Drivers of Animal Source Food Consumption among Transitioning Tanzanian Pastoral Communities: Implications on Maternal and Child Health

By: Ruby Shah

Bachelor of Science
St. Bonaventure University
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Thesis Committee Chair: Amy Webb-Girard, PhD

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Abstract

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Background: Multiple pressures contribute to sedentarization among pastoralists in Tanzania as they pursue adaptation and diversification related to sustenance, both nutritional and economic. Sedentarization has myriad positive and negative effects. One of the most significant changes that occurs during sedentarization is decreased consumption of animal source food consumption (ASF) especially among children, contributing to malnutrition. Drivers of ASF and subsequent maternal and child health implications during this transition to sedentism are largely unknown.

Objective: The purpose of this study is to understand drivers of ASF choice during the transition from nomadism to sedentism in study communities and to understand how ASF choice can result in various maternal and child health outcomes

Methods: Data collection stemmed from focus groups and key informant interviews among pastoralists in Morogoro and Tanga Regions of Tanzania using a grounded theory approach. Secondary data analysis was utilized to identify emergent themes related to drivers of ASF choice and potential MCH implications.

Results: Five primary themes related to ASF choice emerged:1) lack of cattle and subsequent production of ASF, 2) availability of other non-ASF foods, 3) convenience, 4) changes in cultural norms and perceptions with subthemes of (a) reduction of stigma and (b) modernization, and 5) habit with subthemes of (a) sensory perceptions and (b) food roots. Each of these themes and subthemes were identified as a facilitator or barrier to ASF consumption.

Conclusions: Consumption of cow meat, blood, and milk have significantly reduced due to the barriers of lack of cattle and habit, with negative implications on MCH outcomes. Convenience and changes in cultural norms and perceptions are facilitators to ASF consumption, which have the potential to improve MCH outcomes by reducing malnutrition within transitioning Tanzanian pastoral communities.

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Chapter 1: Introduction

Context

Nomadic pastoralists are commonly portrayed standing still, holding onto a goad used to manage the herd of cattle in the background kicking up clouds of dust, in the midst of slowly traveling from one land to another. In a world of increasing globalization and advancements in technology, an existing stereotype of nomadic pastoral communities is that they, like the portrayal above, stand still in terms of upholding their livelihoods by exclusively depending on livestock and traditional lifestyles of mobility in search of fresh pasture and other resources.[1] However, for the past few decades, there has been an increase in adaptation and diversification among nomadic pastoral communities related to sustenance, both nutritional and economic, leading to various positive and negative effects.[1,2] The increasing need for adaptation among nomadic pastoral communities stem from a myriad of reasons including, but not limited to, land tenure, political pressure, population growth, intensification of livestock production, droughts, and climate change. This has led to livelihood diversifications that have profound implications on the culture, demography and ultimately health and well-being of former pastoral communities, with one of the most significant diversifications being sedentarization.[1,2]

Sedentarization is the process in which former nomadic groups settle into nonmobile or sedentary communities.[1,2] This phenomenon has become the norm among former nomadic pastoralists in Tanzania as they settle down in the effort to alleviate the dietary stress faced during intense droughts by having access to alternative employment, food markets, and public services.[2,3] With this shift to more sedentary lifestyles has come changes in diet, especially related to animal source food (ASF) consumption.[3] ASFs - any foods coming from an animal such as milk, eggs, meat, blood, etc. - are known for their nutritional significance and positive health impacts, and thus are an essential food-based strategy for improving diet across the globe.[4] Diets of former

nomadic pastoralists relied heavily on ASFs, protein-heavy and nutrient-rich.[4-7] However, as these communities settled down, consumption of ASFs altered and in particular, consumption of milk decreased considerably. Consequently, malnutrition increased within settled pastoralists, with rates of stunting and wasting significantly higher in comparison to nomadic pastoralists.[4-7] Effects of malnutrition include increased risk of morbidity and long-term consequences.[8] Those most vulnerable to malnutrition comprise of women of reproductive age, the fetus, and young children due to their special nutrient needs. Approximately 198 million children globally currently suffer from malnutrition.[9] Children within transitioning pastoral communities are especially at risk for the lasting implications of poor diet.[4-7] While the motives for sedentarization have been examined among these pastoral communities, the impacts it has on drivers for food choice, especially for nutrient-rich ASFs, and the resulting implications on maternal and child health (MCH) remain unknown.

Problem Statement

Malnutrition in regard to MCH is an immense global health concern, increasing risk of morbidity with long-term physical, mental, and socio-economic consequences and contributing to one of the largest proportions of disabilities adjusted life years.[10] The lasting implications of malnutrition are particularly alarming in Tanzania, as 34% or 3.3 million children under 5 years suffer from stunting and 58 percent or 5.6 million suffer from anemia.[9] According to USAID, if nutrition in Tanzania does not improve, especially among pregnant women and children, the country will lose approximately US$20 billion by 2025. On the other hand, investing in nutrition allows for the country to gain up to US$4.7 billion by 2025 and paves the way for successful and healthy outcomes among Tanzanians.[11] Contributing towards improved nutrition includes addressing malnutrition within the 1.5 million pastoralists transitioning to sedentism in Tanzania.[12]

While others have documented the impacts on sedentarization on maternal and child nutrition outcomes, few have explored how sedentarization affects intermediary behaviors such as food choice, and dietary intakes and subsequent implications for ASF consumption and MCH outcomes.[1-4] Due to this gap in understanding, this thesis seeks to address the following research question: *What are the drivers of animal source food consumption and the subsequent implications on maternal and child health among Tanzanian pastoral communities transitioning into sedentary lifestyles?*

Specific Aims

In order to answer this research question there are two primary aims:

1. To understand the drivers of ASF choice in study communities in the context of sedentarization
2. To understand how ASF choice can result in various maternal and child health outcomes

Purpose

The purpose of this qualitative research is to develop theory that explains the choices being made about ASF consumption by Tanzanian pastoralist undergoing rapid sedentarization and to identify potential subsequent MCH implications and outcomes. This paper will begin by exploring current research on malnutrition in Tanzania, nutritional importance of ASFs, and ASF consumption within transitioning pastoral communities. Next, qualitative data, in the form of focus group discussions, key informant interviews, and in-depth interviews, will be analyzed to develop theory. A comprehensive understanding of the various drivers of ASF consumption and their relation to MCH outcomes will provide fundamental insights toward effectively creating and improving upon interventions designed to address MCH malnutrition in Tanzania.

Definitions and Abbreviations of terms

- ASFs: Animal Source Foods
- MCH: Maternal and Child Health
- FGDs: Focus group discussions
- KIIs: Key informant interviews
- IDIs: In-depth interviews
- ILRI: International Livestock Institute
- SUA: Sokoine University of Agriculture
- EU: Emory University
- EP: Villages that are extensive pastoral
- IP: Villages that are intensive pastoral
- ES: Villages that are extensive sedentary

Chapter 2: Comprehensive Review of Literature

Maternal and Child Health: Malnutrition in Tanzania

Raising healthy children requires ensuring quality nutrition, and enabling environments that permit children to not only survive, but to grow, learn, play, and contribute to society.[8] Malnutrition hampers each of these, increases risk of morbidity and severely hinders children from achieving their full potential, with long-term consequences on human capital, economic productivity, and national development in general.[8-10] Today, nearly half of all deaths in children under five years of age are attributable to malnutrition. Malnutrition consists of any "deficiency, excess or imbalance in an individual's intake of energy and/or nutrients."[8] The etiology of malnutrition does not only include a lack of food intake, but also includes nutrient malabsorption.[14] This occurs when an individual is exposed to a disease or infection that induces diarrhea, malabsorption in the gastro-intestinal tract, loss of appetite, changes in nutrient location due to immune response, and urinary nitrogen loss, all of which lead to nutrient losses.[14] Additionally, certain components of an infection or virus, such as a fever, increase both energy and micronutrient requirements; hence, why malaria and influenza have mortality rates proportionate to the degree of malnutrition. Recurrent and frequent infections, especially diarrhea, heavily contribute to malnutrition regardless of quantity and quality of food intake.[14]

Stunting and wasting are two harmful forms of malnutrition, often used for anthropometric analyses, that result due to poor undernutrition in-utero and early childhood, which includes not only low food intake but also insufficiencies in any important vitamins and minerals.[8-10] These effects are most pronounced during periods of rapid physiological change and accelerated growth such as infancy, early childhood, and adolescence. Additionally, during pregnancy and lactation, a woman must increase her total nutrient requirements in order to ensure proper milk production

and fetal growth. Hence, women of reproductive age, the fetus, and young children are the most vulnerable populations in regard to malnutrition.[8-10]

Stunting involves children suffering from a lower than normal height-to-age, incomplete brain development, and physical and cognitive damage. This condition is often irreversible with implications lasting a lifetime such as difficulties learning in school, decreased wages, and ultimately, decreased participation in their communities due to the many barriers. Currently, approximately 149 million children around the world under five years old suffer from stunting. [9] Wasting involves a low weight-to-height ratio and is a life-threatening result of rapid weight loss or inability to gain weight due to poor nutrition and/or disease. This condition involves weakened immunity, susceptibility to long term developmental delays, and increased risk of mortality when severe. In 2018, over 49 million children under five years old were wasted and nearly 17 million were severely wasted; these children require urgent feeding and immediate treatment in order to survive.[8-10]

Although there have been increasing global efforts to decrease prevalence and incidence of malnutrition, progress has been slow. [9] Percentage of stunted children under age 5 globally has decreased from 32.5% in 2000 to 21.9% in 2018.[9] However, Africa was the only region where the number of stunted children increased in 2018. Eastern Africa now has 24 million children under 5 who suffer from stunting, accounting for more than 1/3 of stunted children globally, and is second for region with the highest number of stunted children behind Southern Asia.[9] The long-term implications of malnutrition are particularly alarming in Tanzania, as 34 percent or 3.3 million children under 5 years suffer from stunting and 58 percent or 5.6 million suffer from anemia (most commonly due to an iron deficiency).[11] According to USAID, if nutrition in Tanzania does not improve, especially among pregnant women and children, the country will lose approximately US$20 billion by 2025. On the other hand, investing in nutrition allows for the country to gain up

to US$4.7 billion by 2025 and paves the way for successful and healthy outcomes among Tanzanians.[31] Hence, investing in interventions to provide quality nutrition is essential in allowing children to pursue uncompromised lives and Tanzania, collectively, to advance as a nation.

Importance of Animal Source Foods (ASFs)

Animal source foods (ASFs) - any food coming from an animal, such as milk, meat, eggs, etc. - have been long known for their nutritional significance and positive health impacts, and thus are an essential food-based strategy for improving diet across the globe.[4,5,15] ASFs consist of protein and energy that are high in quality and readily digested. Additionally, they contain absorbable, highly bioavailable micronutrients and are specifically rich in iron, zinc, riboflavin, vitamin A, vitamin B12, and calcium in comparison to plant foods. While some plant foods are reasonably high in iron, zinc, or calcium (such as spinach and legumes), the micronutrients are poorly absorbed due to high oxalate levels which form insoluble compounds and consequently, reduce the mineral uptake in the intestine.[15,16] Consumption of ASF can offer high nutrient absorption and utilization by the body due to the presence of heme protein which is found in cattle blood, meat, fish, and fowl.[15-17] Not only does heme protein contribute to increased nutrient absorption from ASF, it also improves zinc and iron absorption from cereal and other plant sources, making it a key component of a wholesome diet.[15,16]

The benefits of ASF consumption are multi-faceted. ASF consumption "promotes growth, cognitive function, physical activity, and overall health, particularly for children and pregnant women." [15-16] ASFs can meet micronutrient requirements at a "lower volume of intake than can plant source foods" making them an efficient and compact means of contributing to a healthy diet. For example, "100g of cooked beef provides an entire day's recommended intake of protein, vitamin b12, and zinc" and also contributes considerably to the iron and riboflavin intake

recommendations.[16] Similarly, milk can provide a significant amount of calcium, vitamin b12, vitamin A, and riboflavin – as a comparison, a solely cereal-based diet provides only a mere fraction of these nutrients.[15-16] Milk is protective against stunting and wasting, as exemplified by various studies that demonstrate the association between milk consumption and increased linear growth in children.[18] Furthermore, ASFs can provide numerous micronutrients at a time which is especially important for those lacking in more than one nutrient due to limited variety in diet. Thus, even modest amounts of ASF can compensate for many vitamin and mineral inadequacies.[15,16] For instance, to accomplish the average daily requirements for energy, iron, or zinc, a child would need to consume 1.7–2.0 kg of maize and beans in one day as opposed to only 60 g of meat per day which fulfills the same requirement.[16] The latter is much more tolerable and an efficient amount of food to consume.[16]

ASFs are also a great source of macronutrients such as saturated fat and cholesterol. A concentrated source of these macronutrients allow children to grow substantially and properly, especially during stages of accelerated growth, lessening the risk of malnutrition, stunting/wasting and morbidity.[15] Furthermore, ASFs are beneficial to consume during pregnancy and lactation, as they help fulfill the requirement of increased nutrient intake for proper fetal growth and milk production.[15] In a longitudinal observation study conducted by Human Nutrition Collaborative Research Support Program (NCRSP) through 1983-1987 in various areas of Kenya, Mexico, and Egypt, findings reflected that across the 250 households that were studied, ASF consumption was highly correlated with zinc, B12, iron, and fat levels in diet as well as B12 levels in breast milk.[19] Various studies have exemplified the importance of ASF consumption in relation to pregnancy outcome, growth, cognitive development, school and work performance, morbidity, and immune function. Thus, women of reproductive age, the fetus, and young children are groups that can benefit the most from consuming ASFs due to their vulnerability to malnutrition.[15-19]

Consumption of ASF within Pastoral Communities

Throughout history, nomadic pastoral communities have relied heavily on ASF consumption as this is most convenient and in line with their livelihoods.[1-3] Nomadic pastoral diets have consisted of high protein and low calories with seasonal variation in protein and energy content. [1-3] This diet is based on three main food groups: milk, meat products (meat, bone, fat, blood), and cereals acquired either by purchase or cultivation.[3] Meat is primarily only consumed when livestock animals, generally cows, are slaughtered for religious and social events. Milk accounts for 30-65% of diets of various nomadic pastoral communities throughout East Africa and is mainly consumed during the wet seasons. [1-3,5] The Maasai, in particular, rely heavily on milk intake, as demonstrated in a study by Lawson et. al in 2014, in which Maasai children were more likely to have recently consumed milk than any other ethnic group.[20] Milk consumption among nomadic pastoralists serves as a protective factor, though levels of intake are currently insufficient to meet complete nutrient requirements. It has also been shown that milk provided approximately ½ of vitamin C intakes within the Samburu, a nomadic pastoral community in Northern Kenya.[4]

However, dry seasons in Eastern Africa (usually November-March and May-August) result in dietary stress and inadequate nutrient intake due to scarce livestock pasture and subsequent limited availability of water and milk for human consumption.[1-4] During these periods, pastoralists usually either consume blood (tapped from animal) and smaller livestock (goat or sheep) or sell them in order to purchase cereals (maize/posho) and other types of carbohydrates. This shift in diet offers only a limited amount of calories and stimulant to prevent hunger.[3] Generally, caloric intake among all pastoralists is low, i.e. 1000 kcal daily among Maasai, which can also lead to low body mass indices indicating chronic energy deficiencies.[21] Furthermore, a majority of this caloric intake during the dry seasons derives from high maize consumption, which is known to contain phytates that inhibit zinc absorption.[6] There is also evidence of micronutrient deficiencies in iron,

vitamin A, and vitamin C in current nomadic pastoral diets.[22] Despite the limitations in nutrition and intake, pastoralists have higher protein consumption than that of most agriculturalists. For example, the Maasai have protein levels of 44.9 grams per person per day. This dietary pattern has been previously described as the "protein-rich, calorie-low" phenomenon.[3] Although seasonal changes lead to inadequate nutritional resources, the adaptability of the pastoral diet is sufficient in allowing pastoralists to subsist in drier lands unable to sustain agriculture. This represents a fundamental difference between mobile and settled pastoral communities.

In East Africa, pastoralists who replace mobile livelihoods with sedentary lifestyles in towns or farms often face worsened conditions in terms of accessibility to quality and comprehensive nutrition, particularly with protein losses from meat and milk. This ultimately contributes to greater malnutrition, specifically for children.[1-4] Although pastoral communities are being "pulled" towards substituting livestock ownership with livestock commercialization and crop cultivation to ensure food energy and market access, they are being pushed away from higher quality animal foods that are customarily a significant portion of their diet.[4,6] Previous findings demonstrated that within the Samburu, all livestock ownership significantly decreased due to sedentarization. [4,6] Despite this, livestock holdings for goats and cattle remained positively predictive of household milk consumption. Additionally, regression modeling indicated that cattle ownership was associated with improved child anthropometry, suggesting increased access to milk due to livestock ownership and subsequent contribution to vitamin A and B12 intake vital for growth. Interestingly, income differentially contributed to vitamin C adequacy; this may be due to better access to vitamin C-rich fruits and vegetables, especially within settled pastoral communities.[4,6]

In relation to other effects on MCH due to ASF consumption and sedentarization, there have been multiple potential positive and negative implications. Consistent with previous findings,

Lawson et. al. found that although there was an apparent availability of cow's milk within the nomadic Maasai communities, breastfeeding was fairly prolonged compared to other regional ethnic groups.[20] In other pastoral communities, it has been shown that cattle-holding households did not wean children earlier compared to households without cattle. In accordance with these findings, Sellen and Smay have revealed that at least in population-level comparisons, food availability at the time of weaning is not greatly predictive of weaning age.[23] Thus, the effects of sedentarization on breastfeeding have not been closely studied and is worth examining if food availability at the time of weaning currently is in any way predictive of weaning age, given reduced milk consumption and improved access to food markets.

There has been conflicting evidence related to the possible benefits of sedentarization on MCH nutrition. The Rendille Sedentarization Project found that settled communities had more malnourished children due to decreased milk intake and increased starch and sugar communities in comparison to nomadic communities.[3] However, a study done by Little and Gray in 1990 found that nutrition improved overall in settled communities with settled children being 7.5 cm taller than the nomadic children at age 9. Weight, calf circumference, and skinfolds were also larger in settled children.[24] It has also been shown that market integration and commercial agriculture due to sedentarization has led to improved child nutrition, when included with subsistence production; this trend can be seen within the Kenyan Taita farmers.[3] It is apparent that investigating the nuances in nutritional status resulting from sedentarization and ASF consumption among pastoralists is necessary to gain a comprehensive understanding of the diet shifts.

Sedentarization of Pastoral Communities in Tanzania and Consumption of ASF

In recent decades, nomadic/mobile pastoral communities have been transitioning into more sedentary lifestyles for a myriad of reasons, including but not limited to political pressure, demographic shifts, limited pasture available for open livestock grazing, drought and other environmental changes.[1-4,25] Former nomadic pastoral communities have settled into more urban areas and take advantage of alternate forms of economic strategies such as cultivation, trade, wage labor, etc. Pastoralists have shifted their economy from a focus on subsistence and producing mainly milk for the household consumption to commercialism and producing beef and dairy products for market sale. These options as economic resources help ease the limitation in food availability during seasonal changes, though not necessarily in nutrition quality, and allow families to survive during periods of intense drought.[1-4,25]

A substantial number of the 1.5 million pastoralists in Tanzania have also shifted into a settled lifestyle in response to the pushes away from pastoral livelihood and to the pulls of urban/agricultural life.[26] The Maasai in Kenya have lost a substantial amount of grazing lands due to the growth of sedentary pastoral communities, privatization of land, and expansion of game parks; all factors that have restricted the mobility of nomadic Maasai with similar trends in Tanzania as well.[3] Land use in Tanzania is also heavily politized with multiple regulations in place to allocate use to different types of land, such as reserved land, village land, and general land. Land used for pasture is currently primarily restricted to general land use and is heavily controlled by the government, impeding on the mobility of pastoral communities and negatively impacting their livestock-based livelihoods.[26]

Environmental changes in Tanzania also have had significant negative effects on livestock productivity pushing nomadic pastoralists to pursue a sedentary lifestyle. Pastoralists in Tanzania are responsible for the majority of the country's cattle, which is estimated to be 21 million cattle.[26]

These cattle rely on forage growth in rangelands, which is ensured by timely rainfall.[26] However, the effects of climate change in Tanzania over the past century, such as decreased rainfall and increased temperature, has led to the decline in rangeland productivity and resulting compromised health of livestock. Tanzania has experienced a mean annual increase of 1.0°C in temperature since 1960 and decreasing rainfall of 2.8 mm per month (3.3% per decade countrywide).[27] Kimaro et.al conducted a mixed-methods study in the Monduli District of Tanzania in 2018, in order to assess how exactly cattle owners, including pastoralists, perceive the climate change in terms of their livestock production.[27] According to the findings, 95.8% of cattle owners reported "experiencing negative impacts on their livestock during periods of severe water and pasture shortage," which includes massive and widespread cattle death. These cattle owners also reported low sale prices for their livestock contributing to significant economic loss and hassle when trying to search for adequate pasture and water for the animals.[27] Consistent with previous literature, this study also explained that limited open pasture and inadequate feed in quantity and quality among cattle was associated with lower milk yield. Unfortunately, participants expect to lose even more livestock with long-term climate change with increased subsequent reductions in milk production, as temperature in Tanzania is predicted to rise by 3–5 °C by 2075.[27] These impacts of environmental change pressure pastoral communities to forgo nomadism in exchange for access to other forms of employment, markets, and public services by settling down.

As discussed, multiple factors have instigated the sedentarization of former nomadic pastoral communities. Studies have revealed significant differences in nutritional outcomes between nomadic pastoralists and sedentary pastoralists with the former showing wider dietary diversity and higher ASF consumption throughout various seasonal changes.[3] Although sedentarization has yielded numerous beneficial effects such as better access to drinking water, education, health care and a market economy, sedentary pastoral communities have widening

disparities in wealth distribution and access to food resources. This phenomenon has had negative implications on maternal and child health as exemplified by poor child anthropocentric measurements in settled populations in comparison to those in pastoral populations.[3] Previous literature has explained that this could be in part due to the separation of women and children from the herd leading to significant reduction in milk consumption among settled pastoralists, with nomadic pastoralists consuming up to 3 times as much milk in comparison.[1-4,18] However, the specific drivers of intake for not only milk, but also other important ASFs (such as cow meat, chicken, eggs, fish, etc.) have yet to be explored for sedentary pastoral communities in Tanzania, which this study aims to do.

Remaining Gaps – Drivers of ASF Choice

Understanding drivers of food choice is essential in identifying which and how social and economic expressions of characteristics, proclivities, and cultural connotations influence nutrient intake and overall health. An abundance of prior studies have demonstrated the insignificant or negative impacts of failing to utilize a culture-centered approach when implementing nutritional programs. This approach includes analyzing perceptions, behaviors, and contextual factors surrounding dietary choices.[28] The Food Choice Process Model outlines that decisions regarding food choice are recurrent, convoluted, and multi-faceted, with multiple variations throughout the life course.[29] Prior research has found that cultural ideals and personal factors like sensory perception (taste/appearance/aroma) and identities are some of the most salient drivers of food choice.[29] Some examples of the implications for nutrition due to these drivers include limited dietary benefits from fish due to stigma within the Maasai communities and increased consumption of vitamin A among infants due to effective, culturally-sensitive interventions introducing orange-flesh sweet potatoes in Western Kenya.[30] Additionally, these drivers and food values are estimated

to impact a greater proportion of people in less developed countries.[28,29] Thus, in order for the design of an intervention or a policy implementation to meet cultural needs of at-risk groups within less developed countries, information about diet diversity, nutrition beliefs, and drivers of food choice are essential to determine beforehand.

As aforementioned, women of reproductive age, the fetus, and young children are the most vulnerable populations in regard to malnutrition.[1-4] Thus, drivers of food choice within these populations is imperative to explore, especially in relation to ASFs given their vast nutritional benefits. While the trend of Tanzanian pastoralists transitioning from nomadism to sedentism has been well-studied, the nutritional impacts of this shift in relation to ASF consumption and subsequent maternal and child health (MCH) outcomes have not been examined in depth thus far. To address this research gap, this study will utilize qualitative research methods to explore the drivers of ASF consumption within transitioning pastoral communities and their implications on MCH, particularly within the Morogoro and Handeni regions of Tanzania. Qualitative data use for this research study will provide the emic perspectives among pastoralists, identify various drivers, and contribute to the foundation on how to effectively create and improve upon intervention designs aiming to tackle MCH undernutrition in Tanzania.

Chapter 3: Manuscript

Abstract:

Background: Multiple pressures contribute to sedentarization among pastoralists in Tanzania as they pursue adaptation and diversification related to sustenance, both nutritional and economic. Sedentarization has myriad positive and negative effects. One of the most significant changes that occurs during sedentarization is decreased consumption of animal source food consumption (ASF) especially among children and contributing to malnutrition Drivers of ASF and subsequent maternal and child health implications during this transition to sedentism are largely unknown.

Objective: The purpose of this study is to understand drivers of ASF choice during the transition from nomadism to sedentism in study communities and to understand how ASF choice can result in various maternal and child health outcomes

Methods: Data collection stemmed from focus groups and key informant interviews among pastoralists in Morogoro and Tanga Regions of Tanzania using a grounded theory approach. Secondary data analysis was utilized to identify emergent themes related to drivers of ASF choice and potential MCH implications.

Results: Five primary themes related to ASF choice emerged:1) lack of cattle, 2) availability of other foods, 3) convenience, 4) changes in cultural norms and perceptions with subthemes of (a) reduction of stigma and (b) modernization, and 5) habit with subthemes of (a) sensory perceptions and (b) food roots. Each of these themes and subthemes were identified as a facilitator or barrier to ASF consumption.

Conclusions: Consumption of cow meat, blood, and milk have significantly reduced due to the barriers of lack of cattle and habit, with negative implications on MCH outcomes. Convenience and changes in cultural norms and perceptions are facilitators to ASF consumption, which have the potential to improve MCH outcomes by reducing malnutrition within transitioning Tanzanian pastoral communities.

Keywords: MCH, Malnutrition, Animal Source Food, Pastoralism

Introduction

Raising healthy children requires ensuring quality nutrition and enabling environments that permit children to not only survive, but to grow, learn, play, and contribute to society.[1] Malnutrition hampers each of these, increases risk of morbidity and severely hinders children from achieving their full potential, with long-term consequences on human capital, economic productivity, and national development in general. [8-10] Today, nearly half of all deaths in children under five years of age are attributable to malnutrition. Malnutrition consists of any "deficiency, excess or imbalance in an individual's intake of energy and/or nutrients," which can be influenced by both amount of intake and infection.[8] Eastern Africa now has 24 million children under 5 who suffer from stunting, accounting for more than 1/3 of stunted children globally, and is second for region with the highest number of stunted children behind Southern Asia.[9] The long-term implications of malnutrition are particularly alarming in Tanzania, as 34 percent or 3.3 million children under 5 years suffer from stunting and 58 percent or 5.6 million suffer from anemia (most commonly due to an iron deficiency).[11] According to USAID, if nutrition in Tanzania does not improve, especially among pregnant women and children, the country will lose approximately US$20 billion by 2025. On the other hand, investing in nutrition allows for the country to gain up to US$4.7 billion by 2025 and paves the way for successful and healthy outcomes among Tanzanians. [31] Hence, investing in interventions to provide quality nutrition is essential in allowing children to pursue uncompromised lives and Tanzania, collectively, to advance as a nation.

There are 1.5 million pastoralists in Tanzania, who are known to maintain their livelihoods by exclusively depending on livestock and traditional lifestyles of mobility in search of fresh pasture and other resources.[12] However, for the past few decades, there has been an increase in adaptation and diversification among nomadic pastoral communities related to sustenance, both nutritional and economic, leading to various positive and negative effects.[1-4] One of the most

significant diversifications is sedentarization, which is a process wherein former nomadic groups settle into nonmobile or sedentary communities. This phenomenon has become the norm among former nomadic pastoralists in Tanzania as they settle down in the effort to alleviate the dietary stress faced during intense droughts by having access to alternative employment, food markets, and public services.[1-4] With this shift to more sedentary lifestyles has come changes in diet, especially related to animal source food (ASF) consumption. [1-4] ASFs - any foods coming from an animal such as milk, eggs, meat, blood, etc. - have been known for their nutritional significance and positive health impacts, and thus are an essential food-based strategy for improving diet across the globe.[4] Diets of former nomadic pastoralists relied heavily on ASFs, protein-heavy and nutrient-rich.[4-7] However, as these communities settled down, consumption of ASFs altered and in particular, consumption milk decreased considerably. Consequently, malnutrition increased within settled pastoralists, with rates of stunting and wasting significantly higher in comparison to nomadic pastoralists. [4-7] Effects of malnutrition include increased risk of morbidity and long-term consequences.[8] Those most vulnerable to malnutrition comprise of women of reproductive age, the fetus, and young children due to their special nutrient needs. Approximately 198 million children globally currently suffer from malnutrition.[9] Children within transitioning pastoral communities are especially at risk for the lasting implications of poor diet.[4-7] While the motives for sedentarization have been examined among these pastoral communities, the impacts it has on drivers for food choice, especially for nutrient-rich ASFs, and the resulting implications on maternal and child health (MCH) remain unknown. Thus, the purpose of this study is to examine the drivers of animal source food choice and the subsequent implications on maternal and child health among Tanzanian pastoral communities transitioning into sedentary lifestyles.

Methods

This research is built upon secondary qualitative data analysis obtained as a part of a mixed methods study on drivers of food choice conducted in partnership between International Livestock Institute (ILRI), Sokoine University of Agriculture (SUA), and Emory University (EU). Qualitative methods were utilized and data was collected by trained local study team members.

Study Population:

Data collection occurred in two districts of Eastern Tanzania: Mvomero and Handeni. Mvomero is a large livelihood district in Morogoro region, with limited market access but agriculture being the dominant activity, supplying households with food and cash. However, the poorer households may have shorter harvests resulting in selling their labor in order to purchase food and other necessities. Livestock sales in Mvomero also provide a substantial secondary income for the wealthier families and are primarily sold locally. Grazing area in this region is limited as both farmers and Maasai pastoralists seek open pasture, resulting in some conflicts. Other hazards in this region include livestock disease and inadequate and erratic rainfall. Handeni is a district, in Tanga region, that benefits from bimodal rain, or two rainy seasons, has a variety of fruits and vegetables that are being grown and sold by households. Livestock are not as vulnerable to disease and are mainly sent to Dar where they are butchered or sold on the international market. Poorer households in this region sell their labor as well as they often to not produce enough food to meet their needs.

Both of these districts contributed a total of 30 villages to a sample frame and were selected by ILRI for participation in a dairy development project. Intervention groups within the two districts were selected using 1) a village list including information on number and type of cattle keepers and cattle population obtained from the district livestock officials and 2) an in-depth study of villages using participatory scoping and observation. The purposive selection of these villages

was facilitated by SUA and ILRI in order to encompass a variety of different village sizes, livelihood strategies, and accessibility to markets. For the purposes of this research, six villages were selected based on distance to town centers and market access and to provide heterogeneity in livelihoods strategy.

Study Design:

Qualitative data collection occurred in two rounds: once during the lean season (September-October 2017) and once during the harvest season (February-March 2017). Data collection utilized a grounded theory approach, taking advantage of iterative changes between the first and second round. Data collection methods included focus group discussions (FGDs), key informant interviews (KIIs), and in-depth interviews (IDIs). Purposive sampling was utilized through previous research and development projects done by ILRI and their partners. Saturation of data determined sample sizes for each method.

Focus Group Discussions (FGDs): 54 FGDs were conducted with 37 in the first round and 17 in the second round. The groups were stratified by gender and life-stage (male and female youth, men and women of reproductive age, and male and female elderly). FGDs were aimed to prompt participates to speak about 1) what a typical diet consists of, 2) valuation of foods which included identifying them as "healthy", "prestigious", "non-prestigious," 3) reasons behind this categorization, 4) roles and responsibilities in the household related to production, sale, purchase, and preparation of foods, and finally 5) changes in each of these themes throughout the life course. The FGDs also incorporated participatory activities such as ranking and pile sorting in order to gain a comprehensive understanding of the perspectives of the participant.

Key Informant Interviews (KIIs): 54 KIIs were conducted with 48 in the first round and 6 in the second round. These were semi-structured, in-depth interviews aimed to garner

information on community beliefs, values, and experiences, how diets have been shifting, and the potential drivers of these diet shifts. There was a wide variety of key informants with different backgrounds such as livestock and agricultural extension agents, village and religious leaders, community health workers, and various ministry officials, allowing for representations of multiple perspectives within the community.

Household In-depth Interviews (IDIs): 60 IDIs within households were conducted with 39 in the first round and 21 in the second round. Purposive sampling for IDIs allowed for variety in food security status, livelihood strategies, and presence of young children.

All data collection occurred in the local languages, Kiswahili or Maasai. Recordings for FDGs, KIIs and IDIs were obtained with participant consent. Audio files were transcribed verbatim into English and verified by bilingual members of the study team for data analysis. These translations were verified by an additional bilingual member of the study team who was not responsible for the original translation.

Data Analysis:

Secondary data analysis was based off the grounded theory approach as this is most fitting for the study goal of theory development. Transcripts were de-identified, written in the English language, and analyzed using MaxQDA2018 Qualitative Analysis Software. Codes were identified inductively, and once consensus was reached about their relevance to the research project and coding agreement was discussed, an initial codebook for the first round of qualitative data was generated. For the second round of qualitative data, the analysis team consisted of two Masters of Public Health students and one Masters in Development Practice student. Due to the similarities of the guides utilized for the second round of qualitative data, a similar codebook was developed in the second round, with additional inductive codes for other ideas that emerged and inter-coder

agreement. The final codebook with definitions was then used by research assistants to apply them to the FDG, KII, and IDI transcripts and form one dataset.

In order to focus specifically on the drivers of ASF, codes for cow meat, blood, eggs, chicken, and fish were developed by a separate researcher, an additional Master's in Public Health student. These codes were initially applied to clean transcripts separately from the original dataset, with the intent of merging afterwards. This allows for the researcher to be unbiased in terms of locating where ASF is mentioned and the surrounding contextual data. After coding for ASFs within all the transcripts, the codes were merged with the original dataset to examine the overlapping codes and the emergent themes surrounding ASF. Subgroups, such as age and gender, within the FDG were compared for analysis.

Ethical Considerations

Verbal informed consent was obtained for each study participant before their participation in data collection activities. This study was reviewed by Institutional Review Boards (IRBs) in both Kenya and the United States. The ILRI Institutional Research Ethics Committee in Kenya granted approval for the study, while the Emory University IRB in the United States granted an exemption for the study.

Results

Five primary themes related to ASF choice that emerged include 1) lack of cattle and subsequent production of ASF 2) increased availability of other (non-ASF) foods, 3) convenience, 4) changes in cultural norms and perceptions – with two subthemes of (a) reduction of stigma and (b) modernization, and 5) habit with two subthemes of (a) sensory perceptions and (b) food roots. Each of these themes and subthemes can be described as either a facilitator or barrier to ASF consumption within young children and women of reproductive age, which is discussed at length below. Table 1 outlines the trends related to each ASF type in relation to implications on MCH. The overall map of drivers of ASF choice can be seen in Figure 1. Figure 2 provides an example of an outline for ASF consumption; in this case, listed are the drivers that increase or decrease blood consumption within the study communities.

Lack of cattle

Lack of cattle has negatively impacted the consumption of milk, meat, and cattle blood, acting as a major barrier across most participants. The majority of the participants explained that drought and disease have significantly contributed to the death of their livestock. In addition, the shift to commercialization of livestock within sedentary communities has contributed to even fewer cattle available. The cattle are no longer slaughtered for personal blood nor meat consumption as they are often needed for milk production in market sales. A youth female in an extensive pastoral (EP) village explains, "*When we were still young, we used to drink much milk because it was free to obtain but nowadays milk has been a commodity, it is sold therefore many people do not drink much milk*." This male participant from an ES (extensive sedentary) village explains the lack of meat consumption due to sales, reiterating the trend of commercialization: *"It is because the life system has changed, most people are very economic, they do not slaughter livestock haphazardly anymore.*" However, during times of drought, not even selling milk has

become an option for settled pastoralists in order to maintain their livelihoods due to the scarcity of cattle and subsequent milk production.

"*We were milking the cows and selling the milk and the money we get was helping us and the family in the general family livelihood process; but nowadays we don't have enough milk and hence we have to depend on the men selling cattle when they are available."* – Reproductive Age Woman in EP FGD

In order to minimize these challenges, some pastoral communities have now sought to shift cattle locations in order to find sufficient resources such as open pasture, instead of having the whole family move with the herd, only those directly involved in cattle rearing, most often men of the household, travel with the herd. This has been consistent with previous findings on changes in East African pastoral mobility leading to a "base residence-satellite camp" model in order to alleviate the limitations in natural resources.[32] This base-camp model often leaves women and children behind with no access to livestock products, such as milk.

"The main reason is shortage of water and pasture, so pastoralists decide to shift their cows to far places where they can get enough water and pasture to feed their livestock, this practice affects the availability of milk in our place."- Youth Female in EP village FGD

This trend has been a recent one as in previous decades, pastoral families were expected to travel together, ensuring equal access to livestock and subsequent access to nutritional resources such as milk.[33]

Lack of cattle – Implications on MCH

The resulting absence in milk, meat, and blood consumption due to lack of cattle in pastoral communities has contributed to malnutrition among children, consistent with previous findings.[1-4.] The findings reinforce the trend Ianotti discusses in regard to livestock holdings for cattle being positively predictive of household milk consumption and associated with improved child anthropometry.[4-6] One female Maasai participant of reproductive age gravely explains the dire

condition some malnourished children are left in due to lack of milk intake caused by drought-related death of cattle.

"You find the children having enlarged tummies and if you touch the skin; it is not as smooth as it is supposed to be. When a child is two years old and you start giving the child milk, that child becomes very healthy and at the age of four, the child's appearance becomes good and acceptable. But the changes of weather have affected us very much as we don't have milk as we were getting in the past. As I am talking now we are almost coming to the month of March but we don't have a drop of milk in our houses; this is not normal. In normal circumstances in the past; in October at around the twentieth, the rains start coming; the cattle start multiplying, milk becomes abundant and the food situation in general becomes stable. But as it is food is very high price in the market, it is difficult to sell cattle as they are very frail and unattractive or to some they don't have any to sell as they have died; A cow which you would have sold at five hundred thousand shillings in normal times is now selling at one hundred thousand or one hundred and fifty thousand shillings at the most. So currently the Maasai community is very much affected."

The "enlarged tummies" of children described above is indicative of Kwashiorkor, a chronic wasting condition.[34] Children with this condition often experience marked skin infections, as described. If prolonged, this condition can also compromise immunity in children by reduction of lymphocyte counts, leaving children susceptible long-term to various types of infections. Infections in turn cause energy loss, leading to a decline in productivity at the community level and further perpetuates the cycle of malnutrition, infection, and poverty. [34] Thus, as supported by previous literature, ASF, especially milk, is an essential component of the pastoral diet in order to ensure proper growth and an overall healthy life course.[1-4,5]

Previously, meat and blood were also given to pregnant or new mothers in order to improve diet, maximize the nutritional benefits of the breastmilk for the infant, and help the mother recover from childbirth, all of which have been well-documented.[1-7], ASF consumption among mothers helps with heme iron intake, which is highly bioavailable and beneficial for both the mother and the infant. However, the lack in ASF has led to starvation in some cases leading to mothers unable to produce breastmilk, consequently severely affecting the nutrition of the infant.

"In the past years, at our young ages, we used to slaughter a cow for a breastfeeding woman, we take the fats and put it in the calabash/gourd for the breastfeeding woman to drink in for some couple of days, the rest of the meat was also kept for the breastfeeding mother, this type of diet enabled breastfeeding women to become healthier and produce enough milk for the baby, the baby also used to grow faster and healthier due to such diets, but nowadays there is no meat, no milk. no animals fast to enable breastfeeding women to become healthier and produce enough milk for their sucking babies, thus most sucking kids undergo dwarfism."- Elder Woman in ES FGD (*participant seems to be explaining stunted growth due to malnutrition*)

Implications for MCH for pastoral mothers not being able to produce breastmilk due to lack in ASF are serious. Exclusive breastfeeding for the first six months of an infant's life is known to offer many benefits such as protection against diarrhea, pneumonia, longer-term health benefits throughout the life course.[35] Not only is exclusive breastfeeding beneficial for the infant, but it also is for the mother in terms of proper birth spacing as a form of family planning. It has been estimated that in regions where breastfeeding is prevalent, 50% more births would be expected in the absence of breastfeeding.[36] Exclusive breastfeeding (% of children under 6 months) in Tanzania was around 59.05% in 2016 according to the World Back collection of development indicators.[37] Given the risk of hunger and perceived inability to produce milk among breastfeeding pastoral mothers, exclusive breastfeeding within the community has not been maintained by some. An adult female in an EP village explains, *"But as it is now the mother does not have enough to eat; it means that the child also will not have enough breast milk. Sometimes the mother has to force giving the infant some soft porridge so as to supplement for the absence of enough milk."* This implies premature introduction of complementary foods and although exclusive breastfeeding rates in the context of pastoral sedentarization in Tanzania have not been clearly determined, there is evidence to suggest that introduction of complementary food before 6 months of age is a common practice among pastoral communities. In the semi-pastoral town of Arusha in Tanzania, a study indicated that 82% of the children were started on complimentary foods before 6 months of age.[38] This is risky as the gut of a young child is not well established to digest semisolid foods

and thus, these children are more vulnerable to gastrointestinal infections. Additionally, early introduction of complementary foods may increase the risk of food-borne infections. These infections can contribute to an even greater risk of malnutrition.[38]

Increased Availability of non-ASF foods

In relation to the lack of cattle, participants expressed that they have had to find other available foods to sustain their diets and oftentimes this included vegetables and fruits at markets. This has led to the introduction of more "new" vegetables and fruits in diets, as participants expressed how there has been a reduction in indigenous and wild vegetable consumption. These results are consistent with previous literature in regard to access to vegetables overall due to sedentarization and market access, however studies have not focused on the lack of access to indigenous/wild vegetables at these markets. A male participant in an IS (intensive sedentary) village explained, "*In the past we used to eat a lot of original foods like mushrooms, many different fruits. Nowadays we have many new things like mango juice or young coconut (madafu). There are subtle changes.*"

Additionally, in contrast to findings by Ianotti which observe a shift away from vegetables toward increasing reliance on milk for vitamin A, participants in this study for the most part could not rely on milk for nutrition purposes due to its inaccessibility and take advantage of market access to vegetables.[4] Participants also acknowledged that environmental changes associated with changes in cattle production have led to modifications in the cultivations of crops and their availability at markets. There has also been an increase in market utilization for food procurement by women. An EP (extensive pastoral) Adult Male FGD participant expressed, "*The women are also affected because in the past there was a lot of pastures, cattle were reproducing smoothly and hence milk was in abundance; some were even extracting ghee from the milk which they use to*

prepare food but nowadays everything is bought." From previously preparing and consuming mainly meat and milk, some of the new bought staples of the settled pastoral diets mentioned by the participants also include carbohydrate heavy foods such as refined cereal, maize meal, and chips as indicated from the pile sorting activities; this allowed participants to characterize the foods that are and are not available in their respective communities.

Increased Availability of non-ASF foods – Implications on MCH

With the transition from nomadism to sedentism, availability of foods other than ASF during dry seasons increased due to food procurement at markets. As expressed by participants and in line with previous research, this resulted in higher consumption of carbohydrate-heavy foods.[1-4] Although carbohydrate rich foods can offer passable caloric intake and reduce hunger needed to survive, they lack in rich micronutrients and increase the risk of micronutrient malnutrition.[4] Maize, in particular, inhibits zinc absorption due to its phytate content. Zinc is fundamental in immunity, cell growth, cell differentiation, and other functions.[4] Potential implications of mothers buying mainly these products at the market for later consumption by her families, may lead to nutritional deficiencies within children. In terms of the difference in types of vegetables and fruits intake, a variety of different micronutrients may be consumed. Quantifying the vegetables and fruits being eaten now and within the next few years, such through 24-hour recalls and food frequency, can offer some insight into which nutrients are being consumed by women of reproductive age and children.

Convenience

With transitioning livelihoods, pastoral women and mothers have had to maximize the way in which they allocate their time and efforts. This involved many female participants contributing to selling milk when prior to sedentarization, they were not expected to engage in such activities.

"*In the past our women were not doing any kind of business; but now they do. They come to the market, cook some food and sell, they also sell milk when there are rains and milk is in abundance they sell the milk. But they were not doing this in the past.*" – Adult man in EP village FGD

Due to their current additional responsibilities, time and resources needed for women to cook are limited. Thus, many participants expressed how they now are consuming sardines packaged and bought at markets as this fish is cheap and requires little preparation, making it convenient to serve and leading to the increase in fish consumption. When preparing for males leaving the community to travel with cattle, women now buy sardines for the males to consume during their journey. "*Maasai also started to eat sardines because they used to travel with cattle from one place to another, along the way they had to prepare stiff porridge, so they used sardines as relish*," expressed an EP female participant. Women also expressed feeding fish to their children as it was quick to prepare, even if they did not consume the fish themselves for reasons that will be discussed later. It is evident that convenience is a major facilitator for fish consumption.

Convenience of Fish – Implications on MCH

The rise in fish consumption due to convenience is a new finding among pastoral communities. FAO has acknowledged that preferences for fish consumption among pastoral communities in East and Central Africa, had been predominantly low and that pastoralists are meat consumers by habit, however convenience has not been mentioned as a driver for fish consumption. Fish, fresh or dried, offers many nutritional benefits, such as rich sources of vitamin B12, vitamin A, heme and non-heme iron, zinc, calcium, and omega-3 fatty acids. Due to the reduction in milk, blood, and meat consumption, the micronutrients aforementioned are lacking in settled pastoral diets and can be in part replaced by fish consumption. Fish is commonly an overlooked source of diet variability and micronutrient adequacy. In a 2018 study by Marinda et. al. conducted in Zambia, the role of dietary fish and subsequent nutritional status was examined

among women of reproductive and children aged 6-59 months.[39] Quantity of fish consumed by children was significantly associated with reduced stunting, despite children from poorer households consuming the most fish.[39] This indicates that fish consumption among settled pastoral children may be a protective factor against malnutrition, and one that mothers should take advantage of when feeding their children.

Changes in Cultural Norms and Perceptions

Sedentarization of pastoral communities began decades ago, contributing to a massive change in cultural norms and perceptions.[1-4] Participants frequently expressed the intergenerational differences in cultural norms and perceptions regarding ASF food choice, with the two main sub-themes of reduction of stigma and modernization related to increased consumption of fish, chicken and eggs and decreased consumption of cattle blood.

A) Reduction of Stigma

Historically, Tanzanian pastoralists, especially the Maasai, have not consumed fish due to it being looked down upon.[40] A woman of reproductive age in an EP village explained how eating fish was comparable to eating snakes in terms of how taboo it was for the Maasai to consume fish in the past. However, over the past few decades, sedentarization has led to better access to education and increases in interethnic exchanges, resulting in normalization of certain food patterns and shifts in perceptions surrounding fish consumption among former nomadic pastoralists for the majority of participants.

"*When kids/youth go to school they associate with different people from different other tribes and who have different ways of life (e.g. cooking) so the kids learn and adopt those ways and once they went back home they practice those new ways… Mixed up with different people from different tribes contributes to those changes, in the past Maasai we were living in the forest all by*

ourselves without mixed up with other tribes but now we are living in town with different people, so this causes to adopt other people's way of living including what they eat." – Youth Male in EP FGD

This young male participant shares similar points of view with many of the youth and adults of reproductive age participants in the study in terms of the considerable reduction of stigma related to fish. The elderly have also acknowledged that the younger generations have been consuming fish and although they do not engage in fish consumption to the same extent, they recognize the reduction in stigma surrounding it.

B) Modernization

Sedentarization in towns has led to more children attending school, exposure of different norms, alterations in gender roles, and accessibility to healthcare and religious institutions, all of which have contributed to transitioning from traditional ways of life to more modern ones among the pastoralists, all of which have been cited in previous literature.[1-4] This has had a significant positive impact on the consumption of chicken and eggs and a negative impact on the consumption of cattle blood. Modernization also led families to be income-generating oriented, including women. In stark contrast to previous times when this was the duty of the father of the household, women are now expected to assist in income generation, household sustenance, and to share responsibilities. As expressed by participants, at the end of the day, women are expected to come together with men and share the income they have worked for collaboratively, making space for an equal voice in terms of decisions for the family including food choice ultimately leading to more consumption of fish, chicken, and eggs.

"*At my young age a man and woman used to stay separately, they did not sit together on the same place, but nowadays they sit together and discuss some issues for their families, At my young age, some people did not eat sardines, cassava, chicken, eggs etc., but nowadays due to nutrition education provided to the community, more especially on the important nutrients found in these*

foods which are very essential in the body growth and strength, people have started eating sardines, fish, chicken, eggs, etc." – Elder Male Participant in ES village FGD

The accessibility to education through various channels has led to the aforementioned changes in diet. Schools and healthcare facilities have provided nutritional education in terms of the benefits of chicken, eggs, and fish and the risks of cattle blood consumption to mothers, children, and women of reproductive age. Some Maasai pastoralists who have given up certain cultural beliefs in the pursuit of participation at religious institutions have described that these institutions look down about cattle blood consumption and therefore there has been a decrease in blood consumption. Children attending schools has led to their families learning about various nutritional knowledge and changes in diet as well, beneficial for all family members.

" *Children convince us to eat as some even demand to eat the food; say a child can boil or fry some eggs and eat or cook some chicken. In doing this we also see that there is no point in sticking to the traditional norms while we have a food crisis on our hands."*- Adult Woman Participant in EP village FGD

Not only does increase in utilization of chicken and eggs help mitigate the food crisis the woman above described, but it also offers a variety of different meals that can be made. "*We are eating eggs and these are eaten in many styles; we can boil them or fry them or mix them to porridge for the babies*," said an adult woman participant in an EP village. The versatility of eggs makes it easy and appealing for mothers and caregivers to cook and provide for their families.

Changes in Cultural Norms and Perceptions – Implications on MCH

Changes in cultural norms and perceptions within pastoral communities come with a wave of different implications on MCH, mainly positive. First and foremost, the shift towards working women in sedentary pastoral communities allows for empowerment in generating income and having an equal say in food decisions for the family, which is consistent with previous research. It

has been shown through an abundance of literature that women's empowerment and greater agency contribute to improved health outcomes for not only themselves, but also the families and communities they are a part of.[41] Fratkin explains how women's income generated from sales usually goes to purchase different types of foods that are used to feed the household. Thus, the relationship between a women's income and nutritional levels of household members, especially children, is a significant one, perhaps even leading to greater effects on children's health than the income generated by men.[33] Pastoral women will be able to advance their own interests, participate in society, and help improve child nutritional outcomes. Secondly, reduction of stigma of fish consumption can help improve nutritional outcomes for reasons discussed earlier. Thirdly, the reduction of cattle blood consumption has yet to be studied extensively in terms of its exact nutritional value because of its very scarce and declining utilization within current pastoral communities. The reduction in heme iron consumption within mothers and children, contributing to reduced growth and other benefits, is plausible. However, how extensive micronutrient deficiencies are with the lack of blood consumption paired with the increase in micronutrient intake from fish, chicken, and egg consumption, is difficult to determine. This is related to the next major implications of changes in norms and perceptions in regard to increase in chicken and egg consumption. This increased consumption can offer a substantial improvement in nutrition. Although there has been an increase in chicken consumption and is nutritious in protein, B12, and B3, it seems as though eggs are the preferred choice among pastoral communities, as they are cheaper and more accessible as many chickens are sold for income. Eggs can provide vitamin A, B12, selenium, essential fatty acids, protein, choline and other critical nutrients comparable to those found in ASF such as meats and milk, however are more affordable.[42] It has been found that even though eggs have the potential to significantly improve child nutrition, they are underused in the diets of young children particularly in many African countries.[42] This can be seen in nomadic

pastoral communities however the shift to sedentism have allowed children better utilization of eggs as exemplified in the data. The data has shown that pastoralists are recognizing the nutritional value of eggs, versatility in preparation, and demand from children, leading to an increase in consumption of the high-quality complementary food. Though few interventions have been performed in terms of increasing egg consumption in communities, eggs show tremendous potential for improving MCH nutrition for pastoral families.

Habit

Throughout the data, habit has consistently emerged as a barrier to consumption of eggs, fish, and chicken, especially within the elderly pastoralists, which is consistent with previous literature. Within habit are two sub-themes of sensory perceptions (such as taste, aroma, appearance) and food roots.

A) Sensory Perceptions

Sensory perceptions are a huge driver for food choice for all types of food. It has been well-studied and although it is not static, it shapes the way humans interact with and experience food.[43] Among elderly pastoralists, the main finding related to sensory perceptions was a dislike for fish due to its aroma and taste. An elder woman FGD participant in an ES village describes, "*We do not eat sardines or fish because of their smell, so when we eat them we feel like vomiting.*" Although elderly participants have tried fish, they prefer consuming other ASF sources.

B) Food Roots

Food roots can be explained as food habits from childhood that lead to persistent patterns of food choice in adulthood.[44] East African pastoral communities, like the Maasai, have been known

to avoid consumption of fish, chicken, and eggs as they were not part of the customary diet.[1-4] Consistent with these prior findings, food roots were found among the elderly and adult men and women in regard to lack of consumption of fish, chicken, and eggs. They were also found among those who continued to follow cultural norms in relation to cow meat consumption, during the times it was available. Participants explained how in the past, their diet relied heavily on the traditional pastoral diet consisting of meat, milk and blood. Thus, now they do not have the habit of consuming other ASFs as they have not been used to it while growing up.

> ***"****Women and men of our age do not eat sardines and fish because we used to have enough cows, we had enough meat and milk, we had enough goats, so we did not have any need to eat fish, up to this time we do not eat them, but our children do eat these foods."* – Elder woman FGD participant in ES village

A religious leader in an ES village explained during a key informant interview that people are just not interested in consuming eggs, chicken, and fish. Participants explained that although they acknowledge that there is now nothing wrong about consuming eggs or fish, they are not motivated to try it if they have not grown up with consuming these foods. Multiple participants explained that once they have tried these foods, however, they have continued to incorporate these foods into their regular diet and see these foods as normal.

Food roots regarding cow meat consumption relates to the allocation of different cuts of meat to different members of the pastoral community. This is mainly implemented by those who follow traditional norms such as the elderly. For example, whenever a cow is slaughtered for a religious or celebratory occasion, cow kidney is usually reserved for adults and mature men and the softer and often less nutritious parts of the cow are given to the elderly and young children. However, the way in which the distribution of parts is determined is dependent upon the head of the pastoral community and can vary from one group to another.

Habit – Implications on MCH

Habit surrounding fish can lead to the reduction of fish consumption in women. As aforementioned, some mothers prepare fish for their children however are reluctant to try it themselves due to sensory perceptions and food roots. This prevents women from taking advantage of the high-quality nutrition available in fish. However, as some participants expressed, once people do take the opportunity to try new foods, like fish, they often continue to consume it. Perhaps, investigating how to move past sensory perceptions within pastoral communities can offer insight on effectively introducing fish into the diet which would allow women and elders to benefit from its nutrition, which has been touched on in previous literature as well. Blench explains that although making more effective use of fish consumption in pastoral communities to increase food security should be prioritized, changing entrenched dietary preferences is quite difficult.[2]

Habit among the elderly surrounding fish consumption may also lead to nutritional changes in children due to the potential influence of grandmothers on diet.[46] Research has shown that paternal grandmothers have a powerful, complex role in the extended family in other regions of the world, in terms of childcare, agricultural practices, and even marital relations.[46] Although the role of grandmothers within settled Tanzanian pastoral communities have not been examined, it might influence execution of complementary feeding due to differences in food preferences, leading to various nutritional outcomes of the infant.

Food roots related to different cuts of meat for different members of the pastoral communities may lead to nutritional differences among mothers and children. Beef kidney is one of the most nutritious organs to consume, offering 300% of the B12 recommended daily intake and an abundance of other key vitamins.[46] However, this portion of the cow is usually reserved for adults, particularly men. Cow intestines are also nutritious however, also not usually given to

children.[46] Although literature on the specific implications in terms of nutritional intake from each of these cuts are not readily available, it can be assumed that children can benefit from consuming the higher quality cuts as they are already vulnerable to malnutrition. Pregnant and breastfeeding pastoral women can also benefit from these cuts in order to provide the fetus with rich and higher quality nutrients.

Conclusions

Drivers of ASF choice are multifaceted factors embedded within a web of societal structures, environments, and cultures. Sedentarization within pastoral community participants has led to drastic changes in diet and ASF consumption, with various positive and negative implications on MCH. Consistent with previous research, consumption of cow meat, blood, and milk have significantly reduced due to lack of cattle, which has negatively impacted nutrition quality and overall livelihoods. Data revealed that habit has also acted as a noticeable barrier to consumption of other ASF mainly among the elderly and the adults of reproductive age. Despite these barriers, findings indicated that the adaptation of the pastoral communities that include the several facilitators to ASF consumption may improve MCH outcomes by reducing malnutrition within transitioning Tanzanian pastoral communities. Convenience and changes in cultural norms and perceptions with reduction in stigma and modernization enable increased consumption of egg, chicken, and fish within pastoral communities. Understanding exactly how this consumption within pastoral communities can contribute to comprehensive sustenance among infants, children, and women of reproductive age, can provide insight on how nutrition interventions should utilize these food sources in light of the lack of cattle and dietary distress, while still maintaining cultural sensitivity. Moreover, employing methods to continue to empower and educate women about their choices can provide more agency when making food decisions for their families.

Future Research

Based on the findings of this paper, it is evident that sedentarization offers both benefits and constraints. The difficulty now is to reconcile the negative implications on MCH outcomes, the biggest being malnutrition due to lack of cattle and subsequent ASF, with the other possible beneficial social consequences of sedentarization, such as the effects of modernization, namely education among children and women's empowerment. Further research is needed to garner perceptions about a possible intervention that can build off the current pastoral livelihood by preserving pastoral culture and norms instead of trying to completely alter it, giving rise to more sustainable outcomes - only then can policy be implemented.

Currently, policymakers in Tanzania are widely unaware of the challenges that come from sedentarization among pastoralists and are misguided when trying to implement regulations specific to them.[47] This may be one of the contributions to persistent food security issues within pastoral communities as top-down interventions undermine pastoral livelihoods instead of supporting them. Thus, implementing policy focused on uplifting pastoral communities by addressing and catering to current needs is essential. Policies aimed to increase cattle numbers can focus on minimizing cattle death due to drought and starvation by implementing regulations on expanded land use for open pasture. This can also include emphasizing the importance of taking action against rising climate change leading to drought. Additionally, due to the vast consequences related to lack of milk within these pastoral communities, having policies that allow increased accessibility to milk can prove to be beneficial. An example of this can be introducing community-defined livestock interventions aimed to improve nutritional status of young children by offering support to milking cattle that stay close to women and children. This can allow for improved milk consumption among children and subsequent nutritional benefits, while still providing women agency to sell milk when in abundance.

In conjunction with the interventions and policies above, qualitative research can be done to assess how the current facilitators to ASF consumption can drive more egg, fish, and chicken intake within pastoral communities. Finally, further education and information can be disseminated via interventions focused on teaching pastoralists the nutritional value of these foods, especially during the lack of resources for a traditional diet. These recommendations are in line with the Millennium Developmental Goals to "eradicate extreme poverty and hunger, reduce child mortality, and improve maternal health." Building off the current pastoral paradigm, by providing solutions to the barrier of lack of cattle and providing access to milk and new forms of ASF, has the potential to address the most pressing needs to alleviate malnutrition and improve pastoral MCH outcomes.

Limitations

These results are based off secondary data analysis, which can result in a loss of contextual understanding and consideration of nuances of participant perspectives between researchers responsible for data collection and those responsible for data analysis. The codes specific to ASF foods (blood, cow meat, chicken, eggs, fish) were developed and utilized by only one researcher, resulting in a lack of code agreement and potential bias. Finally, the original research question driving data collection was wider and unspecific to implications of MCH and drivers of ASF consumption. This led to a lack of information available in the data regarding certain issues relevant to this paper. Thus, a more specific and focused research study can provide more nuanced and in-depth findings related to drivers of food choice specific to ASF and subsequent implications on MCH outcomes.

Figure 1. Overall Map of Drivers of Animal Source Food Choice. This map displays the various factors that come into play when the study populations ultimately decide to consume a particular ASF group.

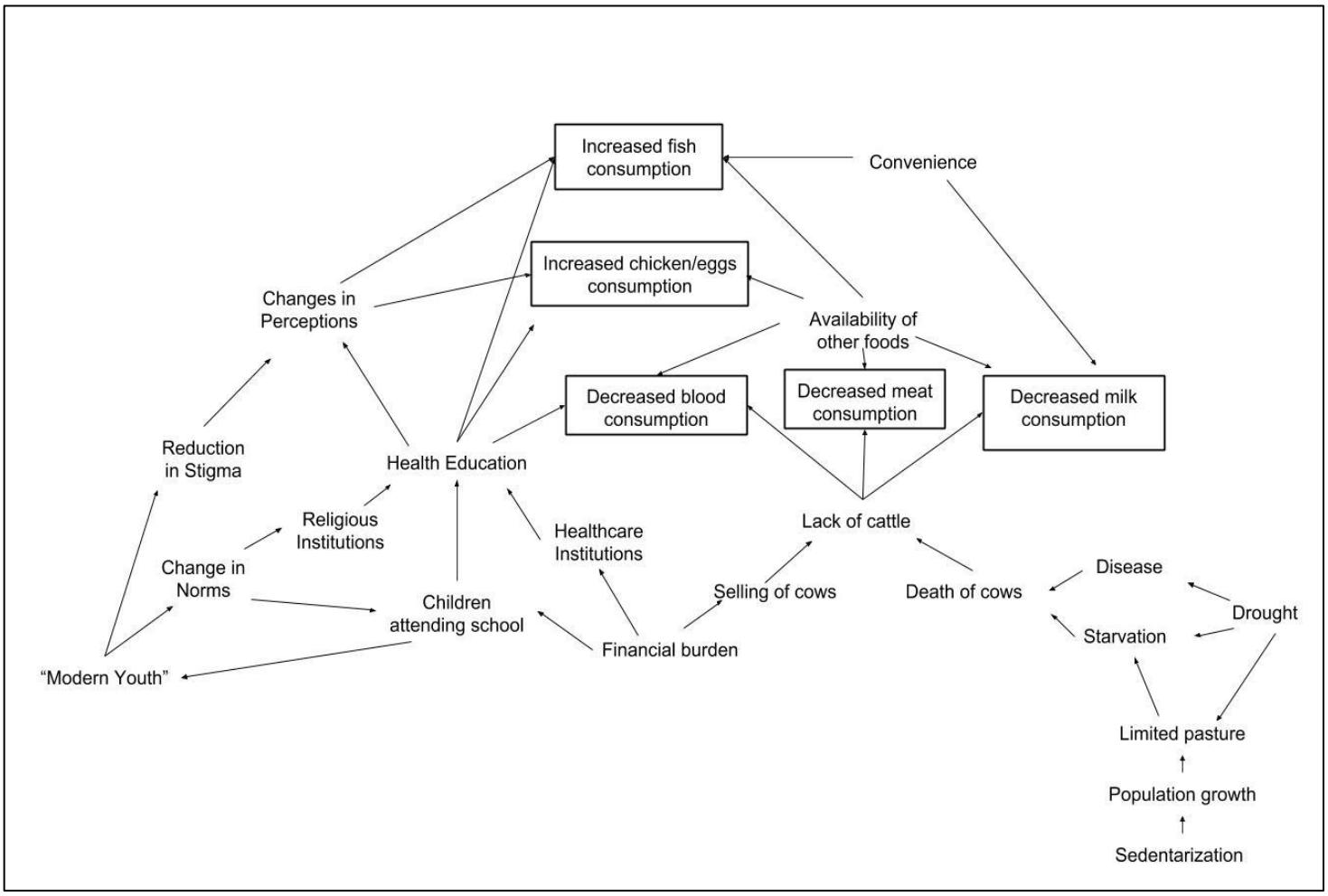

Figure 2. Outline of Drivers that Influence Cattle Blood Consumption

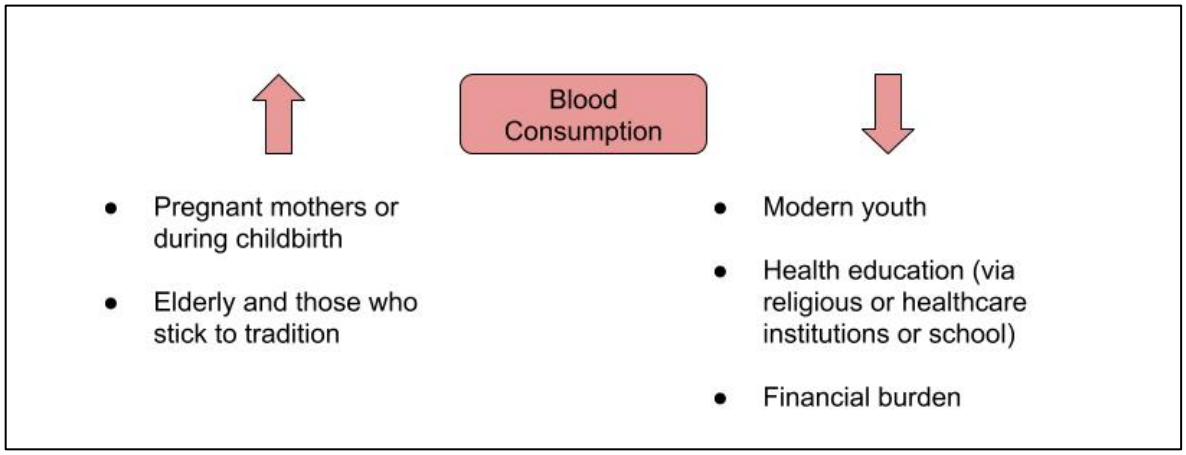

Table 1. Overview of Animal Source Food Choice Trends and Potential Implications on Maternal and Child Health

Animal Source Food	Trend	Implications on MCH
Blood	- Given to pregnant mothers or right after childbirth	- Highly bioavailable heme iron intake present in breastmilk for infant consumption
	- Lack of consumption among children	- Reduced iron intake and potential risk of reduced child growth
Chicken/Eggs	- Increase in consumption within youth, especially girls	- Young girls more likely to consume eggs leading to future outcomes of improved nutrition status among children of next generation
	- Education to young females and mothers about nutritional significance	- Increase in frequency of chicken/egg consumption and therefore higher micronutrient and protein intake within women of reproductive age
	- Variety in dishes being cooked by mother for family	- Motivation for mothers to cook more egg dishes and subsequent increase in frequency of nutrient rich food consumption among children
	- Interethnic interaction	- More children across ethnic groups consuming nutrient-rich foods
Cow Meat	- Specific types of meat allocated to specific people (i.e. children not allowed to eat cow kidney, elderly women given only soft parts, young girls prohibited to eat cow whose calf is died during birth, etc.).	- Varied nutrient intake based off dietary value of each section of cow meat. Children prevented from consuming highly nutritious beef cow kidney, resulting in decreased nutritional status compared to other pastoralists
	- Education about proper meat handling	- Mothers utilize proper food safety and thus decrease the risk of illness among children
Fish	- Dislike in sensory perceptions (taste and aroma)	- Mothers less likely to consume fish, resulting in decreased intake of vital nutrients
	- Increase in consumption within youth	- Increased consumption of nutrient-rich foods among children
	- High level of convenience	- Though mothers are less likely to consume, they may be willing to provide fish as food for children due to their convenience
Milk	- Significant lack of consumption within youth	- Reduced micronutrient intake vital for growth and subsequent risk for malnutrition, stunting/wasting

Chapter 4: Conclusion and Recommendations

Conclusions

Drivers of ASF choice are multifaceted factors embedded within a web of societal structures, environments, and cultures. Sedentarization within pastoral community participants has led to drastic changes in diet and ASF consumption, with various positive and negative implications on MCH. Consistent with previous research, consumption of cow meat, blood, and milk have significantly reduced due to lack of cattle, which has negatively impacted nutrition quality and overall livelihoods. Data revealed that habit has also acted as a noticeable barrier to consumption of other ASF mainly among the elderly and the adults of reproductive age. Despite these barriers, findings indicated that the adaptation of the pastoral communities that include the several facilitators to ASF consumption may improve MCH outcomes by reducing malnutrition within transitioning Tanzanian pastoral communities. Convenience and changes in cultural norms and perceptions with reduction in stigma and modernization enable increased consumption of egg, chicken, and fish within pastoral communities. Understanding exactly how this consumption within pastoral communities can contribute to comprehensive sustenance among infants, children, and women of reproductive age, can provide insight on how nutrition interventions should utilize these food sources in light of the lack of cattle and dietary distress, while still maintaining cultural sensitivity. Moreover, employing methods to continue to empower and educate women about their choices can provide more agency when making food decisions for their families.

Future Research and Policy Recommendations

Based on the findings of this paper, it is evident that sedentarization offers both benefits and constraints. The difficulty now is to reconcile the negative implications on MCH outcomes, the biggest being malnutrition due to lack of cattle and subsequent ASF, with the other possible

beneficial social consequences of sedentarization, such as the effects of modernization, namely education among children and women's empowerment. Further research is needed to garner perceptions about a possible intervention that can build off the current pastoral livelihood by preserving pastoral culture and norms instead of trying to completely alter it, giving rise to more sustainable outcomes - only then can policy be implemented.

Currently, policymakers in Tanzania are widely unaware of the challenges that come from sedentarization among pastoralists and are misguided when trying to implement regulations specific to them.[47] This may be one of the contributions to persistent food security issues within pastoral communities as top-down interventions undermine pastoral livelihoods instead of supporting them. Thus, implementing policy focused on uplifting pastoral communities by addressing and catering to current needs is essential. Policies aimed to increase cattle numbers can focus on minimizing cattle death due to drought and starvation by implementing regulations on expanded land use for open pasture. This can also include emphasizing the importance of taking action against rising climate change leading to drought. Additionally, due to the vast consequences related to lack of milk within these pastoral communities, having policies that allow increased accessibility to milk can prove to be beneficial. An example of this can be introducing community-defined livestock interventions aimed to improve nutritional status of young children by offering support to milking cattle that stay close to women and children. This can allow for improved milk consumption among children and subsequent nutritional benefits, while still providing women agency to sell milk when in abundance.

In conjunction with the interventions and policies above, qualitative research can be done to assess how the current facilitators to ASF consumption can drive more egg, fish, and chicken intake within pastoral communities. Finally, further education and information can be

disseminated via interventions focused on teaching pastoralists the nutritional value of these foods, especially during the lack of resources for a traditional diet. These recommendations are in line with the Millennium Developmental Goals to "eradicate extreme poverty and hunger, reduce child mortality, and improve maternal health." Building off the current pastoral paradigm, by providing solutions to the barrier of lack of cattle and providing access to milk and new forms of ASF, has the potential to address the most pressing needs to alleviate malnutrition and improve pastoral MCH outcomes.

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