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Mobility, Animal Source Foods and Micronutrient Needs Among African Pastoralists

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Abstract

Many mobile pastoral populations depend on livestock to provide animal source foods (ASF: meat, blood and animal fat, milk and milk products) for direct consumption or sale for income. Relative to other foods, ASF contain high levels of bioavailable micronutrients such as iron, zinc, iodine and vitamin A, and ASF consumption in moderate amounts has been shown to promote healthy physical and cognitive development and child survival. Nutrition scientists and policy makers have therefore suggested that ASF are a potentially efficient, effective, and sustainable means to reduce major nutrient deficiencies at community and national level. Historically marginal to global economic development discourse, mobile pastoralist populations have become a recent focus of attention as key producers of ASF at the local, regional, national and global level. This paper briefly examines selected data on ASF consumption, micronutrient deficiency, household food insecurity and under-nutrition among mobile pastoralists in sub-Saharan Africa and identifies key challenges for micronutrient needs assessment and nutrition programming to boost ASF production and consumption among mobile African pastoralists.

Key words: hunger; pastoralism; micronutrients; Africa; nomads
Introduction

Many traditionally mobile populations continue to depend on production of various livestock species such as cattle, sheep, goats, camels, yak, horses and donkeys to provide animal source foods (ASF: meat, blood and animal fat, milk and milk products) that can be sold for income or directly consumed (Randolph et al. 2007). Such livestock-dependent “pastoralists” use mobility to manage uncertainty and risk (Schelling et al. 2005a), and generally move with their herds in response to animal needs, seasonal changes in habitat, socio-political arrangements for land use and access, and violent conflict. Mobile pastoralists typically inhabit areas unsuitable for agriculture and industry, such as high altitude, high latitude (Zinsstag, et al. 2006) and/or arid and semi-arid ecosystems, which are often far from major centres of high population density and infrastructural investment (Munch et al. 2007; Weibel et al. 2008). Migratory movements represent a complex response to a mix of abiotic, biotic and human social factors, including conflict (Dyson-Hudson and Smith 1978, Gray et al. 2003).

Mobility often improves human health as part of a suite of pastoralist adaptations that are continually responding to new opportunities and challenges (Ekpo et al. 2008; Fratkin et al. 1999; Fratkin et al. 2004; McCabe 1994; Nathan et al. 1996; Schelling et al. 2005b), but it also imposes constraints on the determinants of human health and well-being (Hampshire 2002; Mocellin and Foggin 2008; Pike et al. 2010), such as challenges to effective public health surveillance and intervention (Bonfoh et al. 2007; Tanner and Zinsstag 2009; Weibel et al. 2008; Wyss, et al. 2003; Zinsstag et al. 2009). Concerns raised about human health and well-being among mobile pastoralists include an apparently high prevalence of micronutrient malnutrition, or “hidden hunger” as it is termed in advocacy and policy development, and the issue of how to better measure and address it. However, the specific ways in which pastoralist mobility improves or undermines micronutrient consumption remain poorly investigated. This brief paper represents an attempt to map out some of the knowledge gaps that must be closed if we are to better understand the relationship between hidden hunger and mobility among pastoralists.

Hidden hunger

Anthropologists, nutritional scientists and development specialists currently distinguish the “hidden hunger” of micronutrient malnutrition from the hunger that comes from a lack of food. It has been defined as “a chronic lack of vitamins and minerals that often has no visible warning signs, so that people
who suffer from it may not even be aware of it” (The Micronutrient Initiative 2010). Nevertheless, such micronutrient deficiency or hidden hunger can lead to early death or significant deficits across the lifespan that may include mental impairment, physical illness and poor productivity. Global estimates are that one in three people suffer from hidden hunger and that women and children from lower income groups in developing countries are the most affected. Recently, health economists have begun to quantify the large impact of hidden hunger using econometrics.

Animal Source Foods

Animal source foods (ASF) contain high levels of bioavailable micronutrients such as iron, zinc, iodine, and vitamins A and B12. These key micronutrients play an important physiological role in fetal, infant and child growth, cognitive development and health (Neumann et al. 2002). ASF consumption in moderate amounts has been shown to promote healthy physical and cognitive development and child survival (Allen 2003, Murphy and Allen 2003). For people of all ages, ASF have the potential to improve diet quality through increased availability of high-quality protein, energy, minerals, trace metals, and vitamins necessary to meet requirements (Allen 2003). Various lines of evidence suggest that meat-eating has been important throughout human evolution (Larsen 2003, Milton 2003), and that non-human milk has been consumed since the earliest domestication of bovines and ovicaprids (Dudd and Evershed 1998). A consensus has recently emerged among community nutritionists that ASF, consumed in moderate amounts and especially by women, infants and young children, may be essential for optimal health.

Within the last decade policy makers have suggested that ASF are “an effective, efficient and sustainable means to remove the major nutrient deficiencies experienced by populations today” (Demment et al. 1998; Brown 2003). Pastoral populations have also become a focus of attention as key producers of ASF at the household, local, national and global level (Demment et al. 2003, Randolph et al. 2007). However, there has been remarkably little work done on the extent to which members of mobile pastoral populations are able to meet their own micronutrient requirements and avoid hidden hunger by consumption of ASF. A conceptual consideration in the absence of data might lead to opposite predictions. On one hand, one might assume pastoralist producers have easy access to adequate intakes of micronutrients from ASF. On the other hand, micronutrient deficiencies are likely to be prevalent in most pastoral populations because they are rural, poor, under-educated, nomadic and dependent on organisation of production at the level of the household for local markets.
Progress on understanding the implications of mobility for micronutrient status is important for nutrition programming among mobile pastoralist populations.

Potential links with mobility

Both the diet of pastoralists, and also any longitudinal nutrition research and data analysis, are complicated by unstable residence. This mobility may have seasonal dimensions. However, it is also linked to transhumance on a weekly or daily basis to fulfill human and livestock needs, residence changes linked to the social dynamics of the life course of individuals and the developmental cycle of households, to conflict, and finally to failures in the food system or the environmental services on which livelihoods depend, for example through climate change.

This point is exemplified by a study conducted in a small community of east African pastoralists, the semi-nomadic Datoga who live in the Eyasi Basin of western Tanzania (Sellen 1995). Table 1 summarizes the migratory movements recorded by repeated census at different times during a 3 1/2 year period of data collection between May, 1989 and December, 1992. In total, 124 households (containing the families of 135 men) were visited during this time, of which 34 (25%) migrated into the area after the study began. Fifty-one percent of the households recruited into the study at some point migrated out of the area before the study ended and were lost to follow-up. An additional 14 households (11.3%) were observed to move out, and then return to the study site at a later date. The study area as a whole experienced a net loss of households in every year, averaging 6 per year (approx. 7%), and over the entire period household emigration was 50% more frequent than immigration. Datoga informants state that the population density in the Eyasi area was increased between the 1960s and the early 1990’s by an influx of Datoga families avoiding interethnic conflicts to the south (such as the violent Sukuma wars of the mid 1980s) or a fear of cattle raiding to the north and west, other Datoga displaced from their original pastures by large-scale agricultural development projects (such as the Hanang wheat project), and also by a reported the influx of shifting cultivators from other parts of Tanzania. The environment appears to have become degraded and would not normally be viewed as an ideal site for settlement in the absence of these other pressures.
Table 1. Stability of residence within four seasonal settlement areas used by a community of Datoga pastoralists in Tanzania.

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TOTAL | 90 (98) | 71 (84) | 70 (84) |

**Cumulative emigration**

-7 (-19) -35 (-40) -48 (-60) -51 (-63)

**Cumulative immigration**

+7 (+7) +17 (+18) +31 (+33) +34 (+37)

*includes 2 households that left and then returned during this time

**Not included in totals since added to the study area at a late stage
Public health nutrition situation among mobile African pastoralists

Anthropologists have identified some key features of African pastoral diets, using fairly consistent definitions of pastoralism (Galvin 1992, Little 2002, Sellen 1996, Galvin et al. 1994, Sadler et al. 2010). In the last 15 years, there have been a number of excellent reviews of the limited information on the public health nutrition situation among mobile pastoralists in the “grey literature” on pastoralist development (e.g. Blench 2001; see also sources listed at: http://www.eldis.org/go/topics/resource-guides/agriculture/pastoralism; http://www.ids.ac.uk/go/livestock-research). Although the diversity of contemporary pastoral systems limits the value of general conclusions, a short review of the nutrition situation in pastoralist populations reveals some key gaps in information.

Anthropometric indicators

There are virtually no studies of direct links between mobility and diet among pastoralists, so we must instead look at anthropometric indicators. Figure 1 compares body sizes for men and women in seven populations for whom we have good estimates of the mean and distribution of heights and weights. There are almost no good data available in English from beyond Africa. (A recent study among the Evenki of Siberia shows they are short compared to westerners and African pastoralists, but that energy balance is more adequate [Leonard et al. 2002, Leonard et al. 1994]). While much has been made of the tallness of pastoralists, particularly Africans, the available data suggest that their stature falls within the range of well-fed westerners or is less. What is more striking is that men and women in all African pastoralist populations for which there are data fall on the line relating body weight to stature that indicates a body mass index of 18.5. This is in fact the cutoff value below which we currently define moderate chronic energy deficiency (Shetty and James 1994).

Taken together, these data indicate that the average surviving adult in many of these mobile populations has a marginally adequate energy flux, but that this cannot be directly attributable to mobile diets. The distribution around this low mean suggest many individuals are leaner than is healthy. For example, in a study conducted among Eyasi Datoga women in Tanzania, almost half were indicated to be chronically energy deficient (BMI <18.5) and were estimated to have very low fat stores (Sellen 2000a). Other data reveal a complex pattern of vulnerability by age and sex among children from mobile pastoralist populations; children's anthropometric status appears to be associated with the age- and gender-specific pattern of work activities typical of many pastoral populations.
Figure 1. Anthropometric indicators of nutritional status of adults living in selected, ethnographically studied pastoralist communities and a representative sample from an industrial society (African Americans, 1990).


For example, among the Eyasi Datoga, the prevalence of low anthropometric status of children also typically ranges between 25-50% (Sellen 2000a), a range typical for African pastoralists (Sellen 1996). However these aggregate data mask gendered disparities in the association of indicators of under-nutrition with child age. Results of a gender analysis suggest that younger girls (who must help with arduous household chores such as water-bearing) and older boys (who spend long days away from homes and meals while herding) are vulnerable. More than 40% of girls aged between 9 and 12 presented with stunting and/or wasting, a greater rate than at any other age for girls and more than twice the rate among boys of similar age (Sellen 2000b). A working hypothesis is that this may be attributable to an increased caloric deficit in relation to requirement associated
with the physical workload of water and firewood collection, which can increase with mobility linked to pasture selection. In addition, the highest rates of stunting and wasting for any group of children, exceeding 70% and 50% respectively, are observed among boys aged between 13 and 16 years (Sellen 2000b). A working hypothesis is that this may be attributable to an increased caloric deficit in relation to requirement associated with the physical workload of herding livestock each day, which requires walking and running large distances and also missing meals prepared at the homestead. If this is true, it may mediate a relationship between mobile life ways and delayed pubertal development and achievement of adult stature among males in African pastoralist societies (Sellen 1999).

In fact, very few studies actually look at diet or nutritional status in relation to age, gender, and wealth among pastoral populations, despite a valuable and growing number of studies of gendered livelihoods (Brockington 2001, Brunson et al. 2009, Dancause et al. 2010). Indications are that the quality of the diet varies across the lifespan of individuals (Gray et al. 2008), and on the basis of observations in non-pastoral populations it is reasonable to assume that women, young children and the elderly are particularly vulnerable to under-nutrition.

Indicators of micronutrient deficiencies

Studies of micronutrient consumption are rare, despite the knowledge that carbohydrate staple foods such as maize are low in certain nutrients (particularly iron and vitamins A and C). Studies of dietary diversity are usually conducted with tools developed for use in agrarian populations and focus on capturing information on fruit and vegetables as primary sources of micronutrients in the diet. Such tools may not accurately capture the full diversity of the diet, particularly any consumption of wild animal and vegetable foods and also blood from larger livestock (Teklehaymanot and Giday 2010). Only a handful of studies provide estimates of the prevalence of specific micronutrient deficiencies based on biochemical assay or clinical symptoms, and micronutrients such as zinc for which there is no easy assay are largely ignored in the literature. Cow’s milk is usually found to be the main source of vitamin A, vitamin C and riboflavin and a few studies have examined the retention of micronutrients in milk and meat products prepared and stored in rural settings (Amr 1990, Holter 1988). Although several studies, principally in sub-Saharan Africa, suggest protein intakes do not limit growth and functional capacity, we are not yet in a position to say this about micronutrients. Prevalence of anaemia and deficiencies of iron, zinc, vitamin A, riboflavin and other micronutrients are unknown for most pastoralist populations. We also lack data on birth weights and gestation length with which to assess fetal nutrition (Pike 2000).
Production and consumption of ASF

It is often assumed that increasing livestock production results in increased availability and consumption of ASF at household, regional and national levels of analysis. The data on this relationship are equivocal, however. Significant gaps remain in our understanding of: the adequacy of pastoralist diets, the extent to which ASF improve the nutrition situation among pastoral populations and their partners in trade and exchange, the extent to which pastoral households consume the products of their labor or use cash incomes generated by livestock sales to purchase higher quality diets.

There is wide variation in ASF consumption among pastoralist populations worldwide. For example, Casimir (1991) summarized data from a survey of 56 pastoral populations. This comparison suggested that east and southern African pastoralists tend to consume fewer ASF as a proportion of total diet than pastoralists living in Eurasia at generally higher latitudes and altitudes, but also that ASF consumption exceeds 50% of total diet by caloric estimates. There is also variation within regions. For example, for a small sample of just nine African pastoralist populations for whom sufficient data exist it has been estimated that the annual per capita dietary contribution of ASFs varies between 20% and 80% (Galvin et al. 1994). This variation is associated with mobility as a response to seasonality as well as climate change, and reflects the diversity of pastoral systems owing to a complex mix of factors, including climate, ecology, history and political economy.

Production and consumption of meat

Among east and southern African pastoralists, meat is normally eaten during social celebrations such as marriages, funerals, and the births of children; when an animal has died, is dying or deemed incurably sick; or during severe food shortages as a disaster food. This is clearly linked to mobility, since livestock represent a sustainable, renewable and moveable source of milk for continued consumption and sale of meat for cash that can be used to purchase a higher number of calories from grains. Small stock such as goats and sheep are most usually consumed during social events, both because of their faster reproductive cycle and lesser unit value, but also because larger animals would produce a glut of meat that could not be easily transported or stored before spoilage. Indeed, large animals such as cattle and camels are usually only consumed at a feast to which a very large social network is invited and attend, such as funerals of very widely known and respected persons. Meat has high social and economic value and when it is consumed it is more likely to be shared beyond the family or household unit. This is important because such social events where meat is
shared for consumption afford the poorest households that may not have the resources to consume their own small stock opportunities to consume a fat- and micronutrient dense food source that is normally unavailable.

In sum, the data are few but indicate that among mobile African pastoralists meat consumption is infrequent even in wealthier households, and the total contribution to the diet remains modest in caloric terms (Sellen 2003). Nevertheless, the importance of meat as a source of micronutrients is potentially high and more studies of meat consumption by age and gender, and of the contribution of meat to micronutrient requirements, are needed.

Production and consumption of milk

Although few long-term observational studies of animal milk consumption are available, it is a core component of pastoralist diets world-wide and milk is the preferred ASF in virtually all pastoral populations (Sadler et al. 2010). Milk is a nutrient-rich food that is thought to contribute a high proportion of nutrients required by pastoralist people of all ages, but particularly children and women (Hetzel et al. 2004; Sadler et al. 2009; Schelling and Zinsstag 2002). Animal milk can be a major source of energy, vitamin A, fats, and proteins, but pastoralist areas tend to have high rates of indicators of deficiencies in these nutrients, suggesting challenges in supply to meet adequate needs (Wolde-Gebriel et al. 1991). It is widely processed into a bewildering array of dairy products whose storage potential varies greatly (Blench 2001). The relative amounts of fresh versus stored dairy products consumed may be linked to mobility and the use of pack animals (i.e. more mobility and/or fewer pack animals, less storage) but this hypothesis remains untested.

Milk is also widely used to feed infants and young children (Gray 1998, Gray et al. 2008, Gray 1996, Sellen 1998, Sellen 2001), although it is not clear that this results in earlier weaning of children in mobile societies versus others (Sellen et al. 2000). A recent participatory study among pastoralists in the Somali region of Ethiopia found that average consumption of animal milk by children aged 1-2 years was more than sufficient to satisfy estimated energy and protein needs, and that participants perceived direct and important associations between milk intake and weight gain or loss among young children.

Effects of seasonality

D. Sellen
The quality of milk produced and the quantity of milk consumed vary seasonally in all mobile pastoralists studied, as do the patterns of festivals and animal deaths that might influence meat supply. Since milk is the largest contributor to the high ASF consumption of mobile African pastoralists, the seasonal fluctuation in milk supply and consumption may be linked to mobility. On the one hand, mobility should facilitate the “smoothing” of milk production across seasons as herds are moved to areas with optimal forage, including areas “set-aside” for dry season grazing through customary land-use practices. On the other hand, seasonality and rainfall stochasticity in arid and semi-arid lands (ASAL) may overwhelm the adaptive limits of mobile African pastoralist food systems.

**Figure 2.** Estimated individual energy intakes for selected African pastoralists.


The indications are that, although chronic energy deficiency and seasonal shortfalls in micronutrient intakes are common, mobile African pastoralists are highly effective at coping with seasonal food shortage. For example, among the
Eyasi Datoga, extended dry season conditions are associated with only marginal drops in adiposity of women and children even though many individuals are in poor physical nutritional status (Sellen 2000b). A comparison across African pastoralist populations suggests adults lose only about 5% of body weight and the prevalence of underweight among children, though already high, does not increase significantly (Sellen 1996). It is important to note that seasonal weight losses are much greater among agricultural populations in Africa and that moderate weight fluctuations are not a known risk factor for poor health among well-nourished populations.

Few studies have examined individual differences in total energy intakes, and all were conducted in the 1980s on African pastoralists (Bénéfice, et al. 1984, Bernus 1988, Galvin 1992, Little, Galvin and Leslie 1988, Nestel 1985, Nestel 1986). It is apparent that population estimates differ quite markedly, and the pattern of seasonal differences in intake depends on the specific ecology (Figure 2). Even when reasonably good individual consumption data are available it is difficult to estimate the adequacy of energy intake. Such data exist for only two populations, both from Africa (Bénéfice, Chevassus-Agnes and Barral 1984, Bernus 1988, Galvin 1992, Little, Galvin and Leslie 1988). Taken together, they suggest that energy intakes do not meet requirements for good health and adequate function, even when averaged across the year (Figure 3).

The effects of seasonal flux in food intake and energy expenditure can be powerful, however. Among the Datoga, the impact of dry season conditions on mothers is exacerbated during lactation (Sellen 2000), highlighting the importance of nutrition at key points in the life cycle and across generations (Little et al. 1992). Indirect data from all other populations studied show lower dietary contributions from milk in some seasons versus others--the “drier” seasons in the case of tropical Africa. A recent study among mobile pastoralists in two areas of Somali Region, Ethiopia, found that on average the amount of animal milk fed to children between 1 and 2 years of age was sufficient to meet requirements for both energy and protein (Sadler and Catley 2010).

Nevertheless, seasonality exerted a strong effect on milk supply and intakes by young children varied by more than three-fold across seasons even in a “normal” year, reducing intakes by 70% among 1 year olds. In drought years, dry season intakes diminished to zero for many young children. Qualitative investigations revealed that adult participants perceived a “direct and important association
between reduced [animal] milk intake and weight loss among their young children. Several studies have suggested that household labour stress, women’s work patterns, and kin cooperation strongly affect infant feeding practices among mobile Africa pastoralists (Gray 1998, Sellen 2001), and that all of these can be influenced by season (Sellen 2001). A few reports suggest pastoral diets are seasonally deficient in iron and generally deficient in calcium, vitamin A and ascorbic acid. Nevertheless, mobility appears to be protective against large seasonal variation in nutrient intakes, including micronutrients.

**Settlement**

In contrast to the rather weak effects of seasonality, several studies on settlement have suggested that there are protective effects of mobility on pastoralist diets. Settlement is associated with a decrease in dietary diversity, an increase in seasonal differences in food intake and a decrease in indicators of both adult and children’s nutritional status (Little, et al. 1993, Nathan, Fratkin and Roth 1996, Shell-Duncan and Obiero 2000). Indeed, settlement of pastoralist families has...
been associated with poorer nutritional status of children than that observed among settled agrarian families (Peterson and Benjaminsen 2008).

Settlement involves complex changes in a number of factors influencing nutritional status, and therefore it is difficult to tease apart in analysis the independent influence on diet alone. For example, disease types, prevalence and seasonal distribution will change but few studies are able to separate out the independent and synergistic effects of parasitic and other infectious disease on nutritional status (Alemu and Lindtjorn 1995, Lindtjørn et al. 1992). Most families that settle are “drop-outs” from mobile pastoralist ways of life; they may have been forced to settle through catastrophic or chronic livestock losses and often become dependent on food assistance. Nevertheless, within mobile pastoralist groups a range of wealth measured in terms of holdings is usually observed. It is logical to hypothesise that relative poverty is a strong risk factor for micronutrient deficiency, but the data are sparse and indirect. Several studies have indicated that food intakes and physical nutritional status rarely increase with household wealth in livestock-keeping communities (Fratkin et al. 1999, Grandin 1988, Homewood and Rodgers 1991, McCabe et al. 1989, Nathan et al. 1996, Shell-Duncan and Obiero 2000). Most studies show little or no effect, possibly because households relatively poorer in livestock diversify their livelihoods (Brockington 2001) or because wealthier households share food widely beyond the household or have not always been wealthy (Sellen 2003). Data from a study among the Datoga pastoralist of Tanzania revealed that, although 95% of households studied fell below poverty cut-offs, a 20-fold variation in wealth remained across households and the proportion of stunted and wasted children was lower in wealthier households (Figure 4).

Practical challenges of mobility

It has long been recognized that nomadism presents significant challenges to both research design and provision of services (Swift et al. 1990). The mobility of many African pastoralists presents a set of specific practical challenges of assessment of hidden hunger and micronutrient needs that must be overcome in order to design programmes with the potential to meet the micronutrient needs of vulnerable groups.
The first challenge is a continuing severe paucity of detailed dietary and micronutrient status data despite many agricultural, livestock and other development projects that engage mobile pastoralists. This is connected in part to a historical weakness in linking agricultural and livelihood assessments and interventions with nutrition outcomes and interventions. Few studies have estimated nutritional status among pastoral peoples. Reports on dietary intake probably exist for no more than 50 communities. Although some extremely detailed studies exist, notably among groups of Turkana, Borana and Maasai, investigators have conducted detailed studies of diet in only about 20 of the world’s pastoral populations. The entire literature is based on dietary, anthropometric, clinical or biochemical assessment of no more than about 5,000 individuals. Non-nutritionists conducted many studies more than 20 years ago on small samples. A majority of reports from Africa have been collected in famine situations.

Second, community-based studies almost always adopt a mixed cross-sectional rather than a prospective cohort design as a logistic response to high pastoral mobility. Sampling bias hampers interpretation of most cross-sectional surveys.
Sex- and age-biased recruitment can be difficult to avoid because of the gendered and age-structured organisation and spatial distribution of pastoralist subsistence work activities. Labile family, residential and community organisation and both daily and seasonal activities present significant logistical challenges to following up on all individuals. Small sample sizes (<30 per age/sex group) are usually achieved owing to a combination of the limitations of low population density and field logistics (Galvin and Little 1999).

Third, there is an acute paucity of directly comparable data. It is difficult to compare results between the few detailed studies that exist because methods for estimating intakes and adequacy of intakes vary enormously. Studies also deploy a wide variety of analytic strategies to deal with the challenge of averaging across seasons. Most studies measure only anthropometric status and tell us nothing about variation in individual micronutrient nutrient intakes. Energy intakes are almost always reported using grossly aggregated estimates. Methods used to calculate proportional contributions of dietary components (such as ASF or plants, fats, proteins and carbohydrates) are often imprecise or not clearly specified. Individual food and nutrient intakes are very difficult to measure because of the common practice of eating from a common pot, or usually a set of gendered and age-stratified shared pots. There is a strong tendency of individuals in pastoral societies to consume food in several different households.

Fourth, age and sex categories are often lumped in analysis. This limits the ability to identify vulnerable groups from a life course and gender perspective and can result in imprecise estimates for individuals. Almost all dietary surveys of pastoral populations are unable to discriminate individuals with consistently low intakes from those with intermittently low intakes and those with marginally adequate or adequate intakes. Age determination without birth records makes assessment of anthropometric status challenging. Wide disparities exist in the existing published literature in the population references and cutoffs used in dietary and anthropometric assessment (Sellen 1996). Methods of data collection for assessment of diet quality and analytic strategies for dealing with temporal variability are also widely discrepant. Indicators of poor growth or nutritional status cannot be directly attributed to poor diet because of confounding and effect modification by illness, levels of work activity and intergenerational effects. Comparison among more or less wealthy or economically secure individuals or groups within communities is often hampered by economic “drop-outs”, people who switch livelihood strategies in response to loss of livestock (Sellen 2003).
Summary and conclusions

It is not possible to assess the extent to which mobility protects pastoralists against hidden hunger, but preliminary indications are that it does. A selective review of some relevant published data suggests that a number of nutrition concerns are common to pastoral populations, micronutrient deficiencies may be prevalent in many of them, and the consumption of ASF may not be high and diminishes upon settlement and among impoverished sub-groups. Indicators of household food insecurity and poor individual growth or nutritional status are prevalent in many mobile pastoralist populations but cannot be directly attributed to micronutrient deficiency because of confounding and effect modification by illness, levels of work activity and intergenerational influences. Indeed, relatively little is known about the local, context-specific social and economic processes that likely condition ASF consumption by individuals in mobile households. We are woefully ignorant of micronutrient intakes and micronutrient status of individuals. Future studies should aim to avoid the problems of small sample size, sampling bias in cross-sectional survey, and augment measures of anthropometric status with estimates of individual intakes of micronutrient and ASF.

Despite a paucity of directly comparable data, however, a brief review of evidence for ASF consumption in pastoral populations and of the significant challenges for micronutrient needs assessment and nutrition programming allows for some general conclusions. Given what nutritionists and economists have learned about the importance of ASF in the last 15 years, renewed investigation of whether low consumption has negative impacts on health and well-being in pastoralist populations is warranted. Consumption of ASF is highly variable among African producers. Most pastoral diets are low in energy, as evidenced by high prevalence of chronic energy deficiency in adults and underweight in children, but adequate in protein. Nutrition is only weakly associated with household wealth, and more strongly associated with allocation of food and work within families. Relatively poorer households, women and young children can be assumed to be particularly vulnerable to under-nutrition, but studies suggest that women and children are efficiently buffered from seasonal deficiencies and that older children and boys can be vulnerable to under-nutrition because of the nature of their work. We are too ignorant of individual micronutrient intakes and micronutrient status in pastoral populations. The nomadism of many pastoralist populations presents special challenges for the design of studies to sample, assess or target individuals for nutrition programming, and for evaluation of the short- and long-term effects of nutrition interventions among pastoralists.
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