

## **Is Settling Good for Pastoralists? The Effects of Pastoral Sedentarization on Children's Nutrition, Growth, and Health Among Rendille and Ariaal of Marsabit District, Northern Kenya**



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## Abstract

The settling of formerly mobile pastoral populations is occurring rapidly throughout East Africa. Pastoral sedentarization has been encouraged by international development agencies and national governments to alleviate problems of food insecurity, health care delivery, and national integration. However, it has not been demonstrated that abandoning the pastoral way of life, and particularly access to livestock products, has been beneficial to the health and well-being of pastoral populations.

This paper reports the results of a three-year study of pastoral and settled Rendille and Ariaal (mixed Samburu/Rendille) communities in Marsabit District northern Kenya, which compares levels of child malnutrition and illness between five different Rendille communities, ranging from purely pastoral to agricultural and urban communities. Analysis of bimonthly dietary recalls, anthropometric measurements, morbidity data, and economic differentiation and specialization among 202 mothers and their 488 children under age 9 reveals large differences in the growth patterns and morbidity of nomadic vs. settled children. In particular, age-specific height and weight measurements for the nomadic pastoral community are significantly higher than same-aged measurements of children from the sedentary villages. Furthermore, women and especially pregnant women showed higher levels of malnutrition in the settled communities. Both women and children showed higher rates of respiratory and diarrheal morbidity in settled versus nomadic communities, although malaria rates were uniformly higher in lowland communities than in the highlands.

Differences in child growth are attributed mainly to better nutrition, and particularly access to camel's milk within the nomadic communities. The striking decrease in diarrheal and respiratory diseases for the nomadic children vs. settled children coupled with the findings of a relative decrease in malnutrition and stunting indicate an unexpected edge for health and growth of nomadic Rendille children.

The policy implications of our findings are significant. Although pastoralism is not an option for everyone living in dry regions like northern Kenya, the decrease in diarrheal and respiratory illness and for pastoralist children, and the higher levels of stunting in settled children from pastoral populations, should be part of decisions affecting social, economic, and health policy for pastoral regions.

## 1. Health and Nutrition Among Nomadic and Settled Pastoralists

The shift to sedentism by African pastoralists has increased dramatically in the late 20th century as a result of sharp economic, political, demographic, and environmental changes. Although the many, if not the majority, of pastoralist households remain committed to the raising of livestock in the savannas and arid regions of East Africa, Northeast Africa, and West Africa, many formerly pastoral families have settled in or near towns and farms to pursue alternate economic strategies, including cultivation, agro-pastoralism, or urban wage labor.

Our research on the consequences of settling of Rendille and Ariaal people in northern Kenya, has looked at both costs and opportunities for settled pastoralists, particularly on the health and well being of women and children, those most at risk of morbidity and mortality (Fratkin and Roth 2005, Fratkin et al. 2004; Nathan et al. 2005). Several studies point to problems of impoverishment and destitution of pastoralists who settle (Hogg 1986; Little 1985) which may particularly affect women (Talle 1988), while others point to increased marketing benefits (Ensminger 1992; Sato 1997; Zaal and Dietz 1999) including those to women selling milk and agricultural products (Fratkin and Smith 1995, Little 1994; Smith 1999; Waters-Bayer 1988). Several studies, however, report negative social and health consequences of pastoral sedentarization, including poorer nutrition, inadequate housing, lack of clean drinking water, and higher rates of certain infectious diseases despite better access of settled populations to formal education and health care (Chabasse *et al.* 1985; Fratkin *et al.* 1999; Galvin *et al.* 1994; Hill 1985; Klepp *et al.* 1994; Nathan *et al.* 1996).

Studies of health and nutrition in Africa show important differences between nomadic pastoralist populations and settled agricultural and agro-pastoral populations. This paper reviews some of the findings about health and nutrition among nomadic and settled pastoralists, and reports on our long term study of nutritional and health changes among nomadic and settled Ariaal and Rendille communities in Marsabit District, Kenya.

### 1a. Nutrition

Nomadic pastoral diets are typically protein-rich and calorie-poor. based on three food groups: milk, meat products (meat, bone, fat, blood), and cereals acquired by trade or cultivation. Meat products are rarely consumed, where animals are slaughtered for ritual occasions or social obligations. Milk accounts for 66% of diets of pastoral Turkana, Maasai, and Rendille, and 30% of diets of Tuareg, Fulani, and Ethiopian Boran (Galvin 1992; Sellen 1996). There is marked seasonal variation in consumption of these products, where milk is consumed mainly in the short wet seasons and people turn to cereals as pastoralists sell livestock (usually goats and sheep) to purchase maize meal (*posho* in Kenya), sugar, tea, and tobacco, which yield little more than immediate calories and stimulant to avoid hunger (Galvin and Little 1999).

Milk is high in protein and micronutrients including vitamins A, C, and calcium. However, milk has low caloric value and accounts for only 10-25% of total calories consumed by individuals annually in nomadic communities. Reported caloric intake among pastoralists ranges from 1080 Kcal/day for Kenyan Maasai women and children and 1350 kcal for Turkana, with declines in daily calories increasing in wet season as milk replaces grains (Sellen 1996). Among Datoga of Tanzania, Sellen (2000) found undernutrition among married women who had low total body weights and fat reserves, and undernutrition in children over 5, particularly girls 5-9, boys 9-12, and all teenagers. Sellen attributes this to the particularly arduous work loads for these age and gender groups, including herding animals and collecting water and fuel wood. Sellen found no significant differences between boys and girls in Datoga in terms of overall nutrition or mortality, and little evidence of sex preferential treatment of children. Wealth differences within livestock keeping pastoralist communities have little bearing on nutritional status, a fact attributed to a “moral economy” where wealthier households share milk and livestock with poorer relatives in nomadic communities (Fratkin 2004; Fratkin and Roth 1990; Sellen 2003). However, adult women show greater undernutrition than adult men, a fact which may be due to higher energy consumption associated with domestic labor and childbearing (Fujita et al. 2004), and differential consumption associated with male privilege (Fratkin 2004; Fratkin and Smith 1995).

#### 1b. Health

African pastoralists suffer many of the same infectious diseases experienced by agricultural populations, including high rates of malaria in lowland areas and of upper-respiratory infections at higher elevations (Nathan et al. 2005). Under-five mortality in Kenya is one of the world's highest at 122 per thousand, with per year under-five deaths reported at 132,000 (UNICEF 2004). The major infectious killers of Kenyan children remain diarrhea, acute respiratory infection, and malaria, although HIV/AIDS is fast becoming a risk for childhood mortality (National Research Council 1993; Omondi-Odhiambo 1984; UNICEF 2004). These figures should apply to pastoralists as well as farming and urban populations.

In a review of illness and disease among pastoralists across the sub-Saharan Africa (Sheik-Mohamed and Velema 1999), the authors note that the mobility of pastoral communities enable them to decrease exposure to measles, cholera, and helminth infections. However, these same populations suffer particular risks associated with livestock keeping, including high rates of trachoma (corneal scarring caused by bacterium *Chlamydia trachomatis* bacterium, transmitted by flies), brucellosis (flu-like illness caused by *Brucella* bacterium acquired from livestock products, particularly milk), leishmaniasis (skin lesions caused by protozoa transmitted by the bite of a female sand fly), anthrax (livestock-borne bacterium *Bacillus anthracis* resulting in lesions and internal inflammation, with 20% mortality if untreated) and tuberculosis, all of which are compounded by undernutrition, crowded sleeping quarters, and lack of health care. "Existing health care systems are in the hands of settled populations and rarely have access to nomads due to cultural, political and economic obstacles" (Sheik-Mohamed and Velema 1999: 695).

Sexually transmitted diseases are common and spread easily among pastoralists due mainly to lack of treatment. While few studies on HIV/AIDS have been conducted on pastoralists, research among pastoral Maasai in Tanzania reports increasing rates of HIV/AIDS brought back to home communities by men selling livestock in town centers, or those who have migrated to urban areas for wage paying jobs (IBS 2003; Klepp et al. 1995).

#### 1c. Comparison of health and disease among nomadic and settled pastoral populations

Hill's edited volume (1985) on health, nutrition, and demography in Mali reported that nomadic groups had higher rates of tuberculosis, brucellosis, syphilis, trachoma, and child mortality than settled agricultural populations. However, the latter suffered higher rates of bilharzia, and parasitic infections and more malaria and anemia, particularly among those groups living close to rivers (Chabasse et al. 1985). Researchers with the South Turkana Ecosystem Project in Kenya (Little and Leslie 1999) found that settled Turkana experienced reduced fertility, increased morbidity (particularly from malaria) and increased child mortality. Turkana infants (0-2 years) from nomadic families were significantly fatter and heavier than those in settled comparison group (Little et al. 1993), and settled children under five showed more growth stunting than nomadic children. Settled children over five years were heavier, which was attributed to greater role of carbohydrates in their diets, particularly for children receiving supplemental feeding in schools (Brainard 1990; Galvin 1992). Child Nutrition was strongly affected by seasonality (Shell-Duncan 1995) as was female fertility (Leslie and Fry 1989).

In our research among Rendille and Ariaal (discussed in more detail below), we found that settled children had higher morbidity rates than pastoral children in respiratory and diarrheal diseases, while both settled and pastoral communities in the lowlands suffered high seasonal fevers likely due to malaria (Nathan et al. 2005). We also found large differences in nutritional status, where children living in all settled communities studied including farms and towns had higher rates of malnutrition and stunting than the nomadic Rendille (Fratkin et al. 2004; Nathan et al. 1996; Roth et al. 2005).

In addition to the risks of malnutrition and infectious diseases are stress and trauma caused by violence and physical dislocation, particularly in refugee and famine relief camps. Ahmed (2005) described health risks faced by refugee Somali pastoral women in Mandera District Kenya, where drought and violent conflict has led to high degrees of stress, malnutrition, and loss of family supports. This has a particular impact on maternal health, where women face five times the risk of pregnancy loss when living in violent environments. Furthermore, Ahmed reports on a high degree of sexual violence including rapes in the refugee camps. For those groups outside the security of famine or refugee camps, the situation must be worse.

## **2. The Settling of Pastoralists**

The shift to sedentism by East African pastoralists has increased dramatically in the late 20th century as a result of sharp economic, political, demographic, and environmental changes. Although the majority of pastoralist households in many areas remain committed to the raising to livestock keeping, many formerly pastoral families have settled near towns or on farms to pursue alternate economic strategies including cultivation, agro-pastoralism, trade, or wage labor. The wider economic resource base allows them to alleviate seasonal fluctuation of food availability and survive during periods of severe drought (Little et al. 2001; McPeak and Little 2005).

Pastoralists settle for a variety of reasons, both in response to 'pushes' away from the pastoral economy and to 'pulls' of urban or agricultural life. Maasai in southern Kenya, for example, have lost grazing lands due to the growth of agricultural and pastoral populations, privatization of land for commercial farms and ranches, and the expansion of tourist game parks, causing many pastoralists to combine sedentary maize cultivation with animal raising (Campbell 1999; McCabe et al. 1992). In the more arid and sparsely populated north and northeast of Kenya, many pastoralist families have settled in response to the environmental stress of drought and famine combined with political violence of livestock raiding and ethnic conflict. This includes Turkana, Samburu, Rendille, Gabra, Boran, and Somali pastoralists (Fratkin 2001; Galaty 2005; McCabe 2004).

The settling of nomadic or semi-sedentary pastoralists in Africa has been advocated by multilateral and bilateral development agencies, religious missions, conservation groups, and national governments, who promote permanent settlement as beneficial to integrating pastoralists into the national economy, assimilating marginal populations, forging of national identity, and improving the material well being of formerly mobile populations (Dyson-Hudson 1991; Galaty 1999; Kituyi 1990). International donors including the World Bank and USAID have encouraged the privatization of formerly communal range lands and the establishment of individual ranches (Galaty 1994; World Bank 1984), although these policies are being rethought as western ranching models have shown little success in East Africa (Scoones 1994; World Bank 1997). National governments in Africa have long been concerned with the

sedentarizing pastoralists as a better means of controlling and taxing them and in inhibiting cross-border migrations. Some NGOs involved in famine relief work have encouraged poor pastoralists to settle permanently at famine relief points, both to deliver food and social services, but also to separate pastoral populations from their nomadic lifestyle, which is seen as primitive and irrational (Fratkin 1997; Hogg 1982, 1986).

Despite these interventions, it is not clear how beneficial settling is to pastoralists. Several studies point to problems of impoverishment and destitution of pastoralists who settle (Hogg 1986; Little 1985) which may particularly affect women (Talle 1988), while others point to increased marketing benefits (Ensminger 1992; Sato 1997; Zaal and Dietz 1999) including those to women selling milk and agricultural products (Fratkin and Smith 1995, Little 1994; Smith 1999; Waters-Bayer 1988). Several studies report negative health consequences of pastoral sedentarization, including poorer nutrition, lack of clean drinking water, and higher rates of certain infectious diseases including malaria, bilharzia, syphilis, and AIDS, despite better access of settled populations to health care (Chabasse *et al.* 1985; Fratkin *et al.* 1999; Galvin *et al.* 1994; Hill 1985; Klepp *et al.* 1995; Nathan *et al.* 1996; Nathan *et al.* 2005).

Between 1994-1997, we, cultural anthropologist Elliot Fratkin, biological anthropologist Eric Abella Roth and medical doctor Martha A. Nathan, conducted longitudinal research examining the bio-social concomitants of sedentism for Ariaal and Rendille pastoralists of Marsabit District, northern Kenya. We compared different economic strategies and health and nutrition outcomes of varying communities ranging from fully nomadic through agro-pastoral to irrigation agriculturalists (Fratkin and Roth 2005).

We focused our study on women and small children, as they are viewed by health care practitioners as particularly vulnerable groups among human communities at risk from poor environments (Panter-Brick 1998:66). We suspected that since milk protein is an indispensable nutrient for reproductively active pastoral women as well as for infants and growing children (Galvin and Little 1999), the potential protein loss associated with agricultural sedentism may have a negative impact on maternal nutritional health.

Rendille people, camel pastoralists in Marsabit District Kenya, and Ariaal (mixed Rendille/Samburu who raise cattle as well as camels), have adopted different subsistence



strategies in the past thirty years, including a transition to sedentism. Some communities now grow maize to supplement livestock keeping, some grow vegetables for sale in the main market in Marsabit town; others sell milk and/or market livestock, while still others combine these activities with wage labor. Given the diversity of local economies, we chose maternal-child health, measured via morbidity, nutrition and their effects on child growth and development, as the vital currency for appraising the biosocial consequences of sedentism.

### **3. Pastoral Sedentarization in Marsabit District Northern Kenya**

Marsabit District is Kenya's largest, most arid, and least inhabited region, with 121,478 people occupying 61,296 square kilometers. [The district was larger - 138,500 people occupying 75,078 km<sup>2</sup> - before the creation of Moyale District in 1995]. Given its aridity, the region has been historically inhabited by nomadic pastoralists keeping mixed herds of camels, cattle, and goats and sheep, including Boran (pop. approximately 50,000), Gabra (43,000), Rendille (32,000), Samburu/Ariaal (8,000), and Sakuye (13,000) [figures based on estimated number of language speakers, Ethnologue 2006]. Annual rainfall varies from 200 mm in the lowlands to 1000 mm in the highlands, and the majority of the district is made up of vast lowland scrub desert ranging from 400 to 700 m latitude, interspersed with several mountain ranges and hills including the Ndoto Mountains (2660 m) and Marsabit Mountain (1545 m), the location of the district capital of Marsabit town. There are no permanent rivers in the district, although mountain run-offs provide temporary surface water in the lowlands and the highlands have several permanent lakes and pools. Given the district's arid conditions, eighty percent of its people are livestock pastoralists, ten percent highland farmers, five percent are in commerce or trade, and five percent are salaried employees in district administration, police, education, and non-government organizations (Republic of Kenya 1991).

Where Marsabit District remained isolated and undeveloped under both colonial and post-colonial regimes, the area began to change in the early 1970s following a long series of droughts including the Sahelian Famine (1968-1973) and the Ethiopian Famine (1982-834). In 1973, a coalition of religious groups (including the National Christian Churches of Kenya (NCCCK), African Inland Church (AIC), and the Catholic Diocese of

Marsabit) encouraged impoverished Rendille, Ariaal, and Boran pastoralists to settle on new agricultural schemes on Marsabit Mountain, to learn and practice maize and vegetable agriculture as an alternative to pastoralism. In the lowlands occupied by Rendille and Gabra herders, Catholic and Protestant missions established famine relief centers at Korr, Kargi, Maikona, North Horr, Loyangalani, and Laisamis. By the 1990s, perhaps one half of the formerly nomadic populations were settled near towns and farming communities. Although many still owned camels, cattle, and goats and sheep, these were herded in mobile camps by young men and women, leaving women, children, and the elderly dependent on grains without access to milk or meat products of their animals.

#### **4. Maternal and Child Health and Nutrition in Marsabit District**

To monitor child growth and health we (the authors and a team of six assistants) surveyed five Rendille/Ariaal communities in Marsabit District, northern Kenya, every two months over a 34 month period for our longitudinal study sites. One community was a fully nomadic livestock keeping group (Lewogoso), and the other four are sedentary communities (Korr, Karare, Ngrunit, and Songa). Forty women and their under six year old children were selected from each community, for a total of 205 adult women and 488 children in our study. From September 1994 to June 1997, these women and children were surveyed every two months for nutrition (foods eaten within last twenty-four hour period) and morbidity (days that children were ill in last month due to fever, respiratory infections and diarrheal diseases) via recall methodologies. In addition, anthropometric measurements of height, weight, tricep skin folds, and mid-arm circumference were taken. Monthly household expenditures, wages and sales of livestock, milk and/or vegetables, and mother's reproductive status, (pregnant and/or breastfeeding) were also recorded each visit.

The communities are located in Figure 1. These communities are characterized as follows:

1. *Lewogoso* is a nomadic Ariaal camel-, cattle-, and small-stock-keeping settlement of approximately 250 people practicing mixed-species husbandry (*Lewogoso* is an

abbreviation of their clan name Lewogoso Lukumai). This community was extensively studied by Fratkin (1991, 2004) and forms a control community for the comparison of the sedentary villages.

2. *Ngrunit* is a sedentary agro-pastoral community of approximately 1,200 people located in a forested valley in the Ndoto Mountains. This community has several churches, a primary school, and a small dispensary, but is isolated and not well integrated into marketing activities. Its inhabitants raise maize in their gardens and market their livestock.

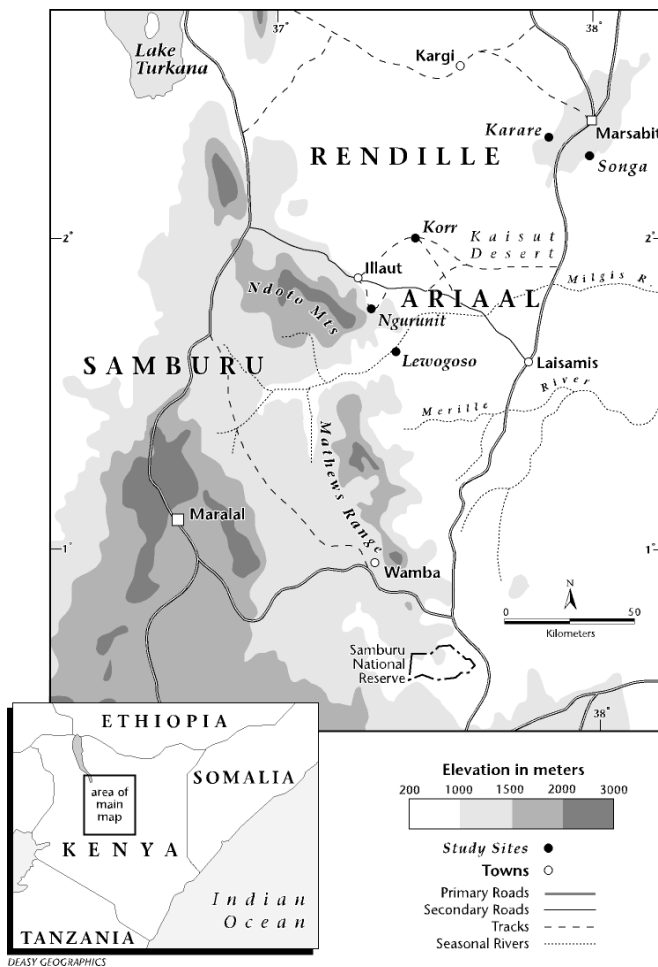
3. *Korr* is a new town in the arid lowlands of the Kaisut Desert below Marsabit Mountain created initially by the Catholic diocese to feed destitute Rendille during the famine of the 1970s. Today Korr has a sedentary population of about 6,000 Rendille, with semi-nomadic livestock-keeping settlements within a mile radius. Korr has poor marketing facilities, although the town provides a local market, mainly represented by small stock sales, for surrounding pastoralists. This community has been extensively studied by Roth (1991, 1993).

4. *Karare* is a settled highland community on Marsabit Mountain about 17 km from Marsabit Town. Its 2,000 residents both keep cattle herds and raise dryland maize. Karare has access to good marketing facilities as well as a large urban population in Marsabit Town and is located on the major truck road from Nairobi to Addis Ababa. Karare women sell milk on a regular basis to Marsabit townspeople. This community has been studied by Roth et al. (2001).

5. *Songa* is a sedentary highland agricultural community of 2,000 Rendille and Ariaal, founded by American missionaries from the African Inland Church in 1973 in a forest on Marsabit Mountain. Practicing drip irrigation, Songa's population grows vegetables for sale in Marsabit town.

(See Figure 1).

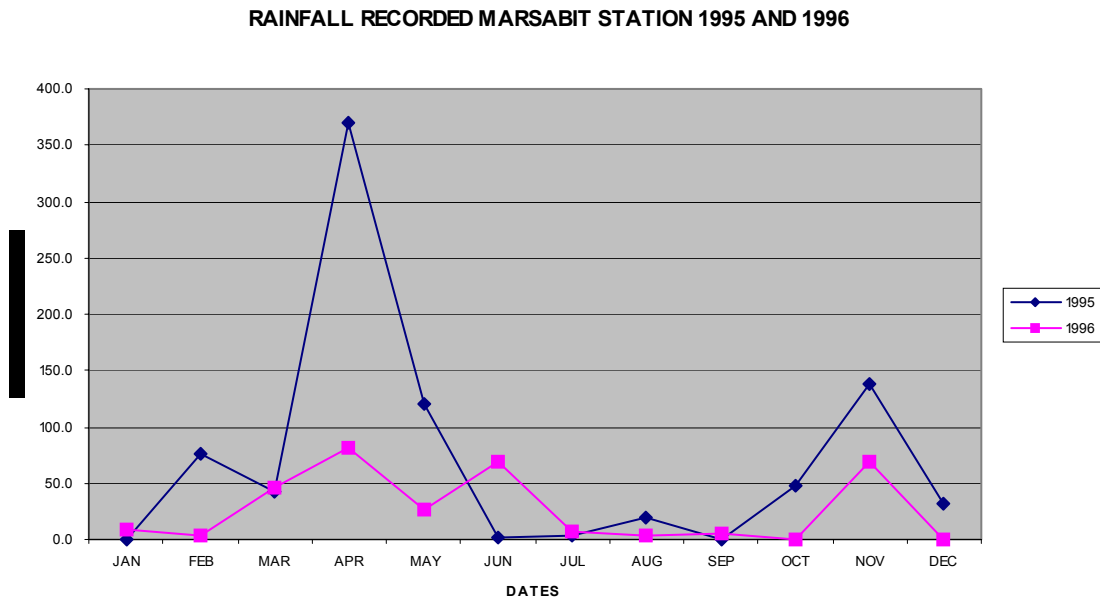
**Figure 1. Study Area in Northern Kenya**



For morbidity data, we asked mothers in each of the five study communities how many days in the past 30 (if any) did her (subject) child experience three specific diseases, diarrheal diseases, fevers and respiratory illness. We also examined the diagnosis records/month for 1994-1997 from the outpatient clinics at Marsabit and Laisamis Hospital and from clinics at Korr, Ngrunit and Karare. Marsabit Hospital serves the district capital Marsabit town whose patients are drawn mainly from the highland regions. Laisamis Hospital is located south of Marsabit town and serves the arid lowlands including Korr and Lewogoso. In addition physical examinations of the study's children were carried out in July, 1995. We also made use of rainfall data, recorded for the district from records from Marsabit Station, to delineate possible environmental effects on health

by site and over time. As can be seen from Figure 2.1, 1995 was a normal year, with a total rainfall of 855 mm. featuring the usual East African bimodal rainfall pattern with significant rains in the spring and the fall. However, 1996 was a drought year in which both season's rains failed and total rainfall only measured 320 mm.

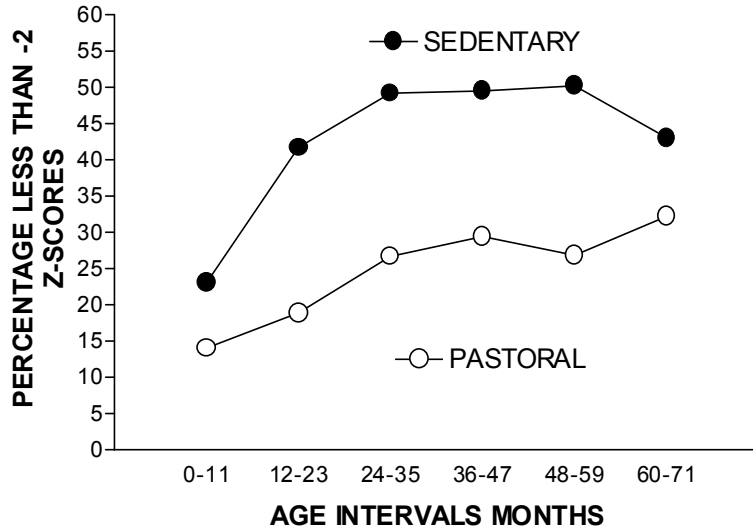
**Figure 2. Rainfall in Marsabit 1995 and 1996.**



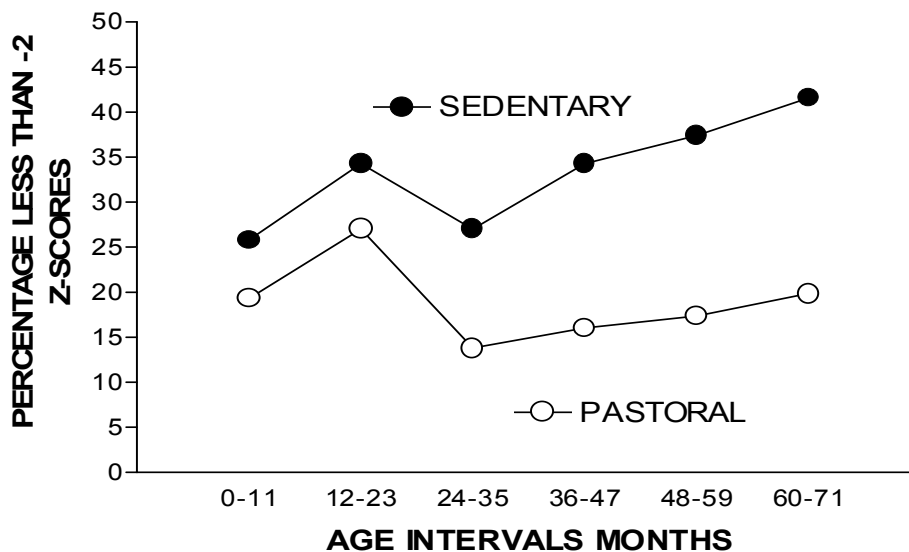
## 5. Study Results

5a. Child Nutrition and Growth. Examining levels of child malnutrition rates using these measurements, reveals large differences in the growth patterns of children for communities. Age-specific height and weight measurements for the nomadic Lewogoso community are uniformly higher than same-aged measurements from the sedentary villages, as shown in Figures 3 and 4.

**Figure 3. Measures of malnutrition for weight-by-age, pastoral versus sedentary samples, wasting defined as below  $-2$  Z-scores**



**Figure 4. Measures of malnutrition for height-by-age, pastoral versus sedentary samples, stunting defined as below  $-2$  Z-scores**



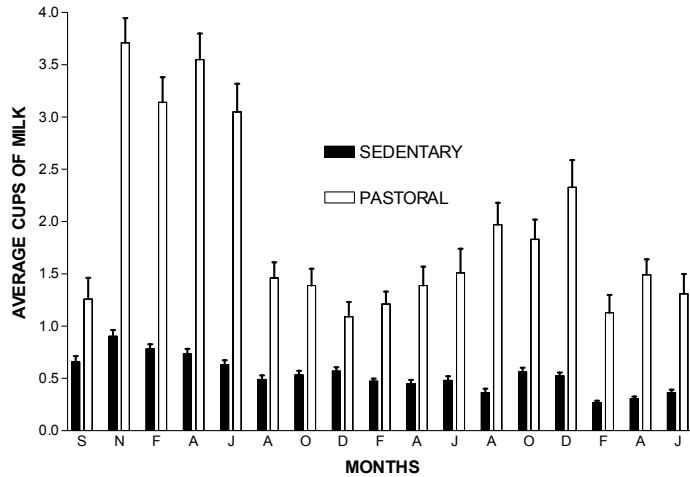
Figures 3 and 4 reveals large differences in the growth patterns of children for communities. Age-specific height and weight measurements for the nomadic Lewogoso community are uniformly higher than same-aged measurements from the sedentary villages. For the latter, growth faltering, characteristic of many African populations at about the six month range (cf. Eveleth and Tanner 1990; Little et al. 2000) is notable for both height and weight measures. In an earlier study undertaken in both a normal (1990) and drought year (1992), only 6% of children (under six years old) in the nomadic community of Lewogoso were severely malnourished, while the percentages of malnourished children in the four settled communities ranged from 17-23% [Severe malnourishment is defined as two standard deviations (80%) below the mean of Center for Disease Control average weight for height squared] (Fratkin et al. 1999). For the latter, growth faltering, characteristic of many African populations at about the six month range (cf. Eveleth and Tanner 1990) is notable for both height and weight measures, while this is true only for weight in Lewogoso, and not nearly to the same extent. In contrast height remains stable in Lewogoso, and even increases on average throughout the final four periods.

Overall these data clearly show children in the nomadic community of Lewogoso to be heavier and taller than their same-aged counterparts in the four sedentary communities. Viewing child growth as an indicator of population health and environmental adaptation, noting the ill-effects associated with poor growth patterns and stunting (Martorell 1989; Pelletier 1994) the sample of children from the nomadic Ariaal community of Lewogoso can be considered far better adapted to their environment than children from sedentary communities.

What factors account for the large, consistent growth differences between children from nomadic and sedentary communities? Our analyses revealed that inter-community differences arise primarily from dietary change, with milk remaining a central staple of the nomadic diet. For sedentary communities children's milk intake decreased dramatically, replaced largely by grains (See Figure 5). These results are understandable, given that the nomadic community of Lewogoso live and moves with their livestock,

while livestock owned by sedentary village residents are often herded far away in order to take advantage of seasonally fluctuating, locally distributed water and vegetation.

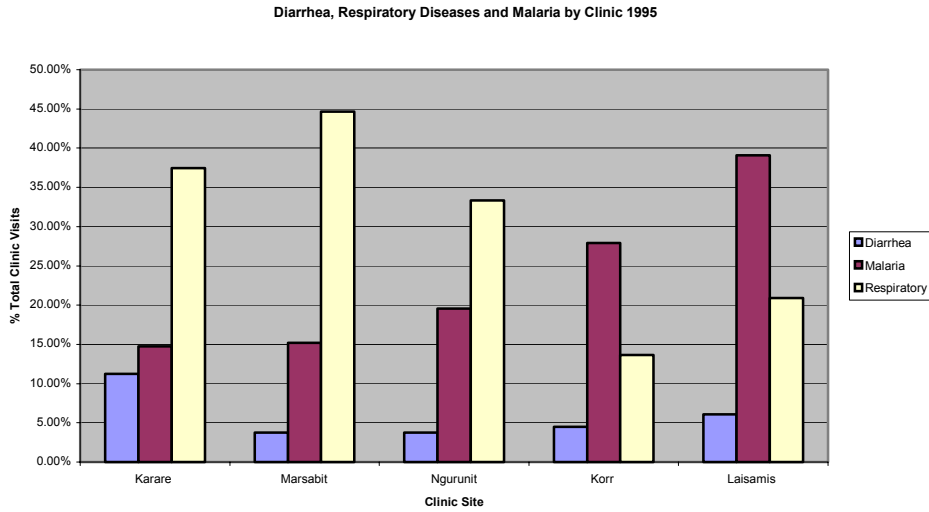
**Figure 5. Daily cups of milk over study period, pastoral versus sedentary samples, means and standard errors of the means**



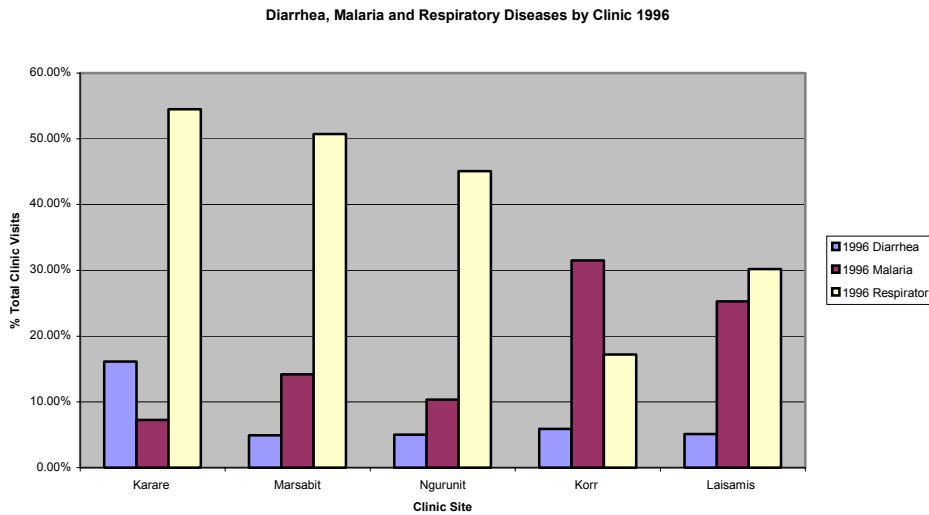
5b. Childhood Morbidity. As mentioned above, we looked at morbidity in two ways. Monthly clinic records for 3 years of the study were obtained from 4 clinics (Karare, Songa, Korr Ngrunit) and 2 hospitals, Marsabit and Laisamis. Secondly, we recorded monthly recalls by mothers of illness days of their children in diarrhea, fever, and colds. The clinic and hospital records show that diarrhea visit rates were relatively low compared to visits for respiratory and malarial illnesses in all areas, with the exception of diarrhea diagnoses in the highland community of Karare, the percent of total clinic visits were approximately twice as high as for any of the other clinics. (Figures 6 and 7).



**Figure 6. Diarrhea, Respiratory Diseases and Malaria by Clinic 1995 (normal year)**



**Figure 7. Diarrhea, Respiratory Diseases and Malaria by Clinic 1996 (drought year)**

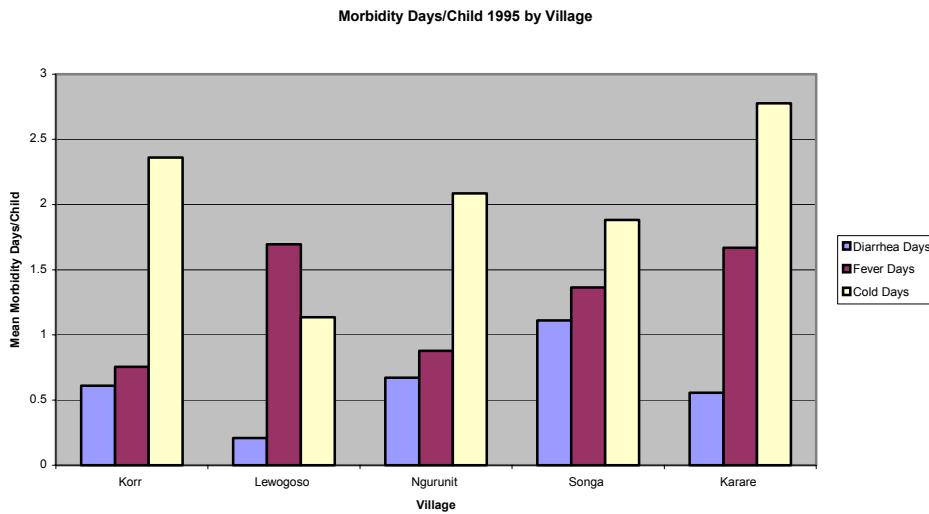


For malaria and respiratory disease, however, there is a marked difference between the highland clinics and the dry lowlands. Visits for malaria in the dry lowlands were approximately twice as common per clinic volume as in the highlands for both the normal and dry years. Conversely, visits for respiratory disease in the highlands were more than twice as frequent/clinic volume as for the dry lowland clinics in both 1995 and 1996.

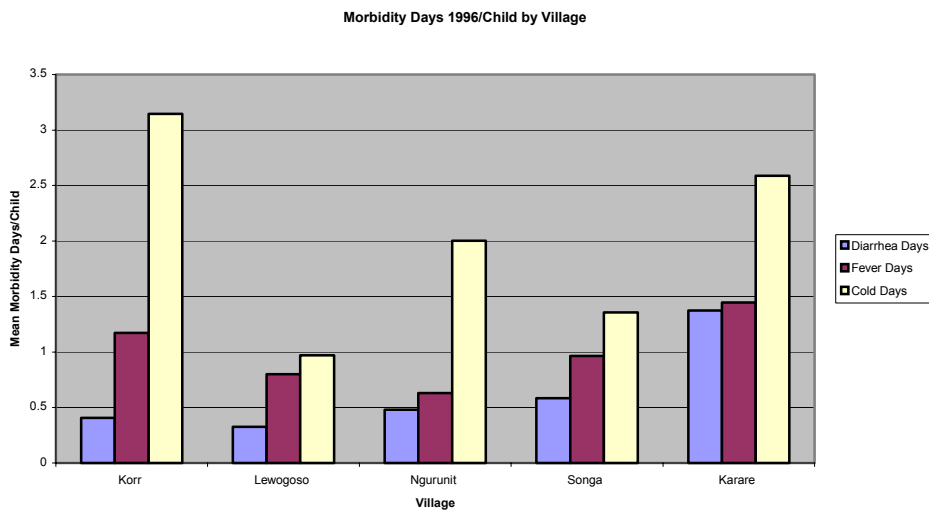
Korr and Laisamis each had a higher percentage of visits for malaria than either Marsabit or Karare, and each dry lowland clinic had a lower percentage of visits for respiratory disease than the highland clinics in both years. Further, malaria decreased in incidence in all sites in the dry year, 1996 vs. 1995. This effect was least noticeable in the large Marsabit clinic, but still was evident. Respiratory disease visits unexpectedly increased in frequency in the drought year in all the clinics.

Mother's reports of child illness days per previous month for each of six interviews/year were combined for each village and the mean symptom-days/child/month was plotted for each village for 1995 and 1996, respectively in Figures 8 and 9. These showed markedly fewer days of diarrhea and colds/month/child for children in the nomadic community of Lewogoso than any of the four sedentary villages in both 1995 and 1996. Korr, the other lowland sample, had lower rates of diarrhea/child/month than did the highland towns of Songa and Karare, but had a higher incidence of cold days/child/month than any of the other towns in 1996 and the second highest of all the towns in the normal year 1995. Thus respiratory illness incidence for children did not seem to fit the highland: dry lowland dichotomy established by the clinic data where the highland clinics treated a higher ratio of respiratory diseases/clinic volume than did the dry lowlands clinics.

**Figure 8. Morbidity Days/Child 1995 by Village (normal year)**

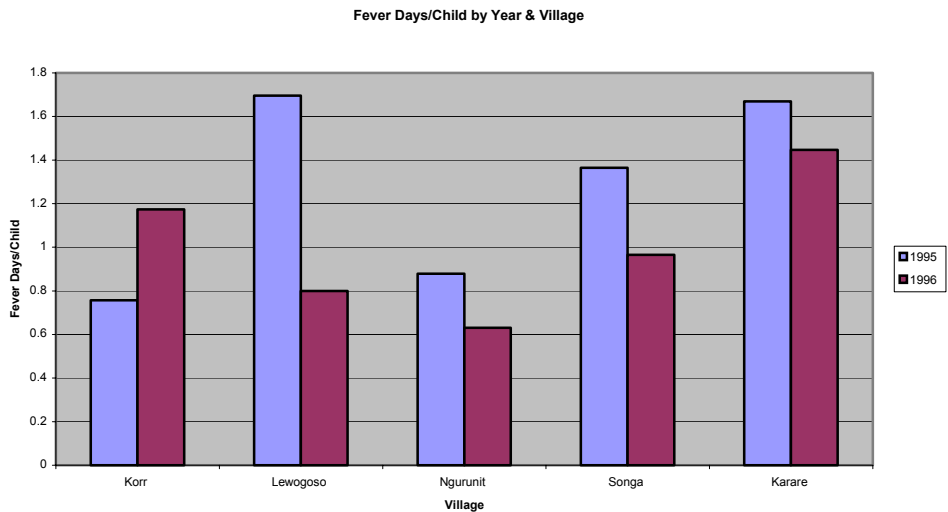


**Figure 9. Morbidity Days/Child 1996 by Village (drought year)**



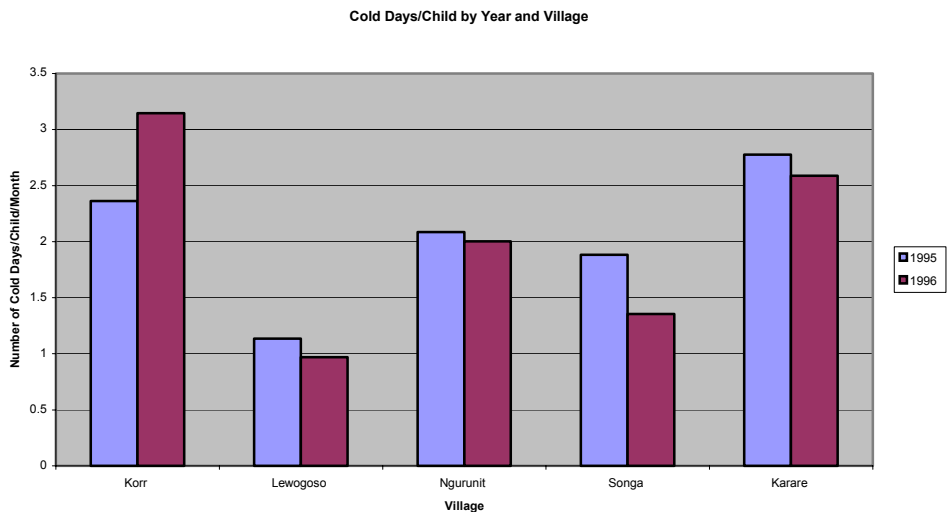
Fever days/child/month, which include illness from malaria but certainly not exclusively, were highest in Lewogoso in 1995 and lowest in Korr of all the communities. In Lewogoso in the normal rainfall year of 1995, there were more fever days/child/month than cold days/child/month, the only village and year in which this pattern occurred. Fever days/child/month appeared to decrease overall in the dry year, except in Korr, the lowland town, where they increased slightly as shown in Figure 10.

**Figure 10. Fever Days/Child by Year and Village**



Interestingly, cold days decreased in every village but Korr in the drought year as seen in Figure 12. Ngurunit's child morbidity pattern was very similar to Korr's: high rates of respiratory disease, low rates of diarrhea relative to the highland towns and low rates of fever relative to the highland towns and Lewogoso.

**Figure 11. Cold Days/Child by Year and Village**



Our analysis of the data on the incidence of respiratory diseases, fevers, and diarrhea among settled and nomadic Rendille children in Marsabit district revealed that

nomadic pastoralist children suffered significantly less morbidity from diarrhea and respiratory disease than did children from the settled towns. They endured statistically higher numbers of days of fever than did the settled children in the year of normal rainfall, but not in the dry year. Settled children from the other dry lowland town also suffered less diarrheal disease than did children of the highland town, but differed from the nomadic children in that their mothers reported more days of respiratory illness than did the mothers of the settled children in the highlands. Except for the children of Korr, who endured more days of respiratory illness in the drought year, children in all the villages suffered less malaria and respiratory disease in the drought year.

These findings are compared to clinic data that displayed a marked highland: dry lowland dichotomy. Respiratory illnesses constituted the plurality of diagnoses for highland clinics, whereas malaria diagnoses outweighed respiratory in dry lowland clinics for both years with the exception of Laisamis in the drought year. Clinic data showed that respiratory illness increased in the drought year, whereas fever days decreased in highlands, dry lowlands and Ngrunit.

The statistically highly significantly lower rates of diarrhea and respiratory diseases for the nomadic children were unexpected. These families live long distances from clinics and lack clean water supply and access by mothers to education. The lower number of diarrhea days and cold days held in normal and drought years.

Child morbidity did not fully mirror the clinic findings on the effect of drought. Drought years bring great suffering but less fever and malaria, with the only exceptions the incidence of fever in Korr and diarrhea in Karare each of which increased in 1996. However, in the general population clinic data, respiratory illnesses increased in the

drought year, but for the children in all the villages but Korr, the number of cold days increased. Again, it is clear that adult disease patterns cannot necessarily be generalized to children.

It is of particular interest that nomadic Lewogoso children suffered the least number of diarrhea days in each year of any of the communities. The nomads have the most tenuous access to water – walking long distances to fetch it from Ngrunit in the dry season and relying on rain catchments in the rainy season. They also have no formal sanitation system, simply walking outside the village to relieve themselves.

All of the other settled communities have piped water, although the purity of that water is by no means assured. The community whose water, though accessible, is most apt to be contaminated is Karare, where cattle have access to the water source at Gof Bongole crater, and where, in the latter part of the drought year there appears to have been an epidemic of diarrhea affecting the children in our study and clinic patients.

Thus simple access to water may not be key to health for Rendille children. Key is access to *clean* water, which may not be the case when nomads settle.

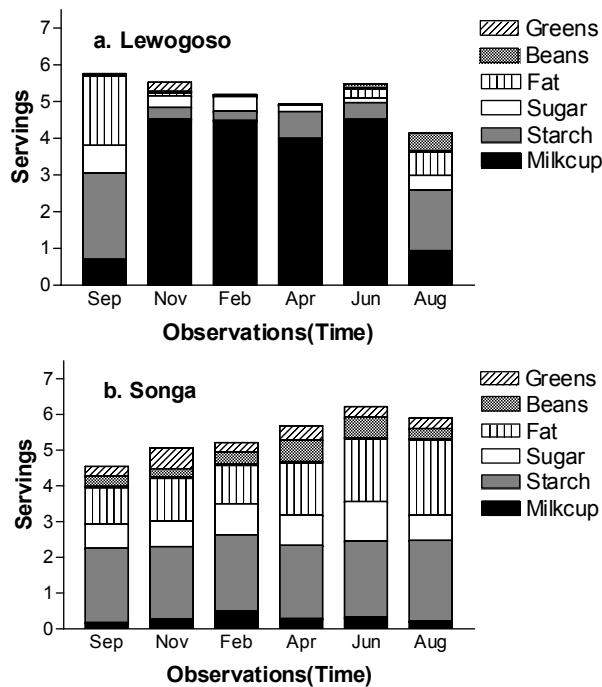
The other unknown variable in this study is the prevalence of HIV. Diagnosis of HIV was not recorded in clinic records during the period of our study, but was acknowledged with increasing frequency in the District (Roth et al. 2001). Its impact is simply unknown, but can be presumed to affect the settled communities more than the more isolated nomads. HIV infection can be represented by any of the forms of morbidity we studied: diarrhea, respiratory disease or fever.

5c. Women's Nutrition. In a comparison of our data from mothers in lowland nomadic Lewogoso and highland agricultural Songa, Fujita et al. (2004) showed significant differences in the anthropometrics (weight, triceps skin folds (TSF) and mid-arm

circumferences (MAC)) that were affected by location, diet, seasonality, and wealth differences. During each bimonthly survey visit, each mother was asked to name foods they consumed the previous day. Furthermore, families were assigned to one of the three economic strata – poor, middle, and rich – based upon the composite measure of household wealth, livestock holdings, wage income, remittances, and household expenditures.

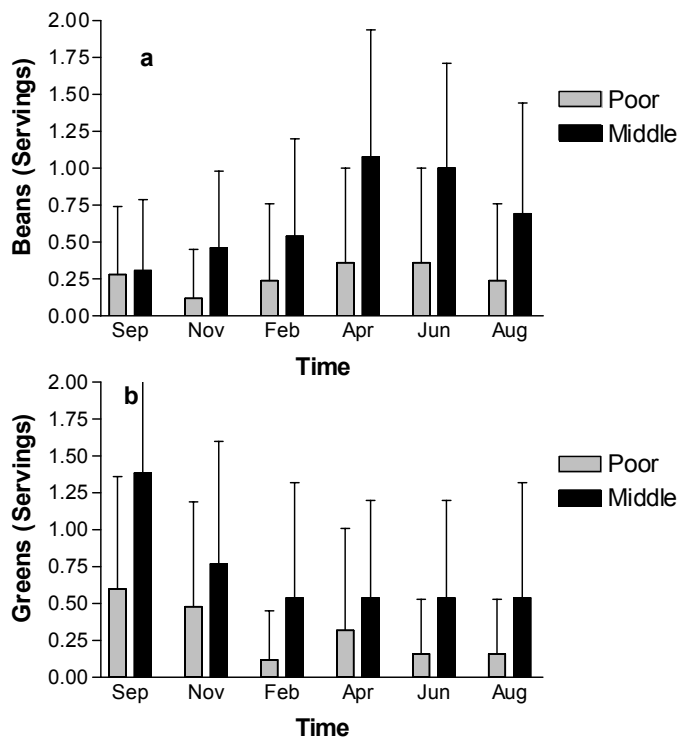
Mothers in Songa mostly consumed high-calorie and low-protein foods: maize meal, sugar, and fat. Throughout the year, these three items occupied the overwhelming majority of mothers’ diet. Contributions from milk, beans, and greens were persistently minor. Dietary composition in Songa remained stable, unlike Lewogoso. In this regard, dietary seasonality is considerably reduced in Songa. (See Figure 12).

**Figure 12. Dietary variety in pastoral Lewogoso and agricultural Songa, 1994-1995**



In contrast to nomadic Lewogoso, diet in Songa was influenced by economic status. Two food items – beans and greens – were significantly differentiated by mothers’ economic status, with poorer women consistently eating posho meal without access to beans or greens, important sources of protein and iron (see Figure 13)

**Figure 13. Bean and greens intake by economic status in agricultural Songa 1994-1995**





In all, the women of nomadic Lewogoso showed better nutritional indices with little or no differentiation based on economic status. We attribute the lower nutritional indices in Songa as due to poorer diets, greater work load, and the decline or absence of “moral economy” of food sharing which is found in the kinship based nomadic groups in the lowlands.

## **6. Summary and Discussion**

Our study of longitudinal growth and morbidity data collected over a three-year period reveal far poorer growth patterns in a sample of children from four sedentary Rendille and Ariaal communities, relative to same-aged children from the nomadic Ariaal community of Lewogoso. Analysis of dietary and morbidity patterns in both communities shed possible light on the underlying causes for the large differences. As in our previous cross-sectional studies (cf. Nathan et al. 1996; Fratkin et al. 1999) the nomadic group’s diet featured significantly more milk consumption throughout the entire study period. This finding is hardly surprising since nomadic communities are always with their animals, while sedentary communities often are separated from their herds.

Our analysis of childhood morbidity revealed significant differences between the sedentary and nomadic samples. Our analysis of two-year data collection on the incidence of respiratory diseases, fevers, and diarrhea among settled and nomadic Rendille children in Marsabit district revealed that nomadic pastoralist children suffered significantly less morbidity from diarrhea and respiratory disease than did children from the settled towns. They endured statistically higher numbers of days of fever than did the settled children in the year of normal rainfall, but not in the dry year. Settled children from the other dry lowland town also suffered less diarrheal disease than did children of the highland town, but differed from the nomadic children in that their mothers reported more days of respiratory illness than did the mothers of the settled children in the highlands. Except for the children of Korr, who endured more days of respiratory illness in the drought year, children in all the villages suffered less malaria and respiratory disease in the drought year.

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Together these results support our initial hypothesis that child nutrition and morbidity would worsen in the transition to sedentism for formerly nomadic Rendille and Ariaal pastoralists. In addition to this specific example of the long-recognized nutrition-infection synergistic effect on child growth, we also found socio-economic variables, in the form of household wealth differentiation, exacerbating levels of childhood malnutrition. These consistent findings point to maladaptive biological consequences of sedentism for children in Rendille and Ariaal populations.

Our analysis of women's nutrition also showed strong differences between nomadic pastoral and settled agricultural Rendille, with pastoral women obtaining more nutrients, particularly milk protein, than highland farmers. As with children, the most striking dietary change with sedentism for women was the reduction of milk intake which was taken over by plant foods. This has potentially negative consequences because milk is a major source of protein as well as micronutrients such as vitamin A (Nestel 1986; McLaren and Frigg 2001). Poor and lactating mothers were the hardest hit by the reduction of milk intake.

As the number of milk animals raised in the agricultural communities is small, a realistic solution for protein sources may be to improve the production and distribution of beans. Mixing maize and beans yields balanced amino acids roughly equivalent to animal

protein (Foster 1992). This would require however an increased production of beans for domestic use rather than for market sale.

As with previous studies, the policy implications of our findings are significant. Though pastoralism is not an option for all those in northern Kenya, the decrease in diarrheal and respiratory illness for pastoralist children is important for those policy-makers interested in decreasing child mortality and morbidity for African children, particularly those involved in settling of traditional nomads. According to our findings, the consequences of settling for the health and nutrition of pastoralist children may be negative ones.

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