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Implications of Tanzanian Culture on Nutrition and their Effects in People Living with HIV/AIDS

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Implications of Tanzanian Culture on Nutrition
and their Effects in People Living with HIV/AIDS

An honors thesis presented to the
Department of Human Biology,
University at Albany, State University of New York
in partial fulfillment of the requirements
for graduation from The Honors College.

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Abstract

Many Africans living with HIV/AIDS also suffer from malnutrition. Together, HIV and malnutrition greatly compromise the immune system of an individual, with each condition increasing the effects of the other. This field study examines Maasai in the Arusha region of Tanzania where approximately 5.6% of the population is infected with HIV/AIDS and 45% of children exhibit stunted growth, indicating chronic malnutrition within the population. Cultural factors including gender inequality, knowledge levels, and traditions associated with Maasai (the predominant tribe in the Arusha region) were analyzed in their contributions to malnutrition and HIV. The study was conducted over three months in Arusha through observation, interviews, knowledge surveys, and online databases. International data analyzed show a positive correlation between HIV mortality rates and malnutrition, with Tanzania being near the upper limits of both. Analysis of the traditional Maasai diet (solely consisting of milk and meat) indicates inadequate intake of carbohydrates and deficiencies in micronutrients vital for a strong immune system such as vitamin C and vitamin E. These results support the theory that combined cultural effects on diet are contributing to rapid deterioration of the immune system of HIV-positive Maasai.

Acknowledgements

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Introduction

Over the past few decades, AIDS has gone from an unknown disease to one of the most devastating epidemics of all time. The disease was first detected in California in 1981. Since then, the virus spread rapidly infecting about 8 million people by 1990, 22 million by 1997, and 33 million by 2007 (Avert, 2012). In 2011, there were an estimated 34.2 million people living with HIV worldwide and 1.7 million people who died from AIDS-related deaths. Approximately 70% of these deaths occurred in Sub-Saharan Africa (UNAIDS, 2012). AIDS is the leading cause of death in Sub-Saharan Africa, accounting for 12.9% of all deaths in Africa in 2008 (World Health Organization [WHO], 2011). Although the numbers of AIDS-related deaths and new infections have been decreasing in recent years, the number of people living with HIV/AIDS continues to slowly rise primarily due to longer lifespans from increased antiretroviral treatments worldwide, including in Sub-Saharan Africa (UNAIDS, 2012).

Human Immunodeficiency Virus (HIV) is a retrovirus with genetic material contained in single-stranded RNA. The virus attacks the body by making copies of itself (Figure 1) via CD4 “helper” T cells, a type of white blood cell that plays a vital role in the adaptive immune system. The virus attaches to a T cell at the CD4 glycoprotein co-receptor and fuses with the membrane to release its RNA and viral proteins inside the host cell. One of these proteins, reverse transcriptase, converts the virus’

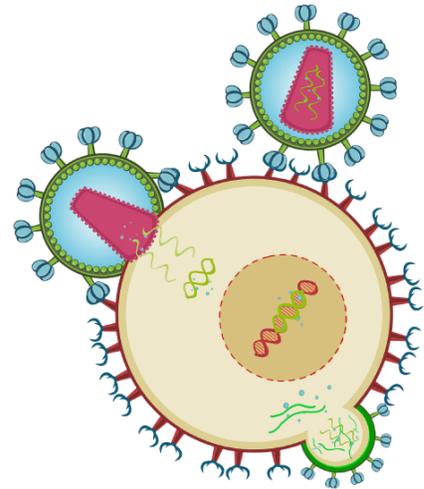


Figure 1. The HIV replication cycle

RNA into double-stranded DNA, enabling the genetic material of the virus to combine with the DNA of the host cell. During this process the HIV is hidden from the immune system because from outside of the host cell the virus cannot be detected. The HIV may remain dormant and

undisturbed inside an infected cell for months or years, one of the reasons the human immune system is never able to completely eliminate the virus from the body. After the HIV DNA integrates into the host cell's DNA, the hybrid DNA is copied during cellular division creating new viral RNA. This new RNA migrates to the surface of the cell, accompanied by new viral proteins, and eventually buds off of the host cell to create a new HIV particle (National Institute of Allergy and Infectious Diseases, 2012).

The virus repeats a cycle of replication, killing host T cells, and infecting nearby cells several times. Because helper T cells are essential for B cell antibody production and for cytotoxic CD8 T cell function, the body attempts to replace T cells that have been killed by the virus. This battle between the body's immune system and HIV continues until too many T cells have been killed for the body to produce an adequate amount of replacement cells. Over time, this loss of T cells weakens the immune system until the HIV-infected individual cannot fight off even the most common of infections. At this point, it is said that the individual has Acquired Immunodeficiency Syndrome, or AIDS (Brown, 1997).

Although HIV is most commonly transmitted through sexual intercourse, infection can also occur from mother-to-child or through contaminated sharp instruments (e.g. needles used for drugs or knives used for circumcisions). In Tanzania, approximately 80% of People Living With HIV/AIDS (PLWHA) contracted the disease through sexual intercourse, 19% from their mothers during pregnancy or delivery, and 1% through contaminated sharp instruments (Global Service Corps [GSC], 2011).

Further complicating the health of Tanzanians and other Africans is the consistently high, continent-wide presence of malnutrition in the form of undernourishment. Undernourishment is

caused by either insufficient caloric intake for energy expenditure or not getting enough of all the essential nutrients through the diet, including macro- and micronutrients (GSC, 2011).

According to the Tanzania National Bureau of Statistics, approximately 42% of Tanzanian children under five are stunted (shorter than average height for age), which indicates chronic malnutrition. Stunting is more common in rural areas (45%) than urban areas (32%), and in the Arusha region, the focus of this case-study, stunting is slightly higher than the national average at 44% (2010). Similar to HIV prevalence rates, levels of malnutrition in Tanzania have decreased over the last decade but are still alarmingly high compared to first-world countries like the United States, where less than 4% of children are stunted (WHO, 2010).

Tanzania's widespread malnutrition poses a specific, heightened threat to PLWHA, which is the acceleration of the decline of the immune system. Like HIV, malnutrition compromises the immune system. It does this in several different ways depending on the severity and nature of the malnutrition, but its overall effect on the immune system is generally called Nutritional-Acquired Immune Deficiency Syndrome (NAIDS) (Duggal, Chugh, & Duggal, 2011). HIV and malnutrition act on each other in a vicious cycle, amplifying one another's negative effects on the body (Figure 2). Poor diet causes malnutrition which suppresses the immune system. This allows HIV to replicate more rapidly, and worsened nutrition is a consequence of this. Not only do PLWHA have higher dietary needs because of increased metabolism used to fight the disease, but HIV also prevents proper absorption of food in the digestive system and lack of appetite. In turn, this malnutrition causes further disease progression (Gillespie, Haddad, & Jackson, 2001).

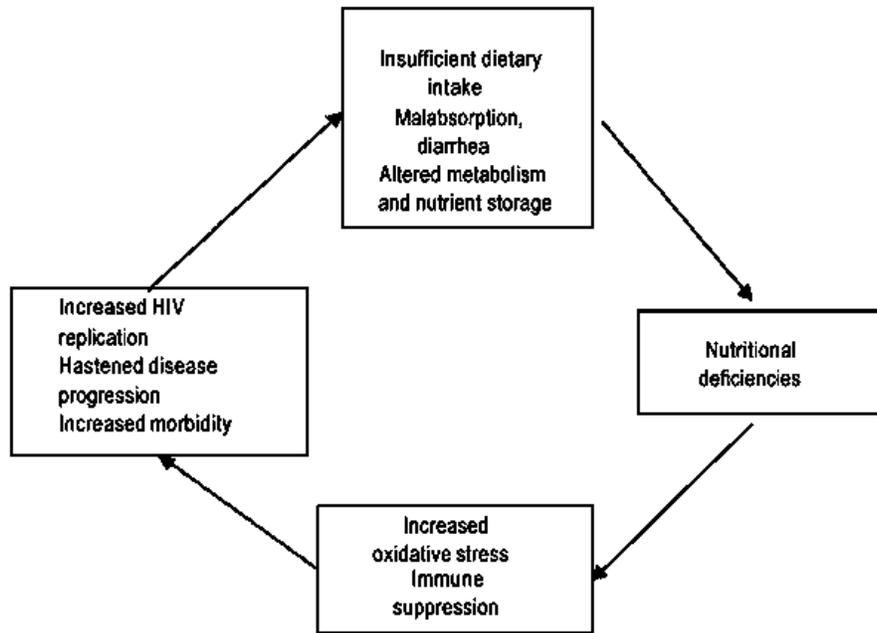


Figure 2. The HIV-malnutrition cycle

There are several variables other than nutrition that affect HIV at multiple levels, and these factors interact with disease progression in a complex web of pathways. This particular case study places culture at the top of this chain of interactions, and seeks to explain in what ways culture contributes to disease progression through malnutrition.

The purpose of this thesis is to explore cultural factors that may be intensifying the effects of interactions between malnutrition and HIV on individuals in the Arusha region of Tanzania. Specifically, gender inequality, knowledge levels, and cultural traditions of the Maasai (the predominant tribe in the Arusha region) were analyzed in their contributions to malnutrition and HIV.

Methods

This field study utilized a number of methods to obtain a deeper understanding of cultural factors acting on malnutrition and HIV. First, Tanzania as a whole country was evaluated at an international level in terms of malnutrition and HIV mortality rate using data from the WHO Global Health Observatory Data Repository. This data was analyzed for 39 different countries (based on availability of data between 2004 and 2006), and included percent children stunted (under five years old), number of deaths due to AIDS, and number of people living with HIV/AIDS. AIDS mortality rates were calculated for each country by dividing the number of people who died of AIDS in a certain year by the total number of people living with HIV/AIDS in that country (before deaths). HIV mortality rate was plotted against the national percentage of children exhibiting stunted growth, which was used as an indicator of malnutrition, and fitted with a linear trend line (excluding outliers).

Preliminary observations regarding culture and nutrition practices were recorded during the first few weeks of field work to aid in hypothesis formation. A short series of open-ended questions was developed to clarify the assumptions made during the observation period. Five questions were formulated to provide a framework that would cover the ways in which gender inequality, knowledge levels, and cultural traditions relate to nutrition practices. The following questions were used loosely to prompt interviewees to discuss anything they felt relevant regarding culture and nutrition in Maasai of the Arusha region:

1. Are there differences between men's and women's diets or eating habits in the Arusha region, specifically among Maasai peoples?
2. What aspects of Maasai culture affect diets?
3. Are there common myths in Tanzania that affect what people eat?
4. Do you think people know what a balanced meal consists of?
5. What do you think the biggest challenge for good nutrition in Tanzania is?

Five interviewees were selected based on profession and experience in order to collect a range of views from people working in different fields. Interviewees included Joyce Nambaso, HIV and nutrition trainer for Global Service Corps, Asha Msangi, nutritionist at the West Meru District Hospital, Restituta Ngowi, a nurse working in the HIV clinic (also at the district hospital), Elizabeth Mosha, director of the women's support group *Women in Action*, and Dr. Oliver Mollel, retired physician and current home-based care provider for PLWHA. Interviews were conducted in English as most interviewees were fluent, although the assistance of a Swahili-English translator was used occasionally.

Data was also used from surveys conducted in 2011 by Global Service Corps (GSC), an NGO that provides education in HIV, nutrition, and sustainable agriculture to rural areas of the Arusha region. These surveys were administered in 11 villages to literate trainees attending GSC HIV/nutrition classes. Because of this selection, the sample population may have consisted of individuals with above-average education levels (often less than half the trainees were able to participate in the survey due to illiteracy). The survey questions were administered in true/false format. Each question was read aloud in Swahili (and sometimes Maasai) at the beginning of each training week and participants were instructed to put an "X" by the question number for "true" or "O" for "false". For this thesis, survey data was used to gauge baseline knowledge levels of villagers regarding nutrition. Survey questions of particular interest to this study include: "Good nutrition helps our bodies fight infection and disease," "Men do not need to eat fruits and vegetables," "For good nutrition, it is not important to eat a variety of foods," and "If a child does not have proper nutrition, the development of their body and brain will be affected."

Lastly, background research for data analysis and comparison was conducted by means of online databases available via the University at Albany library website.

Results

The first topic that must be addressed is whether malnutrition is in fact having an appreciable effect on HIV mortality rate in Tanzania. This was determined by plotting Tanzania along with 38 other countries on a graph where HIV mortality rate was measured against malnutrition. Because malnutrition is a broad term which cannot be directly measured, percent of children stunted under the age of five was used as an indicator of malnutrition. Stunting is defined by two or more standard deviations below median height for age of a reference population (UNICEF, 2012). Stunting indicates moderate to severe chronic malnutrition which can slow or completely stop development in children. It is assumed here that stunting in children is a direct effect of malnutrition in the overall population.

	Children Stunted	# PLWHA	# AIDS Deaths/Year	AIDS Mortality Rate
Tanzania	44.4%	1,400,000	120,000	.0789
United States	3.9%	1,000,000	16,000	.0157

Table 1. WHO data for Tanzania and the United States (for comparison)

According to the WHO (Table 1), Tanzania has 40% more people infected with HIV/AIDS as compared to the United States. This is a substantial difference, but what is even more significant is the 650% difference in number of deaths due to AIDS. Although there are several factors contributing to this gap including healthcare and opportunistic infections, malnutrition is thought to be a major contributing factor to Tanzania's high AIDS mortality rate.

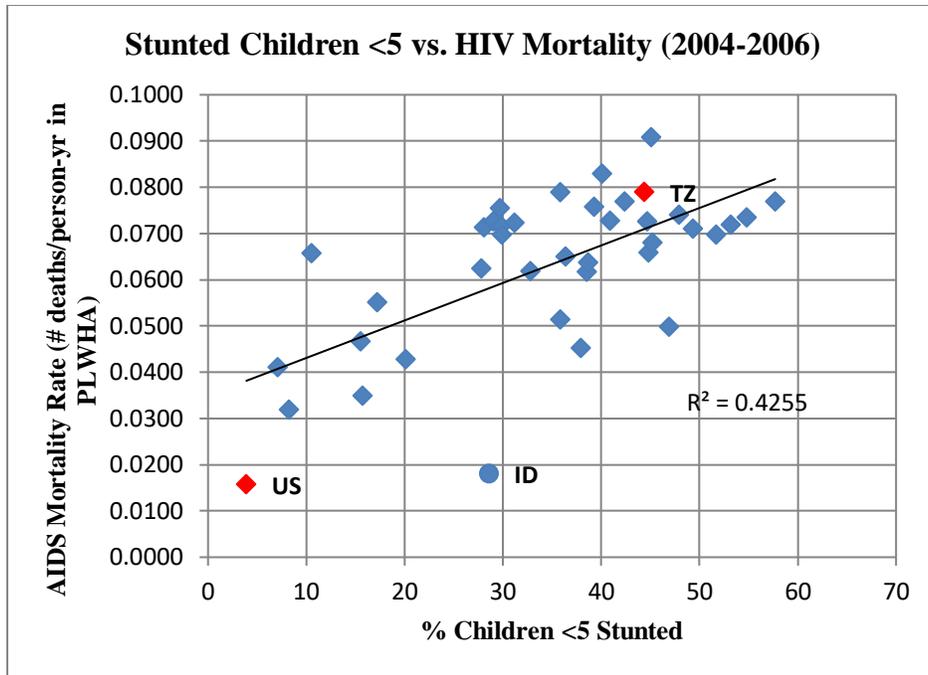


Figure 3. WHO data for malnutrition and HIV mortality for 39 countries with correlation 0.43

Figure 3 displays the global trend between stunting and HIV mortality. Each data point in Figure 3 represents a different country (see Appendix A for complete list of countries and data) with Tanzania labeled TZ and the United States labeled US. The data show a positive relationship between stunting and HIV mortality with correlation 0.48, suggesting a relationship between malnutrition and HIV mortality rate. Tanzania is located high along the trendline having both a high rate of malnutrition and a high AIDS cause-specific mortality rate. Outlier Indonesia (ID) was not included in the correlation calculation (although other sources also report relatively low numbers of deaths in the Indonesian AIDS population between the years 2004-2006, it is uncertain whether mortality actually was low or if deaths due to AIDS were underreported).

While there is a correlation between malnutrition and AIDS mortality rate, the relationship is far from direct. Just as several factors contribute to mortality rate, there are also many causes of malnutrition which differ by population. This study focuses on uncovering some

of the factors that contribute to the complex interactions between culture, nutrition, and HIV/AIDS in the Maasai of northern Tanzania.

Because most Maasai who have HIV do not know it, and will never be tested (GSC, 2011), the following cultural analysis concerns Maasai of the Arusha region as a whole and does not focus on HIV-positive Maasai alone. There are approximately 900,000 Maasai peoples total, scattered across the Great Rift Valley region spanning Tanzania and Kenya. Although they are not directly connected, these tribes all follow the same general cultural practices founded on generations of tradition. One of the most important of these traditions is pastoralism. The livelihoods of Maasai depend upon their livestock, which usually consist of a combination of cattle, sheep, goats, and chickens. The pastoralist lifestyle has shaped the ideal Maasai diet of milk, meat, and blood (Arhem, 1989), with little consumption of other foods.

Gender Inequality

Maasai culture has shaped separate, defined roles and values for men and women. For example, men's success is dependent on the number of wives, children, and animals in his possession, and women's success revolves around her children, especially sons. Maasai women are expected to tend to the household and raise their children while their husbands manage finances, own property, and make decisions for the family. It is clear from this separation of powers that Maasai live in patriarchal societies in which specific gender roles exist to maintain traditional social order. These respective duties have persisted for generations of Maasai through the belief commonly shared by both sexes that women are incapable of managing power (Burton & Kirk, 1979).

With this distinct difference between male and female lifestyle comes the possibility of nutritional differences between sexes. When asked, four out of five interviewees claimed there are significant differences and provided several examples. Most mentioned that men and women eat separately, and that men are typically served first in rural Maasai homes. This has no implications when an adequate amount of food is available, however when food is scarce women and children may be affected more than men. According to Elizabeth Mosha, a woman who has assisted several families affected by HIV, “There are over 130 tribes in Tanzania, and while all of them are different with their own values and traditions, they all value that good food is eaten by men.” This holds true for the Maasai tribe in which “good food” is considered milk and meat, and is reserved for men who dominate the family. For instance, if an inadequate amount of milk or meat is available for the entire family, what is available will be served to men first over women or children. Those family members left without milk or meat may eat *ugali* (a mixture of maize flour and water) and beans, or in extreme cases, nothing at all. Women may also partition more milk for men and make a mixture of milk, maize, greens, and water for themselves (Nambaso, personal communication, November 23, 2012), but this blend of traditional and non-traditional foods is rarely consumed by men as it is perceived “improper food” for Maasai (Arhem, 1989).

The notion that some women and children may have overall inadequate dietary intake due to gender inequalities has major implications for those who are HIV-positive. Macronutrients (carbohydrates, protein, and fats) and micronutrients (vitamins and minerals) are especially essential for PLWHA who require adequate foods for increased energy needs caused by HIV, opportunistic infections, and for a strong immune system (Food and Nutrition Technical Assistance Project [FANTA], 2004). HIV-positive women and children who eat insufficient

amounts of food due to gender inequalities will undergo more rapid disease progression, causing higher AIDS mortality rates at the population level.

Another dietary difference attributed to gender dissimilarity may actually give women's immune systems an advantage over those of Maasai men. While fruits and vegetables are generally avoided by Maasai men, who believe these types of foods are for the weak, they are more commonly consumed by females. Stunting is consistently higher in male children (45.9% in 2010) compared to females (39.2%) (WHO, 2010), and while no conclusive studies have explained this difference it may be caused by micronutrient deficiencies in male children's diets. Amaranth (*mchicha*) is the most preferred green, leafy vegetable among Maasai and provides a substantial amount of nutrients to those who will eat it (Msangi, personal communication, November 29, 2012). For women who do not consume much meat, eating beans or vegetables like amaranth may help make up for low iron and protein levels. Furthermore, leafy vegetables provide some nutrients that cannot be obtained through a diet of meat and milk. For example, vitamin E helps protect cells and increases resistance to diseases and is found in vegetables and fruits, but not in milk or meat (FANTA, 2004).

Fruits are also an essential food group which supplies several micronutrients for good immune health. Though Maasai men eat fruits only occasionally, women and children are more likely to eat a variety of fruits. Available in many Maasai areas is the baobab fruit (Mollel, personal communication, December 6, 2012), an excellent source of vitamin C which is important for protein metabolism and iron absorption, and improves defense against infection (FANTA, 2004). Tamarind is also consumed by Maasai women and children and is rich in antioxidants vitamin A and vitamin C (Mollel, personal communication, December 6, 2012). As

a whole, antioxidants control oxidative stress which, if unchecked, can increase cell death and accelerate HIV replication (FANTA, 2004).

While milk and meat each contain important macro- and micronutrients, fruits and vegetables provide a host of additional micronutrients necessary for proper absorption and utilization of protein and carbohydrates. Because of this role, micronutrients from plant foods are essential to a strong immune system, especially in HIV-positive individuals. Although Maasai men may receive adequate energy intake from a combination of macronutrients provided by the traditional milk-meat diet, women who obtain adequate nutrients from a *variety* of sources (i.e. grains, fruits, and vegetables) are more likely to have better nutrition (FANTA, 2004).

In summary, it seems gender inequality upheld by Maasai culture is working against nutrition in a couple different ways. First, women (and children) may be receiving inadequate amounts of food in certain families where there is a food shortage, although this condition likely affects men as well (perhaps to a lesser extent). Specifically, this puts HIV-infected women at high risk for rapid disease progression due to their inability to meet increased energy demands caused by the disease. Second, Maasai men's unwillingness to eat fruits and vegetables has consequences for their immune systems, especially in those whose immune system is further compromised by HIV.

Gender inequality in Maasai tribes (and throughout Tanzania in general) has also affected the demographics of HIV/AIDS. Women are three times more likely than males to contract HIV in part because they are more susceptible biologically, but also because they lack the right culturally to make the decision to abstain or use protection during sexual intercourse (AMREF, 2013). AIDS-specific mortality rate was slightly higher for women (228.6 deaths per 100,000 people) than men (197.6 deaths) in Tanzania for the year 2008 (WHO, 2011), and may reflect

gender inequalities within the culture. However, many of those interviewed indicated that improved education efforts in schools and by private organizations is helping to decrease the gender gap and its effects on nutrition and HIV.

Lack of Knowledge

Education is currently regarded as the single most important tool in combatting HIV/AIDS in sub-Saharan Africa, and it is desperately needed (UNAIDS, 2009). A large number of Africans, especially in rural areas, do not know how HIV is transmitted or how it affects the body and, most threateningly, most Africans do not know their HIV status (AMREF, 2013). Because the traditional Maasai diet is not optimal for good nutrition, nutritional knowledge (accompanying HIV/AIDS education) is crucial for combatting malnutrition rooted by tradition. This is especially important within the nutrition-HIV relationship because knowledge about both is necessary for a healthy lifestyle. Knowledge about good nutrition is critical as HIV often deteriorates the immune system unbeknownst to its host. Because of the stigma surrounding HIV testing, it is estimated that less than 10% of Tanzanians 18 and older know their status (AMREF, 2013). Furthermore, a minority of PLWHA in Tanzania who do know their status can actually access and afford antiretroviral drugs to treat the disease (about 40%, although this number is likely lower among rural Maasai) (Avert, 2012). For PLWHA who do not know their status or do not have access to HIV/AIDS medical care, a nutritious diet is their first defense against the virus.

All of those interviewed identified “lack of nutritional knowledge” as a major problem among rural Maasai. Although it is commonly assumed that all malnutrition in Africa is caused by food scarcity, HIV and nutrition educator Joyce Nambaso believes the biggest challenge for

good nutrition in Tanzania is lack of knowledge as opposed to famine. It cannot be argued that access to a variety of foods is useless without knowing what combination of foods makes for a healthy diet. Unlike Westerners who prefer different meals throughout the week, the ideal Tanzanian diet consists of eating the same few foods in bulk every day (Msangi, personal communication, November 29, 2012). This cultural preference combined with lack of understanding that eating only a few staple foods is not the healthiest of eating habits has contributed to widespread malnutrition within Maasai communities and across Tanzania.

Contradictory to thoughts offered during interviews, surveys administered by Global Service Corps before HIV/nutrition trainings indicate nutrition knowledge levels among rural Tanzanians may not be as low as hypothesized. In a sample of 140 people (61 males and 79 females), approximately 90% knew that nutrition is important for child development and that good nutrition helps the body fight infections. Lower scoring at 71% was observed in response to a question regarding the importance of fruits and vegetables in the male diet, reflecting Maasai gender roles. The remaining 29% answered either that men do not need to eat fruits and vegetables for good health or that they are unsure. 71% of those surveyed said that for good nutrition it is important to eat a variety of foods, and a promising 93% acknowledged that PLWHA can live a long, healthy life through proper nutrition (see Appendix B for data summary of all nutrition questions).

Although surveys show that rural Maasai have some knowledge of nutrition, they display eating habits characteristic of populations unaware of nutritional needs. People who lack knowledge of nutrition are unlikely to understand the immune system, and therefore do not realize that a balanced diet is necessary for strong defense against pathogens. When this is the case and hunger is the only motivation a person has to eat, their only purpose in consuming foods

is to feel full. Tanzanians (and recently Maasai, who are currently undergoing a dietary shift) often consume a relatively large portion of maize-based *ugali*, which consists mostly of carbohydrates with little protein or fat (Figure 4), accompanied by a small serving of meat or spinach

Ugali Macronutrient Makeup

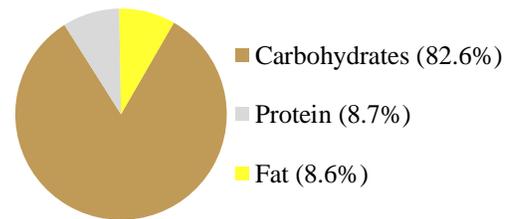


Figure 4. Percentage of calories from each macronutrient in the cornmeal-based *ugali* (<http://www.livestrong.com>)

(Msangi, personal communication, November 29, 2012). Though unbalanced, carbohydrate-rich foods like *ugali* and rice are popular among resource-limited nations because they are inexpensive and filling, satisfying the immediate desire of the consumer to feel full. However, these carbohydrate-dense, micronutrient-deficient meals do not correspond with supporting evidence that Maasai do in fact have adequate nutritional knowledge and access to a variety of foods. This may be because the surveys do not represent the general population accurately, suggesting disproportionately higher scores (described in the discussion section).

Whatever the reasoning, straying away from the traditional milk-meat diet by consuming large portions of carbohydrates may have some positive implications for HIV-positive Maasai. While there is currently no sufficient evidence that PLWHA require excess micronutrients over regular dietary allowances, an increase in energy intake is recommended. WHO suggests asymptomatic HIV adults increase their energy intake by 10% and symptomatic adults by 20-30% (2003). Carbohydrates are the main source of energy for the body and are easily metabolized (McKinley Health Center, 2008), therefore meals high in carbohydrates could accommodate increased energy demands in PLWHA. Unfortunately, Maasai families that consume large portions of *ugali* with little of anything else are unlikely to have adequate dietary

intakes of other macronutrients, vitamins, and minerals, thereby negating the benefits associated with excess carbohydrates in PLWHA.

Cultural Traditions

It is possible that Maasai do have sufficient knowledge regarding nutrition (through educational services provided by organizations targeting underdeveloped, rural areas of Tanzania) but that even with this knowledge, the desire of Maasai to adhere to their culture is stronger than their trust in what is deemed a healthy diet by modern society. Kaj Arhem, a cultural anthropologist who conducted fieldwork in Tanzania during the 1980s, observed that “the Maasai pastoral diet... serves to identify the Maasai as a people and encodes fundamental values of their culture,” (1989). This is especially true in that the traditional Maasai diet consisting solely of milk and meat reflects their livelihood, which is their livestock, with cattle being the most highly valued livestock among Maasai. In fact, there is a myth that all cows on Earth were given to the Maasai by God, and Maasai even use this belief to “repossess” cows from other tribes (Adams, 1997). This value of cattle has shaped the ideal Maasai diet, of which milk is the staple food and beef is eaten during special occasions, such as traditional rituals (which happen often enough for meat to be regularly consumed) (Arhem, 1989).

It is likely that Maasai pastoralism evolved in response to the arid climate of the Great Rift Valley (Fratkin & Mearns, 2003). Much of the Arusha area, especially at higher altitudes, has poor conditions for growing crops with dry soil and very limited water. These conditions prevent successful harvests and promote reliance on livestock. Even in areas where growing conditions are adequate, most of the Maasai encountered during this field study did not farm anything but livestock. Drawing back on the importance of cattle in Maasai culture, non-

traditional foods from anything other than cows is viewed as inferior, including fruits and vegetables. Milk and meat (and blood, during shortages or rituals) have been the supreme foods consumed by Maasai for generations (Arhem, 1989), while “vegetables are for goats and fruits are for birds,” according to the Maasai idealism described by women’s support program director Elizabeth Mosha. Nutritionist Asha Msangi attributes part of malnutrition among Maasai to this type of thinking.

Because milk and meat are the staple foods of Maasai, an analysis of their nutritional value is necessary to determine their effects on the immune system, especially for PLWHA. Despite covering only two food groups, milk and meat consumed in sufficient amounts provide the body with the majority of nutrients it needs to function, as evidenced by the relatively healthy appearance of many Maasai. Most of the calories provided by milk come from fat with the

Vitamin A	Growth and function of T cells, which are weakened by HIV; maintenance of mucosal linings
Vitamin B2	Energy metabolism
Vitamin B3	Energy metabolism
Vitamin B12	Cellular development and maintenance
Calcium	Strengthens bones; muscle function; immune defenses

Table 2. Micronutrient content of milk and their functions

remainder supplied by protein, but it supplies no complex carbohydrates (although natural cow’s milk does contain simple sugars) (<http://www.livestrong.com>). Milk also contains several micronutrients necessary

for immune system health, which are listed in Table 2. Some of these vitamins are also obtained through eating meat. Like milk, meat supplies protein and fat but no carbohydrates (<http://www.livestrong.com>). Meat provides additional B vitamins to those supplied by milk (B1 and B6) which assist energy metabolism, appetite control, and fat and protein absorption. Meat also contains minerals iron and selenium, which are required for utilization of energy and antiviral defenses, respectively (FANTA, 2004).

While milk and meat provide many of the nutrients required for a strong immune system, their range is incomplete and should be supplemented with a variety of other foods for maximum immune strength. Micronutrient deficiencies not only weaken the immune system to increase chances of opportunistic infection, but also cause diseases themselves. For example, lack of vitamin C causes scurvy, a pathology marked by spotted skin and lethargy and common to rural parts of Tanzania, including Maasailand where fruits are infrequently eaten (Mollel, personal communication, December 6, 2012).

Pastoral economies in Tanzania have been declining over the past few decades due to national pressure to shift to agriculture in efforts to increase food production, and this change is threatening the ideal Maasai diet. Weakening of pastoral communities may account for diet-shifting and the growing prevalence of non-traditional foods like *ugali* and vegetables in typical modern-day Maasai meals, particularly in the diets of women and children (Arhem, 1989). Provided the people undergoing this shift are still consuming moderate amounts of milk and meat, the addition of carbohydrates, fruits, and vegetables consumed to compensate for declining livestock levels has positive implications for PLWHA. Regular substitution of excess milk or meat for something else supplies the body with a different host of macro- and micronutrients needed for optimal immunity, especially complex carbohydrates, vitamin C, vitamin E, and magnesium which are not supplied by milk or meat (FANTA, 2004).

The rationale behind Maasai reluctance to make the switch to a healthier, balanced diet is engrained in their cultural traditions. Maasai are among the most well-known of African tribes and are specifically admired for their characteristic strength and courage. Maasai peoples are very proud of this reputation and live to honor their culture through the renowned traditions of their ancestors. Unfortunately, this façade of invincibility hides the harsh realities of HIV and

malnutrition from many Maasai, and creates stigma surrounding disease and weakness that brings shame upon those who are affected. Some avoid HIV testing for fear of losing their status of strength that Maasai possess upon discovery that this is a disease even the most resilient of minds cannot overcome. Traditional Maasai culture discourages the use of modern medicine in general, and a Maasai will often put off a trip to the hospital until they are near death. This makes good nutrition all the more important, as it acts as a Maasai's main support for the immune system in the absence of treatment for HIV/AIDS and other diseases.

Discussion

It is clear from national data that, although indirect, there is a trend between HIV mortality rates and malnutrition. Although confounding variables such as national differences in education and healthcare exist, the data plotted in Figure 3 indicate higher HIV mortality rate is associated with increased national levels of malnutrition. Since several studies support that improved nutrition elongates the lifespans of PLWHA, it is realistic to target malnutrition as a contributing factor to heightened HIV mortality rates in Tanzania, including its rural tribes.

The existence of gender inequality in Maasai culture is undeniable. Maasai lifestyle is dependent upon age and gender without the possibility of mobilizing roles, and this seems to have an appreciable impact on diet. Adult male nutrition is most important to the family because they have the highest responsibility of leading the community. Female and child nutrition is flexible for that of the head of the household as their responsibilities are perceived less essential than adult males'. This is consistent with other studies (i.e. Singh, 2006) which have concluded that females, especially in low-income households, consume less food in the family. Gender

inequality contributes to the complex HIV-malnutrition cycle through increased malnutrition as well as increased rates of infection among females in Tanzania.

Lack of knowledge among Maasai concerning health matters has been an issue for a very long time. In recent years, many Maasai tribes have developed a higher value for education leading to improved knowledge levels. However, Maasai literacy rates are still extremely low, especially among elders who were raised before the upsurge in education efforts. This introduces bias into the surveys distributed at GSC trainings, as only those who could read and write were asked to participate. This literate group produced survey scores higher than expected, perhaps because their heightened knowledge levels reflect a higher level of education and may not be representative of the general population who have had little to no education.

Proper HIV and nutrition education should be delivered together for the most effective response to the HIV/AIDS epidemic in sub-Saharan Africa. In theory, because malnutrition weakens the immune system which allows the HIV virus to replicate faster, malnutrition also increases viral load thereby increasing the chance of transmission. Likewise, a person who is malnourished is also more likely to contract HIV through transmission of lower viral load (Avert, 2012). This suggests that good nutrition may not only be the best treatment for HIV-positive rural Tanzanians, but also a preventative method. Although the effectiveness of nutrition in HIV prevention is a topic in need of research, the most effective HIV prevention methods are known to be abstinence, faithfulness between partners, and condom use. It is essential that these approaches be taught alongside nutrition in the likely event that HIV is already prevalent in the community. Findings of this research and other studies (i.e. Arhem, 1989) demonstrate the strong effects culture has on diet and nutrition, and in the case of Maasai it is probably contributing to more rapid mortality for PLWHA.

There were several limitations to this study. As discussed, knowledge surveys may represent a more educated group resulting in higher than actual scores for the general population. Language caused further limitation to surveys, as questions were written and read in Swahili but sometimes had to be translated into Maasai, introducing the possibility of confusing or inaccurate translations. Interviews conducted for this study were limited to educated individuals who spoke English to eliminate translation problems. Although some of the selected interviewees are descendants of Maasai, they are all currently removed from the rural Arusha-Maasai setting and may therefore be unaware of recent changes in diet or the HIV epidemic. Lastly, for the purpose of analyzing the “typical” Maasai diet, generalizations had to be made which are not necessarily representative of every Maasai family. Culture is a broad term and while this study touches on a few pathways, interactions between culture, nutrition, and HIV are infinitely complex and cannot be fully defined within any community.

This study demonstrates the need for improved nutrition alongside HIV prevention and testing efforts with an approach that is compatible with Maasai culture. This involves working with Maasai elders (who hold the most power and are most respected by the community) to come up with a sustainable, effective plan to increase nutrition and decrease the impact of HIV. Future research should assess these ideas in several Maasai populations to develop approaches for tackling malnutrition and HIV in ways that are appropriate for Maasai culture and accepted by community members.

Conclusion

This research suggests that gender inequality, lack of knowledge, and traditional lifestyle are all cultural driving forces among Maasai of malnutrition, resulting in increased HIV mortality rates. Gender inequality causes bias in food distribution within the family which may be preventing women from consuming adequate nutrition. Gender roles also put men at risk for malnutrition as they are discouraged culturally from eating fruits and vegetables, which are believed to be foods for the weak. Both modes of malnutrition contribute to more rapid deterioration of the immune system in PLWHA.

Because for generations herding and chores have been priorities for children over education, lack of knowledge is widespread in Maasai populations. The cultural value of a few select foods combined with misconception of nutrition and decreasing livestock numbers are likely altering traditional foods to diets higher in carbohydrates but lower in protein and fat. For HIV-positive Maasai, this may imply better energy supply from increased carbohydrates (which are the body's main source of energy), but when these foods replace rather than supplement milk (high in fat) and meat (high in protein), fat and protein intake fall below required amounts.

The traditional diet of milk and meat, which serves to reflect Maasai culture, may supply adequate protein and fat, but is deficient in carbohydrates and micronutrients essential for proper functioning of the immune system. Specifically, milk and meat lack carbohydrates, vitamin C, vitamin E, iodine, and magnesium, each of which are vital in regular amounts for good nutrition of PLWHA.

Fruits and vegetables are the most vital food groups which are absent from the Maasai diet. The result is widespread micronutrient deficiency resulting in high HIV mortality rates among Maasai. Until HIV is eradicated, better nutrition across entire Maasai populations is

crucial for longer lifespans for those infected with HIV/AIDS. This is important not only because most Maasai who contract HIV will never know it, but also for the sake of the population's general health. HIV and malnutrition are linked at the individual and population levels. Both are contributing to high mortality rates in Tanzania and throughout developing nations, and both HIV and malnutrition must be addressed in order to wipe out either malady.

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Appendix A

List of countries and data from WHO (in order of increasing percentage of children stunted)

Country	% children <5 stunted	HIV mortality rate	Country	% children <5 stunted	HIV mortality rate
United States	3.9	0.0157	Sudan	37.9	0.0453
Iran	7.1	0.0411	Mali	38.5	0.0618
Argentina	8.2	0.0319	Uganda	38.7	0.0638
Dominican Republic	10.5	0.0657	Guinea	39.3	0.0758
Mexico	15.5	0.0467	Cote d'Ivoire	40.1	0.0829
Thailand	15.7	0.0349	Kenya	40.9	0.0728
Malaysia	17.2	0.0552	Burkina Faso	42.4	0.0769
Senegal	20.1	0.0428	Tanzania	44.4	0.0789
Togo	27.8	0.0625	Benin	44.7	0.0726
Ghana	28.1	0.0714	Chad	44.8	0.0659
Indonesia	28.6	0.0180	Central African Republic	45.1	0.0909
Ecuador	29	0.0727	Lesotho	45.2	0.0681
Haiti	29.7	0.0755	Sierra Leone	46.9	0.0499
Peru	29.8	0.0717	India	47.9	0.0741
Honduras	29.9	0.0698	Nepal	49.3	0.0711
Congo	31.2	0.0724	Rwanda	51.7	0.0698
South Africa	32.8	0.0619	Malawi	53.2	0.0719
Viet Nam	35.8	0.0514	Niger	54.8	0.0735
Zimbabwe	35.8	0.0789	Burundi	57.7	0.0769
Cameroon	36.4	0.0651			

Appendix B

Full results from Global Service Corps' 2011 nutrition survey questions

With good nutrition and a healthy lifestyle, it is possible for an HIV positive person to remain healthy for many years.	TRUE	130	93%
	FALSE	9	6%
	UNSURE	1	1%
Good nutrition helps our bodies fight infection and disease.	TRUE	127	91%
	FALSE	12	9%
	UNSURE	1	0%
If a child does not have proper nutrition, the development of their body and brain will be affected.	TRUE	124	89%
	FALSE	15	11%
	UNSURE	1	0%
Men do <i>not</i> need to eat fruits and vegetables.	TRUE	36	26%
	FALSE	99	71%
	UNSURE	5	3%
For good nutrition it is <i>not</i> important to eat a variety of foods.	TRUE	35	25%
	FALSE	100	71%
	UNSURE	5	4%