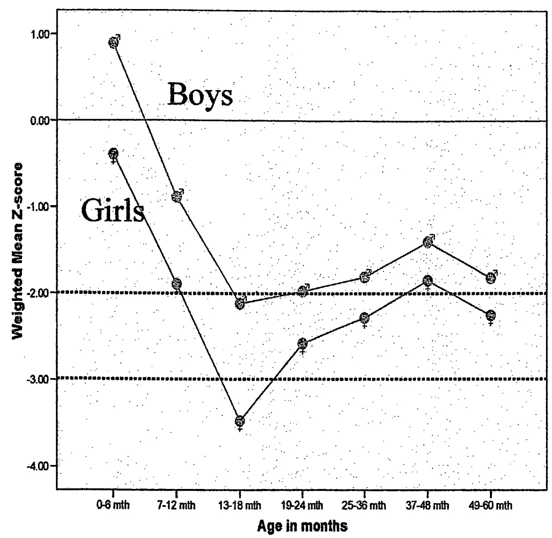

Figure 4a. Height-for-Age Indicator by Gender

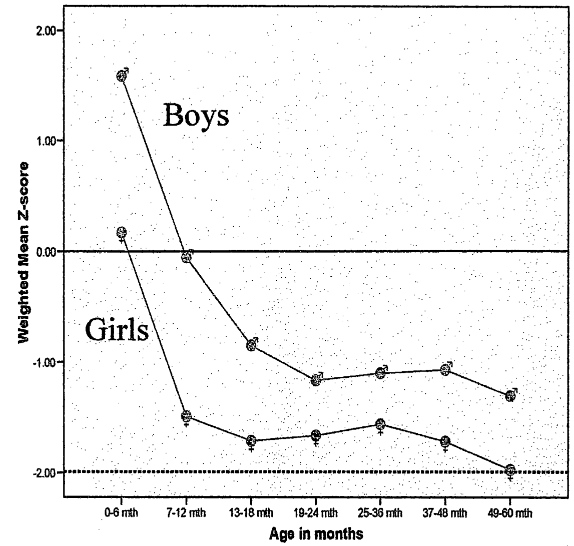

Figure 4b. Weight-for-Age Indicator by Gender

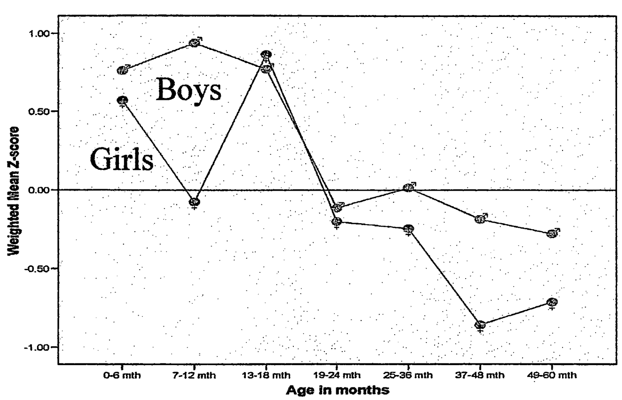

Figure 4c. Weight-for-Height Indicator by Gender

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CHAPTER 6

CONCLUSIONS

A. Summary and Implications of Findings

This chapter summarizes the major findings of this study on under-five children conducted in Mwingi and Makueni, two districts in Ukambani region of Eastern Kenya. The study assessed the nutritional intakes and nutritional status of the children in this region.

The major contributor to total energy intake in children of this region was grains. The main source of protein for these children was legumes and pulses. Overall, children in Mwingi had higher intakes of energy and other nutrients compared to Makueni children. Children in both districts did not meet their recommended daily intakes for energy, fats and iron. There were marked differences in breastfeeding practices in the two districts in that Makueni mothers seemed to sustain breastfeeding longer than Mwingi mothers, while mothers in Mwingi seemed to introduce complementary foods earlier in the first six months of the children's life.

Boys consistently had higher energy intakes than girls and this translated into malnutrition indices. Regardless of gender malnutrition in both boys and girls was related to age. Malnutrition prevalence was higher in the girls than the boys. Boys had more favorable malnutrition indices than girls.

The findings of this study may be used to support nutritional intervention and to inform agricultural, nutrition and gender discrimination policy in Eastern Kenya.

B. Future Research

The causes of malnutrition are complex. They range from unhealthy environments, physiological factors, communicable diseases, perpetual poverty, lack of access to healthy food, gender discrimination, sociological and even cultural factors. In view of all these further research is needed to:

1. Establish if the cultivation and consumption of the traditional cereal pearl millet along side with the other cereals may result in better nourishment of children in arid and semi arid lands like Ukambani region
2. Explore the possible determinants of malnutrition at the household level to determine if there is intra-household discrimination that may possibly generate the observed relative deprivation of the girls.
3. Investigate the breastfeeding and complimentary feeding patterns in this rural setting of Ukambani region.
4. Validate the water measurement method used in this study to aid in estimating portion sizes for the 24-hr recalls.
5. Explore the possible dietary determinants of low hemoglobin levels in children from Ukambani region.
6. Explore the use of other field methods like dried plasma spot measurements of ferritin and transferrin receptor for assessing iron status.

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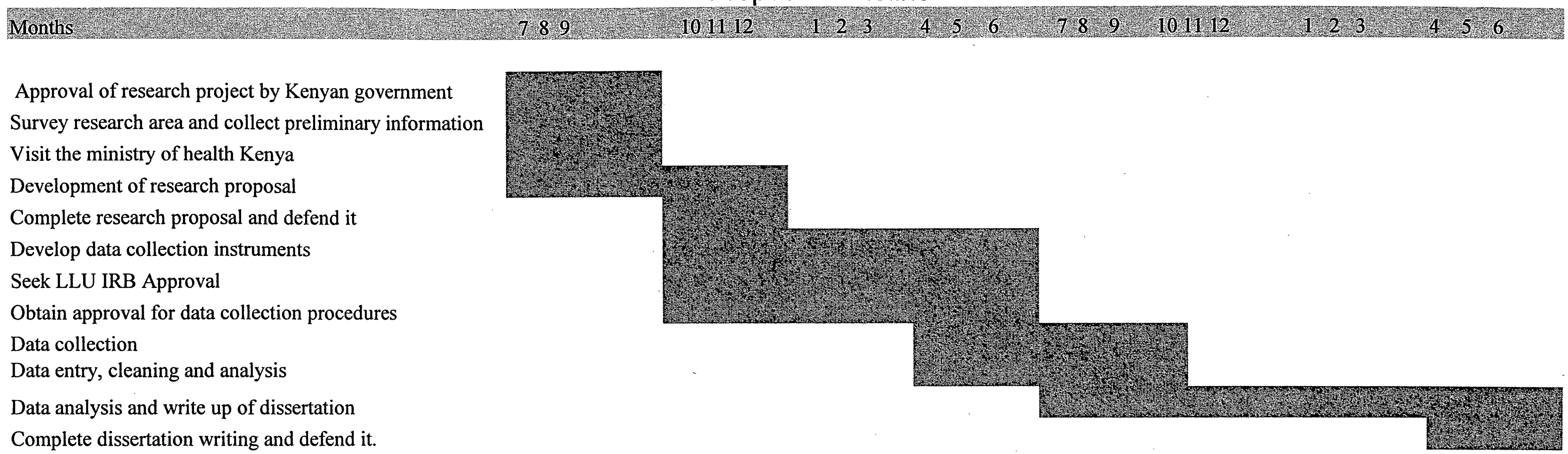
APPENDIX A: GANTT CHART

Proposal Timeline



APPENDIX B: DATA COLLECTION INSTRUMENT

Mother and Child/Children Questionnaire Data Forms: Date_____/_____/_____

House hold ID_________ Total no. of members_________ District Mwingi/Makueni Division _______

Location _________________________Sub-location/ Village___________________________

First Child: ID____________________ [ ]F [ ]M

1. Wt in kg _ Trial $_1$__________Trial $_2$__________
2. Ht in cm _ Trial $_1$__________Trial $_2$__________
   [ ]Standing [ ]Recumbent
3. Hb (g/dl) ____________________________
4. Child born at [ ]home [ ]health center

   Vaccination card [ ]yes [ ]not sure [ ]don't know

   Birth wt. (kg)__________________________
5. Date of birth _______/_______/_______
6. Clinical manifestation of malnutrition
   [ ]edema [ ] brown hair [ ]dry skin [ ]wasting
7. Child suffered in the last one month from
   [ ] diarrhea [ ] malaria [ ] pneumonia
   [ ] measles [ ] fever Other________________
8. Child taken to hospital in the last one year

   [ ] no [ ]yes Why?_______________________
9. Child admitted in the hospital in the last one year [ ]no [ ]yes Why_____________________
10. Received medicine for worms in the last six months [ ] no [ ]yes
11. Child introduced to solid food already
    [ ]no [ ]yes
12. At what age? ___________ Other__________
13. Length breast fed _______ Other__________

Second Child: ID____________________ [ ]F [ ]M

1. Wt in kg _ Trial $_1$__________Trial $_2$__________
2. Ht in cm _ Trial $_1$__________Trial $_2$__________
   [ ]Standing [ ]Recumbent
3. Hb (g/dl) ____________________________
4. Child born at [ ]home [ ]health center

   Vaccination card [ ]yes [ ]not sure [ ]don't know

   Birth wt. (kg)__________________________
5. Date of birth _______/_______/_______
6. Clinical manifestation of malnutrition
   [ ]edema [ ] brown hair [ ]dry skin [ ]wasting
7. Child suffered in the last one month from
   [ ] diarrhea [ ] malaria [ ] pneumonia
   [ ] measles [ ] fever Other________________
8. Child taken to hospital in the last one year

   [ ] no [ ]yes Why?_______________________
9. Child admitted in the hospital in the last one year [ ]no [ ]yes Why_____________________
10. Received medicine for worms in the last six months [ ] no [ ]yes
11. Child introduced to solid food already
    [ ]no [ ]yes
12. At what age? ___________ Other__________
13. Length breast fed _______ Other__________

Third Child: ID__________________ [ ] F [ ] M

1. Wt in kg _ Trial $_1$__________Trial $_2$__________
2. Ht in cm _ Trial $_1$__________Trial $_2$__________
   [ ] Standing [ ] Recumbent
3. Hb (g/dl) ______________________________
4. Child born at [ ] home [ ] health center

   Vaccination card [ ] yes [ ] not sure [ ] don't know

   Birth wt. (kg)__________________________
5. Date of birth ________/______/_______

6. Clinical manifestation of malnutrition
   [ ] edema [ ] brown hair [ ] dry skin [ ] wasting
7. Child suffered in the last one month from
   [ ] diarrhea [ ] malaria [ ] pneumonia
   [ ] measles [ ] fever Other________________
8. Child taken to hospital in the last one year

   [ ] no [ ] yes Why?______________________
9. Child admitted in the hospital in the last one year [ ] no [ ] yes Why_____________________
10. Received medicine for worms in the last six months [ ] no [ ] yes
11. Child introduced to solid food already
    [ ] no [ ] yes
12. At what age? ___________ Other__________
13. Length breast fed ________ Other___________

Fourth Child: ID__________________ [ ] F [ ] M

1. Wt in kg _ Trial $_1$__________Trial $_2$__________
2. Ht in cm _ Trial $_1$__________Trial $_2$__________
   [ ] Standing [ ] Recumbent
3. Hb (g/dl) ______________________________
4. Child born at [ ] home [ ] health center

   Vaccination card [ ] yes [ ] not sure [ ] don't know

   Birth wt. (kg)__________________________
5. Date of birth ________/_______/______

6. Clinical manifestation of malnutrition
   [ ] edema [ ] brown hair [ ] dry skin [ ] wasting
7. Child suffered in the last one month from
   [ ] diarrhea [ ] malaria [ ] pneumonia
   [ ] measles [ ] fever Other________________
8. Child taken to hospital in the last one year

   [ ] no [ ] yes Why?______________________
9. Child admitted in the hospital in the last one year [ ] no [ ] yes Why_____________________
10. Received medicine for worms in the last six months [ ] no [ ] yes
11. Child introduced to solid food already
    [ ] no [ ] yes
12. At what age? ___________ Other__________
13. Length breast fed ________ Other___________

Mother's Section: ID______________________

1. Ht in m _ Trial $_1$________Trial $_2$__________

2. Wt in kg _ Trial $_1$________Trial $_2$__________

3. Hb (g/dl) ______________________

4. Are you pregnant? [ ]$_{no}$ [ ]$_{yes}$

   How many months? ________

4. Date of birth ________/________/________

(Age in years______________________)

5. No. of births (*Masyaa)*________________

6. Stillbirths (*Kutambaika)* ________________

7. Had a miscarriage [ ]$_{no}$ [ ]$_{yes}$ How many? ______
   Why?

8. Living children______________________

9. Deaths of children______________________
{Take notes on deaths

}

10. Your occupation ______________________

11. Your level of education.
    [ ] $_1$ No education and < std 8
    [ ] $_2$ Primary
    [ ] $_3$ Secondary
    [ ] $_4$ Certificate
    [ ] $_5$ Diploma
    [ ] $_6$ Degree and above
    other____________________________

Date: ________/________/________

12. Marital Status: [ ] married [ ] single
    [ ] widowed [ ]*Iweto*
    [ ] divorced

13. Husband's occupation______________________

14. Husband's level of education
    [ ]$_1$ [ ]$_2$[ ]$_3$ [ ]$_4$ [ ]$_5$[ ] $_6$ other________________

15. Does your husband work away from home?
    [ ] no [ ]yes

    How often does he come home?
    [ ] Everyday [ ] weekend
    [ ] end of month [ ] During public holidays
    [ ] end of year [ ] During a crisis
    [ ] Never

16. Do you: -
    Use tobacco [ ]no [ ] yes
    Smoke [ ]no [ ] yes
    Drink alcohol [ ]no [ ] yes

17. Does your husband: -
    Use tobacco [ ]no [ ] yes
    Smoke [ ]no [ ] yes
    Drink alcohol [ ]no [ ]yes

18. What is your main source of household income?

____

Other sources of household income
1.
2.
3.

19. Household durable goods
    [ ] radio [ ] television [ ] phone
    [ ] refrigerator [ ] bicycle [ ] cart truck
    [ ] solar power [ ] wheelbarrow [ ] plough

20. Do you qualify for government relief food? (*Mwolyo*) [ ] no [ ]yes

Did you receive government relief food last Year? [ ] no [ ]yes

What did you receive and how much of each?

Food item	Amount	Month

21. Family living in [ ] Permanent house
[ ] Temporary house

22. Permanent latrine structure [ ] no [ ]yes

23. Type of water source: [ ] well[ ] river [ ] tank

[ ] fountain [ ]bore hole [ ] dam other_________

24. Means of fetching: [ ] cows [ ] donkey[ ] bicycle
[ ] wheelbarrow [ ] back /head

25. Time taken to make one trip to and fro

Hrs___________ Minutes________________

24 hr Recall and FFQ Form

Date _____/______/_______ ID ____________ Gender F [ ] M [ ] District Mwingi/Makueni Division ____________

Location____________________ Sub-Location/Village____________________

Source/ Time	Beverage/food name	Portion size	Preparation method
Breakfast			
Lunch			
Dinner / Supper			
Snacks			

	Frequency / Food items	Never	Occasionally	Monthly	1-2 x/wk	3-5 x/wk	1 x/day	2 x/day	> 3 x/day
Pearl Millet Dishes	Porridge								
	Ungali								
	Ukii								
	Musandi								
	Cake								
	Others-								
Maize Dishes	Porridge								
	Ungali								
	Ikii								
	Isyo								
	Others-								
Animal Products	Cow's milk								
	Goat's milk								
	Beef								
	Goat's meat								
	Game meat								
	Eggs								
	Soup(broth)								
	chicken								
	Others-								

APPENDIX C: KENYA GOVERNMENT RESEARCH PERMIT

REPUBLIC OF KENYA

MINISTRY OF SCIENCE & TECHNOLOGY

Telegrams: "SCIENCE TEC", Nairobi
Telephone: 02-318581
E-Mail:ps@scienceandtechnology.go.ke

JOGOO HOUSE "B"
HARAMBEE AVENUE,
P.O. Box 9583-00200
NAIROBI

When Replying please quote
Ref. MOST 13/001/37C 557/2

23rd August 2007

Hellen M. Ndiku
University of Eastern Africa (Baraton)
P.O. Box 2500
ELDORET

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on, ***'Anthropometric Parameters of Under Five Children and Mothers with Different Dietary Habits in Ukambani Region: A Study in Eastern Province'***

I am pleased to inform you that you have been authorized to carry out research in Mwingi and Makueni Districts for a period ending 30th March 2008.

You are advised to report to the District Commissioners, the District Education Officers and the Medical Officers of Health Mwingi and Makueni Districts before embarking on your research project.

On completion of your research, you are expected to submit two copies of your research report to this office.

M. O. ONDIEKI
FOR: PERMANENT SECRETARY

Copy to:
The District Commissioner
Makueni District
Mwingi District

The District Education Officer
Makueni District
Mwingi District

Medical Officers of Health
Makueni District
Mwingi District

APPENDIX D: IRB APPROVAL

INSTITUTIONAL REVIEW BOARD

Initial Approval Notice - Expedited Review

OSR# 58113

OFFICE OF SPONSORED RESEARCH • 11188 Anderson Street • Loma Linda, CA 92350
(909) 558-4531 (voice) • (909) 558-0131 (fax)

To:	**Sabate, Joan**
Department:	**Nutrition**
Protocol:	*Anthropometric parameters of under five years old children and their mothers with different dietary habits in Ukambani region: a study in eastern rural Kenya*

This study was review and approved administratively on behalf of the IRB. This decision includes the following determinations:

Risk to research subjects:	**Minimal**
Approval period begins	**14-May-2008** and ends **13-May-2009**
Stipulations of approval:	**Waiver of signed consent per 45 CFR 46.110**

Consent Form
Unless IRB has given a specific waiver of informed consent (as documented in the approval stipulations above) the IRB-approved and stamped consent form accompanies this letter. This now becomes the official master consent form for making copies to provide to study participants.

Adverse Events / Protocol Changes
The IRB should be notified in writing of any modifications to the approved research protocol. Adverse effects must be reported to the IRB in accordance with institutional policy. If sponsor or contractual adverse event reporting requirements differ from requirements for reporting to IRB, all reporting requirements must still be met.

Protocol Review
Your protocol is tentatively scheduled for review and renewal at least two weeks prior to the approval end-date indicated above. To assure uninterrupted approval of this project, you will be sent a report form to request renewal by completing and timely returning. to Office of Sponsored Research. Anticipate the approval expiration so your study does not lapse; contact OSR for assistance if necessary. In addition to reporting the requested renewal status information, you may also use the form to close the study at that time, if applicable.

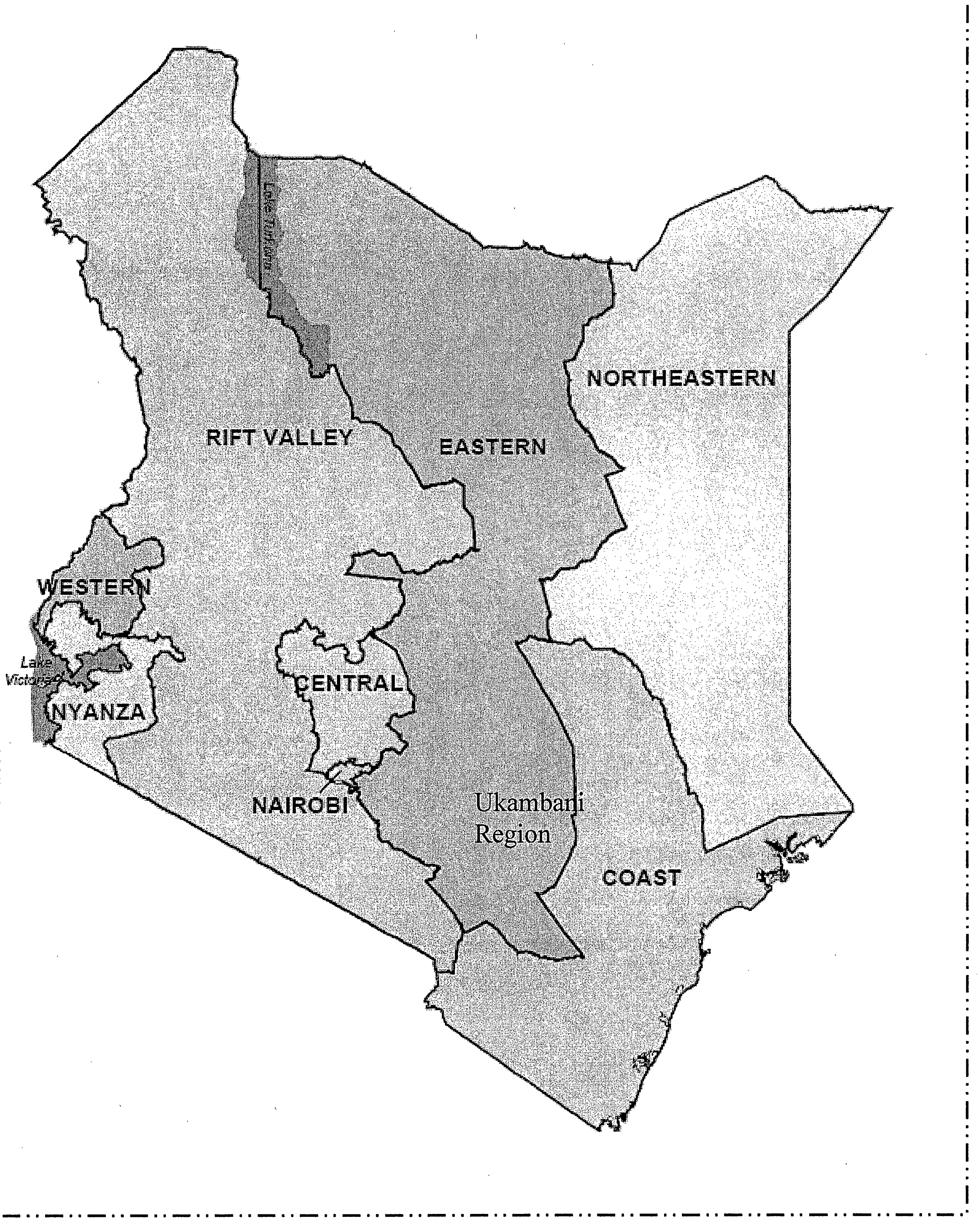
Records
All records relating to this project, including signed consent forms, must be kept on file for three years following completion of the study. **Please note the PI's name and the OSR number assigned to this IRB protocol (as indicated above) on any future communications with the IRB. Direct all communications to the IRB c/o the Office of Sponsored Research.** Thank you for your cooperation in LLU's shared responsibility for the ethical use of human subjects in research.

Signature of IRB Chair/Designee: Helen H. Hlatshwayo

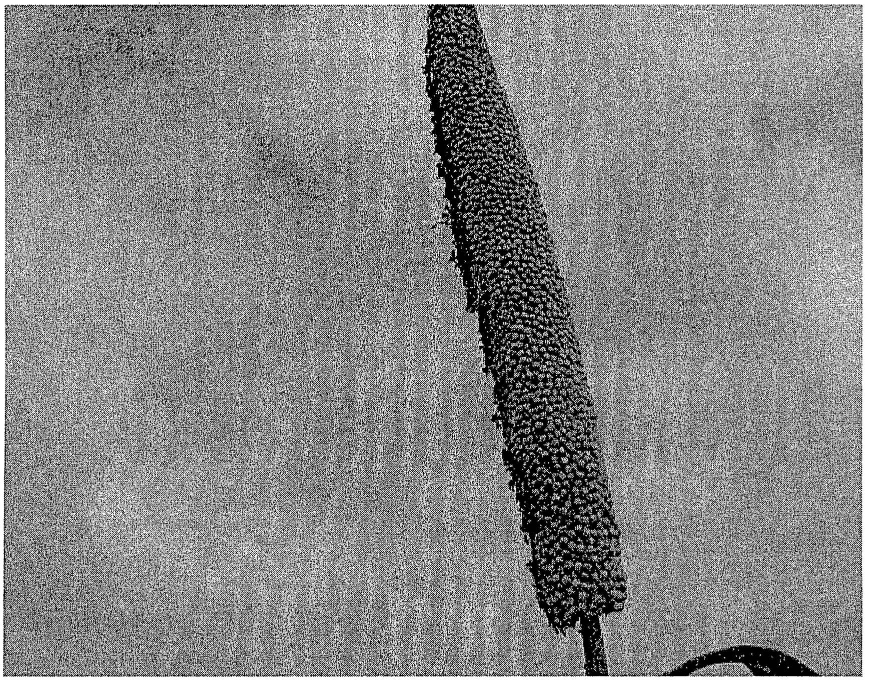
Loma Linda University Adventist Health Sciences Center holds Federalwide Assurance (FWA) No. 6447 with the U.S. Office for Human Research Protections, and the IRB registration no. is IORG226. This Assurance applies to the following institutions: Loma Linda University, Loma Linda University Medical Center (including Loma Linda University Children's Hospital, LLU Community Medical Center), Loma Linda University Behavioral Medicine, and affiliated medical practices groups.

IRB Chair:	IRB Administrator:	IRB Specialist:
Rhodes L. Rigsby, M.D.	Linda G. Halstead, M.A., Director	Mark Testerman
Department of Medicine	*Office of Sponsored Research*	*Office of Sponsored Research*
(909) 558-2341, rrigsby@ahs.llumc.edu	*Ext 43570, Fax 80131, lhalstead@univ.llu.edu*	*Ext 43042, Fax 80131, mtesterman@llu.edu*

APPENDIX E: A MAP OF KENYA SHOWING THE 8 PROVINCES & UKAMBANI REGION

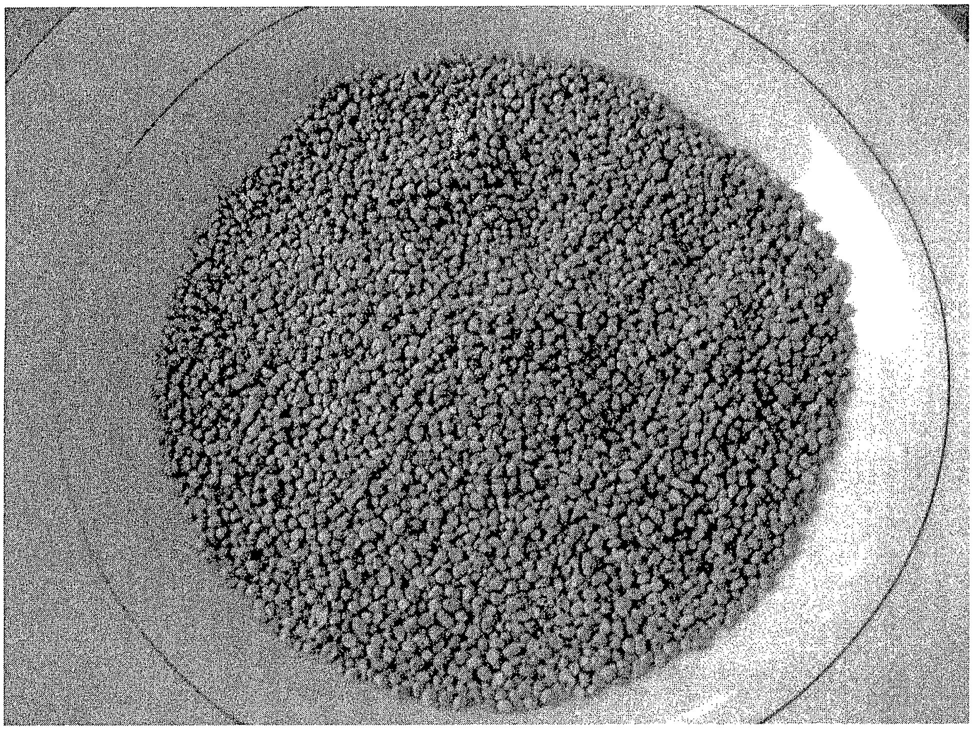


APPENDIX F: PEAR MILLET CROP IN THE FIELD



Pearl Millet Being Dried

Dry Pearl Millet



APPENDIX G: WEIGHT AND HEIGHT PROTOCOLS

Protocol 1: Measuring Infants

1. **Measurer**: Cover the board with table paper.
2. **Assistant**: Ask the assistant to remove hats, barrettes, shoes, and socks. Big hair styles will need to be flattened as much as possible.
3. **Measurer**: Place the sliding foot piece at the end of the measuring board and check to see that it is sliding freely.
4. **Assistant**: Ask the Assistant to lay the child down on his/her back on the measuring board and stand directly behind the child's head. If it is impossible for the Assistant to stand behind the child's head, he/she may stand beside the child.
5. **Measurer**: Position yourself on the right side of the child so you can hold the foot piece with your right hand.
6. **Measurer**: Hold the child securely at the waist while the Assistant positions the head.
7. **Measurer**: When the child's position is correct, read and call out the length measurement. Continue calling until it is recorded.
8. Record the measurement on the data collection sheet as "Recumbent Length". Check to make sure that it is accurate and legible.

Protocol 2: Measuring young children who are more than 2 years old and can stand without assistance

1. **Assistant:** Ask the Assistant to remove socks and shoes on the child and remove or push aside barrettes, braids, or hairstyles that might interfere with the measurement. Big hairstyles will need to be flattened as much as possible.
2. **Assistant:** Ask the Assistant to walk the child to the board and kneel on the right side of the child.
3. **Measurer:** Place the data collection sheet and pen/pencil on the floor near you and kneel on the left side of the child.
4. **Measurer:** Place the child's feet flat and either the knees or feet together in the center of the measuring board.
5. **Assistant:** Ask the Assistant to place her/his right hand just above the child's ankles on the shins and place he left hand on the child's knees and push against the board. Make sure that the child's legs are straight.
6. **Measurer:** Tell the child to look straight ahead. Make sure that the child's line of sight (Frankfort Plane) is level with the floor. With your right hand, lower the headpiece on top of the child's head. Make sure that you push through the child's hair.
7. **Measurer:** When the child's position is correct, read and call out the measurement to 0.1 cm. Continue calling out the measurement until it is recorded.
8. Record the measurement on the data collection sheet as "Standing Height". Check to make sure that it is accurate and legible.

Protocol 3: Weighing children using a beam balance

1. Cover the scale with paper.
2. Make sure that the scale is at zero.
3. Ask the assistant to remove the child's clothing to undergarments.
4. Ask the assistance to place the child on his/her back or sitting on the tray of the scale.
5. Read and call out the weight repeatedly until is it recorded.
6. Record the weight in the data sheet. Check it for accuracy and legibility.

Protocol 4: Weighing children using a Digital scale (children who are more than 2 years old and can stand without assistance)

1. Activate the scale by turning it on. Zeroes will appear on the display panel. Make sure the scale is on "kg" not "lb".
2. Ask the Assistant or child to remove shoes and any heavy clothing such as jackets, sweatshirts, sweaters, etc.
3. Ask the child to step onto the scale. Make sure the child is centered on the platform and arms are at his/her side.
4. The weight will appear on the display panel. Call out the weight until it is recorded.
5. Record the weight on the data collection sheet. Make sure it is accurate and legible.

Protocol 5: Weighing adults using a Digital scale

1. Activate the scale by turning it on. Zeroes will appear on the display panel. Make sure the scale is on "kg" not "lb".
2. Ask the adult to remove shoes and any heavy clothing such as jackets, sweatshirts, sweaters, etc.
3. Ask the adult to step onto the scale. Make sure the adult is centered on the platform and arms are at his/her side.
4. The weight will appear on the display panel. Call out the weight until it is recorded.
5. Record the weight on the data collection sheet. Make sure it is accurate and legible.

Protocol 6: Measuring Adults

1. Ask the adult to remove shoes. Big hairstyles will need to be flattened as much as possible.
2. Ask the adult to walk to the board.
3. Tell the adult to look straight ahead. Make sure that the adult's line of sight (Frankfort Plane) is level with the floor. With your right hand, lower the headpiece on top of the adult's head. Make sure that you push through the adult's hair.
4. When the adult's position is correct, read and call out the measurement to 0.1 cm. Continue calling out the measurement until it is recorded.
5. Record the measurement on the data collection sheet. Check to make sure that it is accurate and legible.

APPENDIX H: ACCESSIBILITY TO OUTSIDE WORLD AS MEASURED BY INFRASTRUCTURE

Date ______/_________/_________ Mwingi /Makueni Division_______________

Sub-location_____________________ Village_____________________________

Instructions: Tick if applicable

Infrastructure

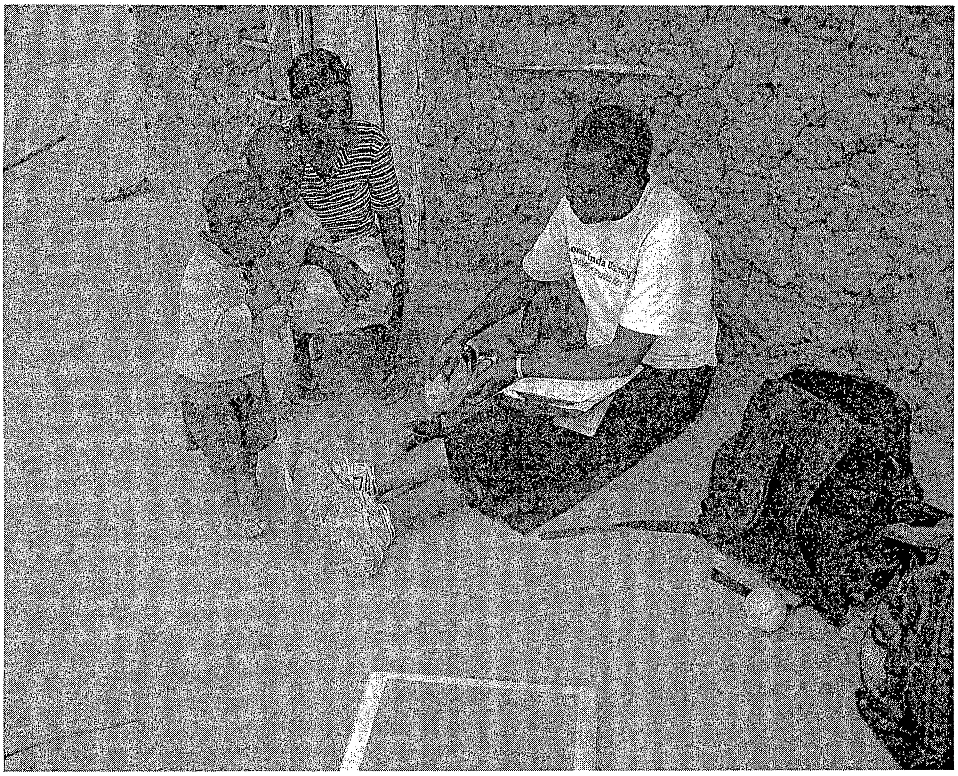
Shopping center	[ ]	How many?
Schools	[ ]	How many?
Churches	[ ]	How many?
Cell phone use	[ ]	
Radio use	[ ]	
Newspapers	[ ]	
Market days	[ ]	
Jua kali industries	[ ]	
Clinics/dispensaries	[ ]	How many?
Public transport	[ ]	every other hour / daily / every other day
Rural electrification	[ ]	

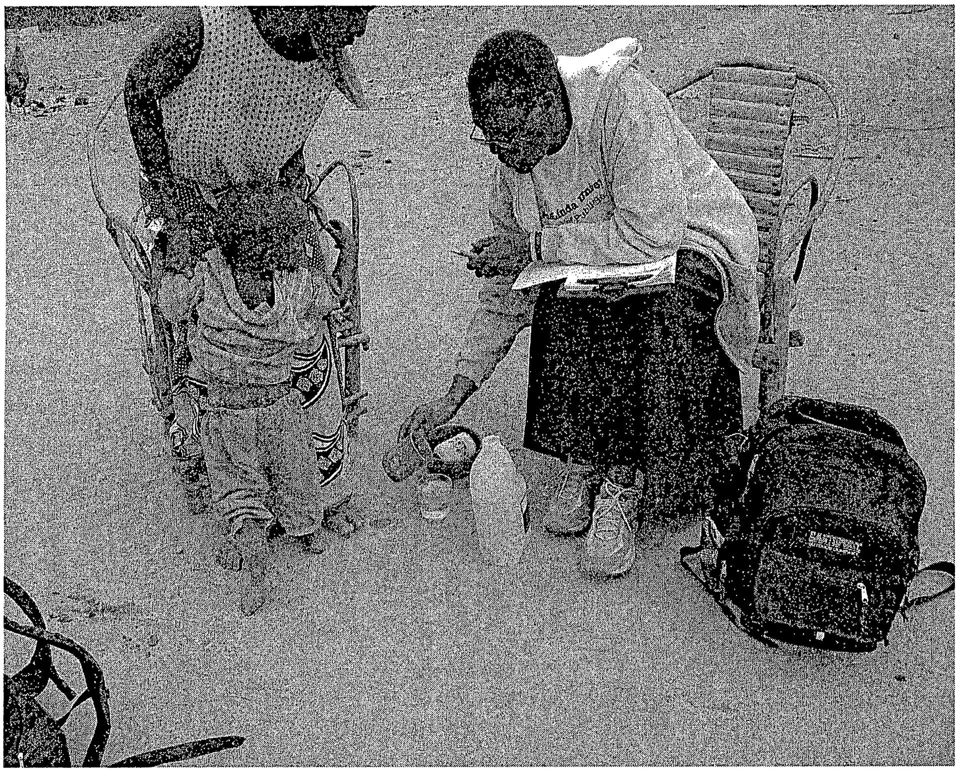
Time taken to walk to the main road

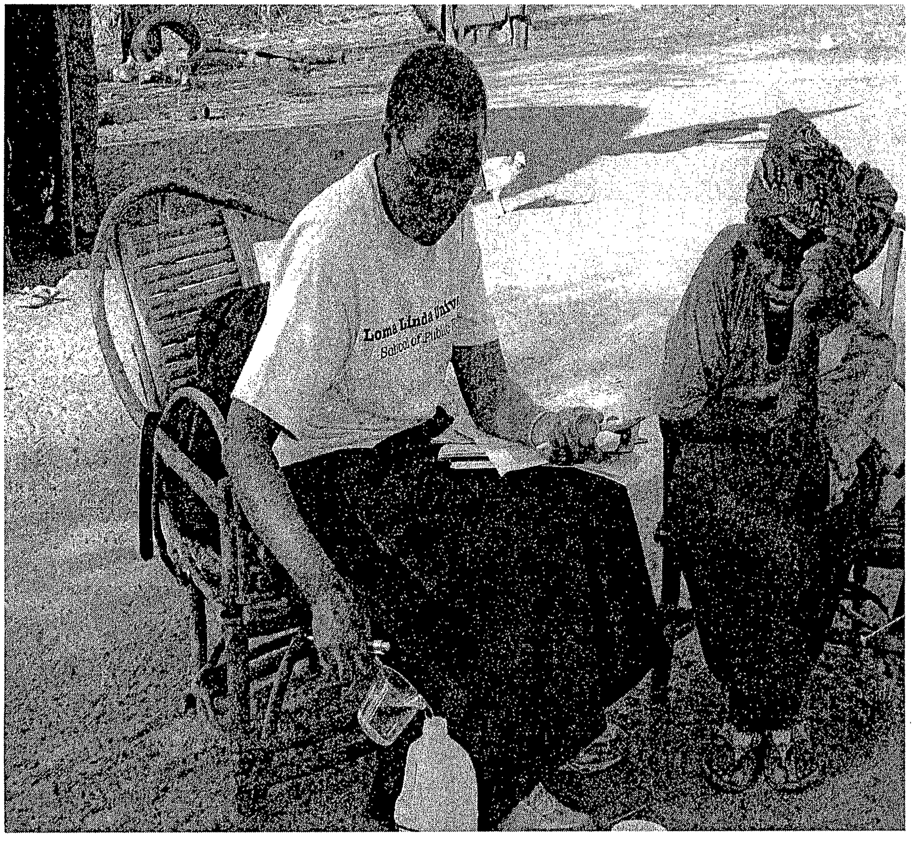
Is transport available during the rainy season?

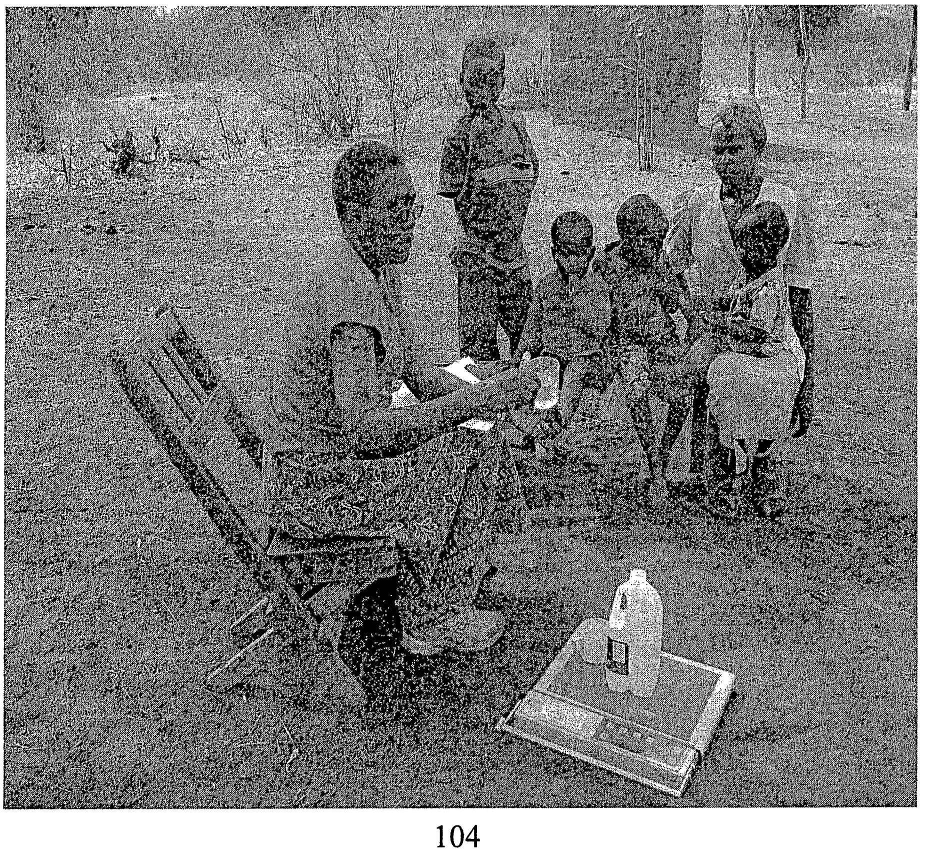
If not available why? Score_______________

APPENDIX I: 24-HR DIETARY RECALL ESTIMATES

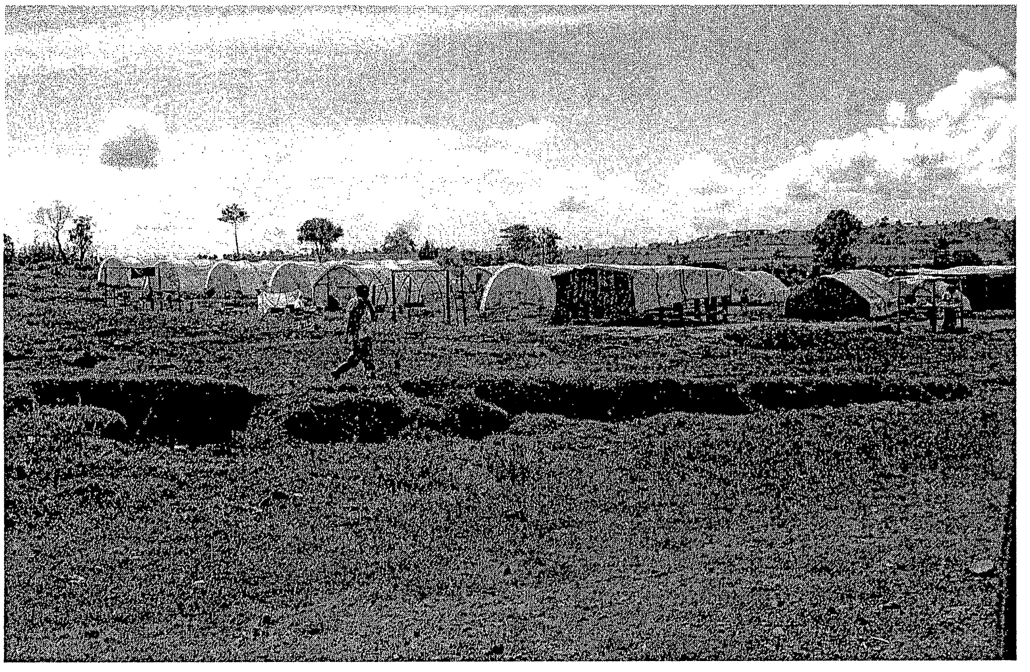


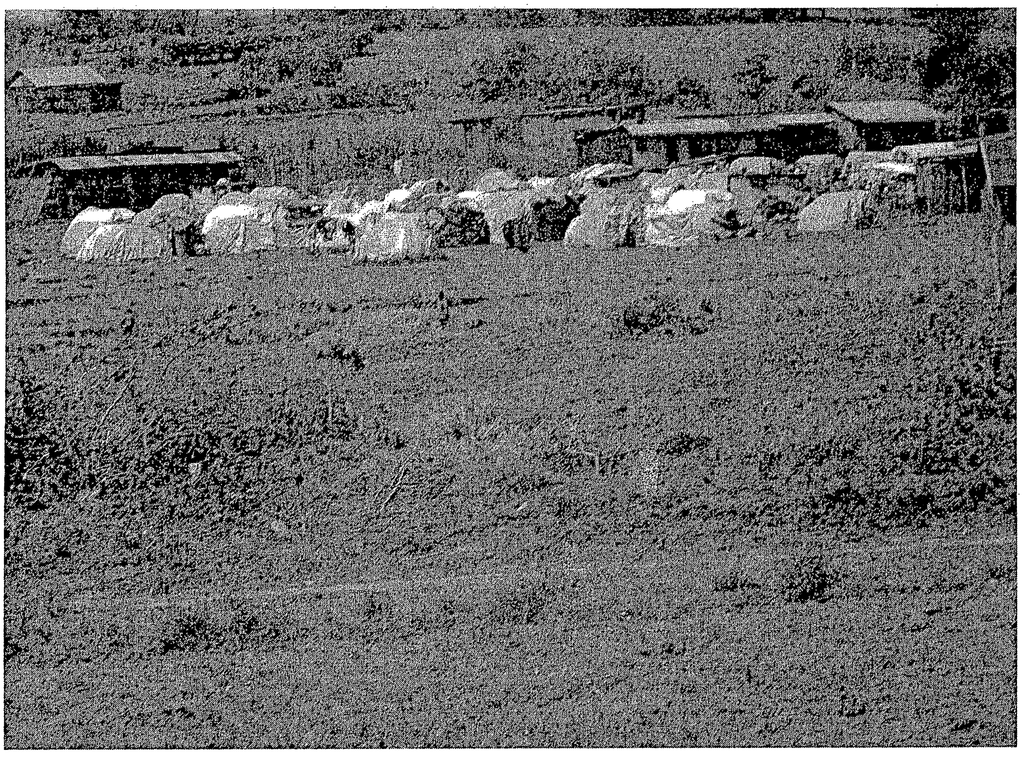



Loma Linda



APPENDIX J: INTERNALLY DISPLACED PEOPLE-CAMPS





APPENDIX K: FOOD GROUP SCHEME

FOOD GROUP DESCRIPTION	
Food Group	Description
Grain	▪ Millet ▪ Corn ▪ Sorghum ▪ Rice ▪ Wheat ▪ Other
Legumes	▪ Beans ▪ Mung beans ▪ Cow peas ▪ Pigeon peas ▪ Lentils
Vegetable	▪ Kale ▪ Spinach ▪ Cow peas
Milk	▪ Breast milk ▪ Cow's milk ▪ Goat's milk
Tubers/roots	▪ Potatoes ▪ Sweet potatoes ▪ Arrow root ▪ Cassava ▪ Yam
Fruits	▪ Papaya ▪ Lemon ▪ Oranges
Meat/Eggs	▪ Chicken ▪ Goat's meat ▪ Beef ▪ Game meat ▪ Eggs ▪ Broth
Beverages	▪ Soda ▪ Water ▪ Black tea ▪ Tea with milk ▪ Coffee ▪ Other
Fata & shortening	▪ All types

APPENDIX L: INFORMED CONSENT -ENGLISH

LOMA · LINDA · UNIVERSITY

Loma Linda University

School of Public Health

Loma Linda, California 92350
(909) 558-4546
Fax: (909) 558-4087

Anthropometric Parameters of Under Five Years Old Children and their Mothers with Different Dietary Habits in Ukambani Region: A study in Eastern Rural Kenya

Verbal Informed Consent

We would like to invite you to participate in a study about dietary habits and maternal child health. You have been randomly chosen among Mwingi/ Makueni districts residents and you are a mother with a child or children under five years old. We are asking you to allow us to interview you about yourself and your child's dietary habits and health

The participation in this study is strictly voluntary. There is no penalty if you decline to participate or withdraw. If you choose to volunteer to help us with our study, we request you to respond to the interview questions as honestly as possible right now. We expect that the interview will take about 45 minutes to 1 hour. The questions concern the dietary habits and the health of your child/children less than five years of age.

The interview is anonymous. We are asking you to tell us basic information about yourself like your age and the ages of your children who are under five years old. We will not record your name or your child's name or ask for any other identifying information. We can never match your answers with your name or the names of your children and we are only interested in what groups of people tell us about these issues. Please feel free and open about your child or children's dietary habits. We will take weight and height of you and your child/children. We will also take a sample of blood from you and your child/children by pricking your child's finger and yours too in order to assess hemoglobin levels.

There is minimum risk involved, no more than daily life. You and your child/children may experience slight discomfort associated with the automatic hypolet device used to prick your fingers. We will apply standard precautions like cleaning your fingers with alcohol, use of gloves etc as required. Your answers are important to our study and we hope that you will decide to help us learn more about the dietary habits in Ukambani region. We would be glad to answer any questions that you may have about this study before you decide to participate.

If you wish to contact an impartial third party not associated with this study regarding any complaint that you may have, please contact the area chief in his/her office during working hours.

Do you have any questions? Would you like to participate in this study?

Read by Mueni Ndiku (Principal Investigator)

Loma Linda University
Adventist Health Sciences Center
Institutional Review Board
Approved 5/14/08 **Void After** 5/13/2009
58113 **Chair**

A SEVENTH-DAY ADVENTIST HEALTH SCIENCES INSTITUTION

APPENDIX M: INFORMED CONSENT- KISWAHILI

LOMA · LINDA · UNIVERSITY

Loma Linda University

School of Public Health

Loma Linda, California 92350
(909) 558-4546
Fax: (909) 558-4087

Verbal Informed Consent in Vernacular

Tunakuomba ushiriki katika utafiti juu ya tabia za lishe na afya ya mama na mtoto. Umechaguliwa kwa bahati nasibu kama mwenyeji wa wilaya ya Mwingi/Makueni na mmojawapo wa mama mwenye mtoto au watoto wenye umri ulio chini ya miaka mitano. Kama ukikubali ombi hili tutakuhoji wewe kuhusu lishe na afya ya wewe mwenyewe na mtoto au watoto.

Kushiriki katika utafiti huu ni kwa hiari kabisa. Hakutakuwa na kunyanyaswa kama ukikataa kushiriki au kuacha kushiriki katikati. Tutakushukuru kama utakubali ombi hili, na ukikubali tutakuomba ujibu maswali utakayoulizwa kwa ukweli na kikamilifu. Uhojaji huu unakadiriwa kuchukua kati ya dakika 45 mpaka 60 (saa moja).

Mambo yote utakayosema yatatunzwa kama siri. Utaulizwa mambo yanayohusu lishe na afya yako na watoto wako wenye umri ulio chini ya miaka mitano. Hatutanakili jina la lako au la mtoto wako mahali popote au kukuuliza mambo ambayo yataweza kukutambulisha kwa watu wengine kama wewe au watoto ni nani. Hivyo jisikie huru kujibu maswali kikamilifu unavyoweza.. Tutachukua vipimo vya uzito na urefu wa wewe na watoto wako. Tutachukua pia kipimo cha sampuli ya damu kidogo toka kwenye kidole chako na cha mtoto au watoto ili kuangalia vipimo vya lishe.

Hatutegemei kwamba kutakuwa na madhara yoyote ambayo ni zaidi ya yale ya maisha ya kawaida kutokana na utafiti huu. Wewe na mtoto au watoto wako mnaweza mkasikia uchungu kidogo sana wakati mtakapokuwa mkitombolewa vidole kutoa sampuli ya damu. Majibu yako yataweza kutusaidia kwenye kuimarisha shughuli za lishe na afya za watoto hapa Ukambani na kwa taifa letu. Tutafurahi kujibu maswali yoyote utakayoweza kuwa nayo kabla ya kushiriki kwenye utafiti huu.

Kama kutakuwa na malalamiko yoyote yanayohusiana na utafiti huu au watafiti jione huru kumwona chifu wa eneo hili ofisini kwake wakati wa saa za kazi.

Je una maswali yeyote? Je ungependa kushiriki katika utafiti huu?

Musomaji Mueni Ndiku (Mchunguzi Mkuu)

Loma Linda University
Adventist Health Sciences Center
Institutional Review Board
Approved 5|14|08 **Void After** 5|13|2009
58113 **Chair** [signature]

A SEVENTH-DAY ADVENTIST HEALTH SCIENCES INSTITUTION

APPENDIX N: UKAMBANI REGION RAIN CYCLES AND AVAILABLE FOOD ITEMS

Jan Feb March	April May June	July August Sep	Oct Nov Dec
Activities ▪ Weeding ▪ Harvesting one season crops i.e. millets, maize, legumes and cow peas ▪ Available fruits: - local mangoes. ▪ Planting end of March for the long rains, which are erratic. ▪ The long rains begin mid March or end of March ▪ A lot of traditional green vegetables available	**Activities** ▪ Weeding ▪ Harvesting of legumes and cow peas ▪ Harvesting of some perennial crops like sweet potatoes, cassava and pumpkins and sorghum ▪ Harvesting pearl millet ▪ Pumpkin leaves vegetables available	**Activities** ▪ Harvesting maize and pigeon peas ▪ Perennial crops harvesting continues in August ▪ Summer begins end of August until end of October ▪ Preparing gardens for the short rains ▪ Oranges, avocados and paw paws available in some areas	**Activities** ▪ Summer continues in October ▪ Short rains begin at the end of October or beginning of November ▪ Planting and weeding ▪ December traditional vegetables available ▪ Local mangoes available in Mwingi and Kitui districts