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Kathryn Mishkin Date

A dairy hub intervention was associated with increased milk intakes among reproductive age women in rural Tanzania

By

Kathryn Mishkin

Master of Public Health

Global Health

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Amy Webb Girard

Committee Chair

# A dairy hub intervention was associated with increased milk intakes among reproductive age women in rural Tanzania

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Masters in Sustainable International Development

Brandeis University

2015

Bachelor of Arts

Smith College

2009

Thesis Committee Chair: Amy Webb Girard, PhD

An abstract of

A thesis submitted to the Faculty of the
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# Abstract

A dairy hub intervention was associated with increased milk intakes among reproductive age women in rural Tanzania

By Kathryn Mishkin

**Objectives:** Animal milk serves as an animal source food that contributes to women's dietary diversity, especially among pastoral communities. Despite this, there is limited literature describing how women's milk consumption is associated with environmental and social influences. The objective of this study was to describe the factors associated with women's milk consumption behavior in four districts in rural Tanzania.

**Methods:** This study utilized data from two surveys conducted in the Morogoro and Tanga regions of Tanzania in 2015. Data from 232 pastoral and agro-pastoral women participating in both surveys were used. Chi-square and Cochran–Mantel–Haenszel analyses were conducted to identify factors associated with whether milk was consumed in a 24-hour period. ANOVA analyses were performed to identify factors associated with frequency of milk consumption. Logistic regression was performed to quantify the independent effect key variables.

**Results:** Of the total sample of women, 76% reported drinking milk in a 24-hour period. The proportion reporting milk consumption in the previous 24 hours was greater among residents of Morogoro ($p<0.01$), self-identifying as Masaai ($p<0.01$), self-identifying as non-Seventh Day Adventist Christians (non-SDA, $p<0.01$), women residing in pastoral households ($p<0.01$), women residing in food insecure households ($p=0.02$), women in the experiment group ($p=0.01$), and women who were breastfeeding ($p=0.01$). The odds of consumption of milk were 16.1 times greater for Masaai than other tribes, adjusting for insecurity status, religion, marital status, presence in the control group, breastfeeding status (95% CI 1.72- 150.44). The odds of consumption among non-Masaai tribe members was 3.45 times greater for those in the experiment, compared to those who were in the control, adjusting for religion, food insecurity status, marital status, relationship to the household head (95% CI 1.07- 11.05). The odds of Masaai consuming milk 3-4 times a day compared to 1-2 times was 9.96 times greater if they were in the experiment group compared to the control, adjusting for breastfeeding, livelihood strategy, food insecurity, marital status, and religion (95% CI 1.03 - 96.09). No factors were associated with increased milk consumption among women who were not Masaai. No factors were associated with maternal underweight or morbidity. Food and milk inadequacy occurred throughout the year, and results showed that severity of milk inadequacy occurred at different times for Masaai and non-Masaai.

**Conclusions:** Milk consumption was greatest among Maasai and those communities with active dairy interventions. Additional longitudinal research with larger and more representative samples should be conducted to verify impacts of the dairy interventions and articulate the factors associated with milk consumption among Masaai and other tribal groups.



KEY WORDS: milk, women's health, nutrition, food security, Tanzania, East Africa, pastoral, sociodemographic

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# Chapter 1

## Introduction and rationale

The preconception health of a woman can impact her health in the perinatal period, her health in the postnatal period, and the health and development of her child [1, 2]. Maternal health impacts both the individual woman's quality of life and that of her community, and because of this, improved maternal health and neonatal health are often synonymous goals [3]. Both the Millennium Development Goals (MDG-5) and Sustainable Development Goals (SDG 3.1) reference maternal health as a key indicator to improve health [4, 5]. Women's health is dependent upon nutrition and women of reproductive age have specific nutritional needs. This is especially true in low and middle income countries (LMIC), where over half of women are at risk for nutritional problems [1]. An estimated 10-20% of women of reproductive age are considered to be underweight in Africa, and this has ramifications for their quality of health and life, as well as their ability to work, and ability to fight off infections, and to provide adequate care for their children [6-10]. This poor nutritional status puts them at risk for complications due to malaria, diarrhea, HIV, measles, and influenza [7]. Furthermore, 40% of women of reproductive age in Africa are affected by anemia and since iron deficiency is considered to contribute to roughly half of anemia cases, it can be estimated that 50% of those women require supplemental iron [9, 11, 12]. Anemia and low body mass index (BMI) is associated with less energy, a deficient immune response to disease, and higher risk of morbidity and mortality [13, 14]. Women who are who are not meeting their nutritional needs in pregnancy are at high risk for maternal morbidity and mortality and inadequate nutrition can also result in slow and/or poor fetal growth, low infant birth weight, and fetal death [7, 15].

## Milk for women's health

Animal milk serves as an excellent source of amino acids and both macro and micro nutrients that can contribute to meeting women's nutrition needs [16]. It is rich in calcium, vitamin A, vitamin C, iodine, riboflavin, and vitamin B12 [17, 18]. Milk has been demonstrated to improve women's health in many ways. Milk consumption is associated with lower, but healthy, BMI in young women and girls [19, 20]. Furthermore, in young obese women, milk consumption is documented to have antihypertensive effects and improved arterial function [21]. Fermented milk is demonstrated to result in more skin hydration and skin elasticity [22]. Women's consumption of whey protein, derived from milk, is also associated with increased insulin growth factor-1 (IGF-1), which promotes bone growth [23]. Dairy consumption contributes to a roughly 40% increase in bone density especially in women [24]. A limitation to these studies is that they have rarely focused on women in resource poor settings.

While there is some research about the effect of maternal animal milk consumption during pregnancy on children's health in wealthier countries, there is much less research about the specific impact of drinking milk while pregnant on women's own health. Research that has been conducted shows that milk consumption serves as a predictor for increased weight gain during the third trimester of pregnancy [25]. Research also indicates that increased calcium intake, such as from that found in milk, may reduce hypertension and the risk for preeclampsia [26, 27]. Understanding the impacts of milk consumption on women's health in resource poor settings is crucial to improving the health status of women in the global sphere.

## Milk intake moderated by sociodemographic factors

Milk consumption is moderated by a variety of factors. Pastoral communities in Africa have long been documented to be dependent upon milk for their nutrition [18]. This is because milk is more

continuously available during most of the year compared to meat, which is only available when animals are killed [28]. While many pastoralist communities are increasingly supplementing their dietary needs with cereals and grains, milk continues to serve as a key source of nutrients [18]. An estimated 10% of the Tanzanian population practices pastoralism or agro-pastoralism [29]. Tanzania produces 1.18 billion liters of milk annually, of which 70% is derived from agro-pastoral and pastoral communities [29]. The communities producing the milk are estimated to consume 90% of the milk [29].

## Problem statement

While there is a significant collection of research about the impacts of animal milk consumption on children's health, there is much less focusing on women's milk consumption in developing country contexts and factors that may influence women's milk consumption.

## Purpose statement

This thesis will contribute to the literature about maternal consumption of milk in resource poor settings. It will provide a descriptive analysis of sociodemographic variables associated with women's milk consumption and the potential health impacts of milk consumption.

## Research question

This thesis seeks to identify sociodemographic variables associated with women's milk consumption as well as the potential effects of milk consumption on women's health outcomes.

## Significance

This thesis will contribute to the scarce literature about women's milk consumption behavior, and the ways in which sociodemographic factors influence milk consumption. Animal milk serves as an excellent source of animal source protein, as well as macro and micronutrients, milk

can serve as an essential part of women's diet. This is especially true in resource poor settings where the killing of animals to obtain animal source protein is excessively expensive. Milk serves as a renewable source of animal protein in this way; all that is required is the maintenance of the animal. This thesis will provide analysis of the factors associated with milk consumption, which may be used to inform nutrition policies and programs.

Definition of terms

| | |
|---|---|
| ASF | Animal Source Food |
| BMI | Body Mass Index |
| DDS | Diet Diversity Score |
| FANTA | Food and Nutrition Technical Assistance Project |
| FAO | Food and Agriculture Organization |
| FVS | Food Variety Scores |
| IGF | Insulin growth factor |
| LMIC | Low and middle income country |
| MAHFP | Months of Adequate Household Food Provisioning |
| M-DDS | Maternal Dietary Diversity Score |
| MDG | Millennium Development Goal |
| MUAC | Mid-upper arm circumference |

# Chapter 2: Literature Review

## Health of women and children dependent upon nutrition

The preconception health of a woman can impact her health in the perinatal period, her health in the postnatal period, and the health and development of her child [1, 2]. Maternal health impacts both the individual woman's quality of life and that of her community, and because of this, improved maternal health and neonatal health are often synonymous goals [3]. Both the Millennium Development Goals (MDG-5) and Sustainable Development Goals (SDG 3.1) reference maternal health as a key indicator to improve health [4, 5]. Women's health is dependent upon nutrition and women of reproductive age have specific nutritional needs. This is especially true in low and middle income countries (LMIC), where over half of women are at risk for nutritional problems [1]. An estimated 10-20% of women of reproductive age are considered to be underweight in Africa, and this has ramifications for their quality of health and life, as well as their ability to work, and ability to fight off infections, and to provide adequate care for their children [6-10]. Poor nutritional status puts them at risk for complications due to malaria, diarrhea, HIV, measles, and influenza [7]. Globally, 7.8% of pregnant women have night blindness (9.4% in Africa) and 15.3% (14.3% in Africa) have low serum retinol, both due to a vitamin A deficiency. Furthermore, 40% of women of reproductive age in Africa are affected by anemia and since iron deficiency is considered to contribute to roughly half of anemia cases, it can be estimated that 50% of those women require supplemental iron [9, 11, 12]. Anemia and low body mass index (BMI) is associated with less energy, a deficient immune response to disease, and higher risk of morbidity and mortality [13, 14]. Women who are who are not meeting their nutritional needs in pregnancy are at high risk for maternal morbidity and mortality [7, 15].

## Importance of micro and macronutrients

Consumption of micro and macronutrients significantly impact the quality of both the mother's health [30]. Sufficient folic acid is recommended to reduce the development of pre-eclampsia and hypertension during pregnancy [31, 32]. Essential amino acids promote the maintenance of the mother's health [33]. Calcium is necessary to prevent pre-eclampsia, hypertension, and excessive bone loss in pregnant women [34-36].

Improving maternal health is especially important for both the health of the mother and the development and health of the fetus. Despite the demonstrated evidence that maternal nutrition in the first six months of the child's life is essential to both the health of mother and child, a large number of women and children continue to be plagued by micronutrient deficiency [37]. Two billion people, most of whom live in developing countries suffer from lack of essential vitamins and minerals [37]. These statistics demonstrate a great need for improved nutrition.

## Dietary Diversity

Despite advances in agriculture production and the development of global markets, malnutrition including over and undernutrition continues to plague a large percentage of the world's population [38]. Malnutrition occurs due to disease, and both low food consumption and poor dietary quality in terms of both micro and macronutrient intake [39, 40]. Dietary diversity also plays a role in quality of nutrition, and dietary diversity can usually predict quality of nutrition [41-43]. Malnutrition plagues rural African small holder farmers because they are at high risk for lack of dietary diversity, inadequate consumption of food, and for illness due to preventable diseases [44]. Access to markets and additional disposable income to purchase supplemental food is associated with higher dietary diversity and with improved nutrition [44].

## Milk as essential component of good nutrition

Animal source foods (ASF) are found to contribute to dietary diversity because they provide vitamins A, E, D, riboflavin, calcium, iron, and zinc [45, 46]. Poor populations are at high risk for macro nutrient deficiency in part because of a lack of access to ASF [47]. Animal milk can improve dietary diversity as it serves as an excellent source of amino acids and both macro and micro nutrients [16]. It is rich in calcium, vitamin A, vitamin C, iodine, riboflavin, and vitamin B12 [17, 18]. In a randomized control trial involving elderly men and women, participants were asked to consume at least twice as much milk as they normally consumed. The benefits of the additional milk included increased intakes of energy, protein, vitamins A, D, and B-12, riboflavin, calcium, phosphorus, magnesium, zinc, and potassium [48, 49]. Participants also experienced lower blood pressure as a result of the additional milk [48].

### Milk for women's health

Milk has been demonstrated to improve women's health in many ways. Milk consumption is associated with lower, but healthy, BMI in young women and girls [19, 20]. Furthermore, in young obese women, milk consumption is documented to have antihypertensive effects and improved arterial function [21]. Fermented milk is demonstrated to result in more skin hydration and skin elasticity [22]. Women's consumption of whey protein, derived from milk, is also associated with increased insulin growth factor-1 (IGF-1), which promotes bone growth [23]. Dairy consumption demonstrates a roughly 40% increase in bone density especially in women [24].

### Milk and disease prevention

Milk may also promote good health through its disease prevention properties. Milk is constituted of 20% whey protein, and this whey protein has been shown to have anti-microbial and immune

boosting properties [50]. In fact, calcium and vitamin D supplementation has been demonstrated to significantly reduce cancers in all people, including postmenopausal women [51, 52]. Furthermore, milk has been demonstrated to reduce insulin resistance, high blood pressure, and abdominal obesity [53]. As a result, milk consumption is associated with overall healthy body weight including normal BMI measurement [54].

### Maternal consumption of animal milk for child health

Milk intake is associated with higher placental weight, higher infant head circumference, and greater abdominal circumference in pregnancy [55]. In a longitudinal study conducted in Denmark from 1996-2002, milk consumption during pregnancy was associated with high birth weight for gestational age, lower risk for small-for-gestational age infants, and higher incidence of large-for-gestational age [55]. In another 20-year longitudinal study, research in Denmark found that mothers that had consumed over 150 ml of milk each day of pregnancy had offspring with higher levels of insulin growth factor 1, which resulted in greater height and weight in adulthood [55]. Even after birth, when children consume milk, they are found to higher cognitive abilities compared to children that do not consume milk [56].

The impacts of maternal milk consumption on children have been documented in only a limited number of studies conducted in developing settings [57]. A limitation to the study of maternal milk consumption on children's health is that the vast majority of research has taken place in the developed world. As a result, it is not known whether and how much animal milk consumption during pregnancy would result in different child health outcomes in developing countries, where health, financial, and other resources are not as commonly available. Furthermore, potential incidence of disease due to unsafe milk quality must be taken into consideration when considering the impact of milk consumption in low resource settings [58]. For example, research

conducted in Tanzania found that isolates of staphylococcus aureus (35.3%), other staphylococci (20.8%), coliforms (27.7%), micrococci (5.8%) and streptococci (9.8%) were found in cows in the Dodoma and Morogoro regions [58].

### Maternal consumption of animal milk for mother health

While effect of maternal animal milk consumption during pregnancy on children's health in the developed world has been studied, less research has been done to identify the specific impact of drinking milk on women's own health in developing country contexts. Research in developed countries suggests that that milk consumption may be associated with increased weight gain during the third trimester of pregnancy [25]. Research also indicates that increased calcium intake, such as from that found in milk, may reduce hypertension and the risk for preeclampsia [26, 27]. Milk is an excellent example of an ASF, serving as a superb supplement to high carbohydrate diets, such as might be found in African settings, because it provides essential amino acids [18]. In fact, research shows that the specific properties of milk promote the human body's ability to best use protein from carbohydrate-heavy foods [59-63]. As a result, evidence shows that incorporating milk into traditionally carbohydrate-rich diets can both supplement nutrition and assist the body to best use all nutrients in food.

The limited research about the effects of milk consumption on women's health in developing countries is regrettable given the burden of maternal malnutrition is disproportionately born in these countries. This thesis will fill the gap in the literature about maternal consumption of milk in the developing world.

## Pastoralist culture and milk

Pastoralist communities in Africa have long been documented to be dependent upon milk for their nutrition [18]. This is because milk is more continuously available during most of the year compared to meat, which is only available when animals are killed [28]. While many pastoralist communities are increasingly supplementing their dietary needs with cereals and grains, milk continues to serve as a key source of nutrients [18]. For example, in a study conducted among pastoralists in Samburu, Kenya, while only 10% of energy intake was due to milk, over half of micronutrients, vitamins A and B12, and C were obtained from milk [64]. The Masaai in particular, a specific traditionally nomadic tribe, consume substantially more cow's milk (90%) compared to other ethnic groups (30-70%) [65].

Increasing access to milk is seen as an essential part of improving health outcomes by pastoralist community members [66]. Pastoral children are, on average, 25% more likely to have periods of malnutrition compared to 15% of agriculturists because of the seasonality of milk consumption [67]. Furthermore, despite receiving much nutrition from milk, pastoralist communities often are affected by childhood malnutrition and a body stature that is not normally found in other areas of the world [64, 67].

### *Seasonality of milk among pastoralists*

The seasonality of animal milk production in pastoralist communities affects the communities' health. In fact, in the Somali region of Ethiopia, child malnutrition is defined by the term 'Cano la'an' or the 'suffering due to lack of milk' [66]. This is especially true for community members who are at risk for disease and that have low fat stores [17]. Significant fluctuations in weight, as assessed through skin folds, BMI, and upper arm circumference, are recorded to take place throughout the year according to the season [17, 67]. Asa  result, despite the access to

micronutrients from milk, the Masaai may be at risk for poor health due to the seasonality of milk consumption and limited access to other foods, including fruits or vegetables that contribute to diverse diets [65]. Because of this macro nutrient deficiency during certain seasons, in rural Tanzania, Masaai children can be at higher risk for poor health compared to other ethnic groups [65]. In a study conducted in 2006 in the Simanjiro district of Tanzania, roughly 30% of children were documented to be underweight and 6% were severely underweight [68]. A 2014 study of ethnic groups in Tanzania found that only 9% of all households were considered to be 'food secure' and 6% experienced 'slight food insecurity' [65].

## Variation in life quality as livelihoods shift

### Health outcomes per livelihood strategy

As traditionally pastoral nomadic tribes increasingly adopt more diverse livelihood strategies, their health outcomes change as well. Settled, agricultural children are documented to have higher morbidity rates compared to pastoral children, and are more susceptible to diseases as well [69]. This is especially interesting because pastoral communities that have higher burden to obtain water have lower rates of childhood diarrhea incidence [69]. Settled children are also more likely to have lower age-specific height and weight measurements compared to nomadic children [69]. Women living in pastoral communities are likely to obtain more nutrients, from milk, compared to sedentary women [69]. Furthermore, when comparing pregnant and post-partum health status of pastoral and agriculture-based women, those living as pastoralist women have significantly higher iron and their children tend to have higher birth weights [70]. Meat consumption was demonstrated to occur more frequently among agro pastoralist communities compared to pastoralists [65].

### Socioeconomic status per livelihood strategy

It is difficult to determine the socioeconomic status of traditional pastoral communities because they do not often interact with traditional markets. Because of their reliance on their own milk production, their lifestyle, and their location, they are less likely to depend on external economies. Livestock raising provides a steady supply of food throughout the year, which results in less reliance on other food supply systems, and a less expensive lifestyle. Instead, it is possible to assess livestock wealth as a measure contributing to socioeconomic status. Within a pastoral community, livestock is essential for social status, as having more livestock results in more capability to produce and/or consume milk or meat. A large quantity of animals provides security in the case of emergencies where livestock may be sold to markets in order to buy goods needed to improve quality of health, such as medicines, schooling, etc. [29]. Livestock wealth in pastoral communities is positively correlated with dietary diversity [65, 71].

### Gender norms per livelihood strategy

In the pastoral community, women and men live in groups, or family clans. Clans serve as a social protective strategy, especially for women, because a woman's clan will protect her and defend her, as an offense committed against one member of a clan is considered an offense committed against the clan itself. Both men and women are considered have access to livestock as users and owners of animals. However, access to livestock does not correlate to control over livestock. Men are historically considered to have final decision-making power within clans, and while women may perform much of the labor related to livestock raising, they may not have the power to control how or why the work is being done, nor the income that is generated as a result of the work [72].

Pastoral communities are increasingly adopting agricultural practices as drought plagues areas where pastoral communities traditionally live, as the government does not recognize pastoralist claims to land use, and as migration is limited [72, 73]. Land ownership insecurity plagues pastoral communities, and this impacts the extent of control that pastoral communities have over their own produce. Female pastoralists have particular challenges, as both women and pastoralists. In situations where women are offered land, it is often of poorer quality and quantity than that allotted to men [74]. Furthermore, women's right to land ownership is often difficult to claim due to the cultural norm and the legal structure which relies on men as customary land owners [72].

Gender roles for agro pastoral communities are changing as land use changes. When pastoral communities adopt agriculture practices, it is often women who are responsible for the agriculture work [72]. Interestingly, when women are involved with income generating activities (IGAs) other than agriculture, men are more willing to adopt agriculture work to replace the work done by women [72]. Regardless, women are overwhelmingly responsible for milk production in pastoral communities [75].

## Impact of female-headed families on nutrition

Female-headed households are associated with reduced child malnutrition problems provided that sufficient financial resources are available [76, 77]. When women are allowed to make decisions about their household, they often make different financial decisions than men. If financial resources are adequate, children in female-headed households eat more nutritiously than those in male-headed households since women more often allot financial resources to the purchase of food compared to male-headed households. In a study conducted in 2011 in rural Tanzania, women's wealth was associated with eating animal source protein excluding fish, and

women participating in business were more likely to consume this ASF and have better blood iron levels [72].

Unfortunately, many female-headed households are often poorer than male-headed households, which leads to many female-headed households suffering from undernutrition due financial insecurity [78]. Women's low education level and marital status are also both indicated as factors affecting their children's malnutrition [79]. For example, gender biased intra-household food allocation prioritization impacts nutrition as well. In a study conducted in a Masaai village, 40% of men were recorded to eat first whereas only 1.6% of women were reported to eat first [79]. Women's lack of economic opportunities can result in poor diet leading to malnutrition, which can increase their risk for infections[80]. However, women who are empowered can greatly improve the health outcomes of their families.

## Milk cooperatives and women's empowerment

The impact of female-run cooperatives on women's health have been studied to some extent. Historically, projects that failed to account for women's contribution to dairy production contributed to unequal access to resources in societies where women have lower social status [81]. While women participated in projects informally, men had control over the resources [82]. Women's social status therefore has a tremendous impact on their health and nutrition status [81]. Research in India found that women-run milk cooperatives do not significantly change individual participant women's consumption of milk as most milk produced is treated as a commodity to be sold [81]. However, with the money gained from the cooperative business, additional food is bought [81, 83]. Some research indicates that increased participation in milk production by women results in shorter breastfeeding time and less exclusive breastfeeding [84].

## Malnutrition and milk in Tanzania

An estimated 10% of the Tanzanian population practices pastoralism or agro-pastoralism [29]. Tanzania produces 1.18 billion liters of milk annually, of which 70% is derived from agro-pastoral and pastoral communities [29]. The communities producing the milk are estimated to consume 90% of the milk [29]. Tanzanian women suffer from nutritional deficiencies. Women's average BMI is healthy at 23, and there is some variability between urban and rural populations [85]. However, while 61% of women ate vitamin-A rich foods, only 37% ate protein-rich foods such as legumes, 35% ate meat/fish/shellfish/poultry/eggs, and 19% ate cheese/yogurt daily [85]. As a result, 40% of women aged 15-49 are anemic and micronutrient deficiencies occur frequently [85]. Consumption of iron-rich food occurred in 35% of the population, and this differed by education level where higher education was associated with more consumption of iron-rich food.

Milk may serve as a means to improve nutritional deficiencies. Tanzania produces 1.18 billion liters of milk annually, of which 70% is derived from agro-pastoral and pastoral communities [29]. The communities producing the milk are estimated to consume 90% of the milk [29].

This thesis will add to the literature about sociodemographic factors and participation in a pro-poor agriculture development project relate to incidence and frequency of milk consumption among Tanzanian women of reproductive age. The study provides comparison of a variety of ethnic groups living in four district sites located in the two regions of Tanga and Morogoro. Analysis of annual milk, both in the general population and separated by Masaai and non-Masaai tribes is described to provide context for the milk consumption data. Liters of milk consumed per adequacy status quantify the adequacy data and further describe seasonality of milk adequacy and consumption. As a final analysis, the impact of sociodemographic factors and milk

consumption behavior on BMI are explored. This research provides a description of the association between various group characteristic factors and women's milk consumption, and as such, it offers a preliminary report of how rural lifestyles, cultural norms, and participation in agricultural projects result in more consumption of milk by women.

Following the literature review described above, I hypothesize that milk consumption will occur more frequently among the Masaai tribe. I hypothesize that seasonality of milk will occur, and that a high milk diet will be associated with healthy BMI Furthermore, I theorize that a high milk diet will result in less disease incidence per participant because of milk's immune-boosting properties [50].

# Chapter 3: Manuscript

A dairy hub intervention was associated with increased milk intakes among reproductive age women in rural Tanzania

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Abstract:

**Objectives:** Animal milk serves as an animal source food that contributes to women's dietary diversity, especially among pastoral communities. Despite this, there is limited literature describing how women's milk consumption is associated with environmental and social influences. This study describes the factors associated with women's milk consumption behavior in four districts in rural Tanzania.

**Methods:** This study utilized data from a sample of 232 women who had participated in two surveys conducted in the Morogoro and Tanga regions of Tanzania in 2015. Chi-square and Cochran–Mantel–Haenszel analyses were conducted to identify factors associated with whether milk was consumed in a 24-hour period. ANOVA analyses were performed to identify factors associated with frequency of milk consumption. Logistic regression was performed to quantify the independent effect key variables.

**Results:** Of the total sample of women, 76% reported drinking milk in a 24-hour period, consumption in the previous 24 hours was greater among residents of Morogoro ($p<0.01$), self-identifying Masaai ($p<0.01$), self-identifying non-Seventh Day Adventist Christians (non-SDA, $p<0.01$), residents in pastoral households ($p<0.01$), residents in food insecure households ($p=0.02$), women in the experiment group ($p=0.01$), and women who were breastfeeding ($p=0.01$). The odds of consumption of milk were 16.1 times greater for Masaai than other tribes, adjusting for insecurity status, religion, marital status, presence in the control group, breastfeeding status (95% CI 1.72- 150.44). The odds of consumption among non-Masaai tribe members was 3.45 times greater for those in the experiment, compared to those who were in the control, adjusting for religion, food insecurity status, marital status, relationship to the household head (95% CI 1.07- 11.05). The odds of Masaai consuming milk 3-4 times a day compared to 1-2 times was 9.96 times greater if they were in the experiment group compared to the control, adjusting for breastfeeding, livelihood strategy, food insecurity, marital status, and religion (95% CI 1.03 - 96.09). No factors were associated with frequency of milk consumption among women who were not Masaai. No factors were associated with poorer BMI. Food and milk inadequacy occurred throughout the year, and results showed that severity of milk inadequacy occurred at different times for Masaai and non-Masaai.

**Conclusions:** Milk consumption was greatest among Maasai and those communities with active dairy interventions. Additional longitudinal research with larger and more representative samples should be conducted to verify impacts of the dairy interventions and articulate the factors associated with milk consumption among Masaai and other tribal groups.

KEY WORDS: milk, women's health, nutrition, food security, Tanzania, East Africa, pastoral, sociodemographic

# Introduction

Women of reproductive age have specific nutritional needs. This is especially true in low and middle income countries, where over half of women are at risk for nutritional problems [1]. In these contexts, animal source foods (ASF) contribute significantly to dietary diversity and protein and micronutrient adequacy [2-7]. Enhancing milk consumption, because it is more ready available and "renewable animal source food may be a feasible strategy to improve women's nutrition. In pregnancy, milk consumption is associated with weight gain during the third trimester of pregnancy while increased calcium intake from milk may reduce hypertension and the risk for preeclampsia [8-10].

## Milk for health in resource poor settings

Some ethnic groups in Africa rely on milk as their primary source of nutrients [11]. While many pastoralist communities are increasingly supplementing their dietary needs with cereals and grains, milk continues to serve as a key source of nutrients [11]. In a study conducted among pastoralists in Kenya, over half of micronutrients, vitamins A and B12, and C were obtained from milk [12]. While the nature of milk production may be more sustainable than killing animals for meat consumption, the seasonality of animal milk production in pastoralist communities affects the communities' health. This is especially true for community members who are at risk for disease and that have low fat stores [13]. Significant fluctuations in weight can occur throughout the year because of these fluctuations in milk availability [13, 14].

## Milk consumption in Tanzania

Tanzanian women suffer from nutritional deficiencies In the 2010 national Demographic and Health Survey, 11% of women were underweight (BMI <18 kg/m2), and 22% were overweight (BMI > 25 kg/m2) [15]. Anemia affected 40% of nonpregnant women aged 15-49 and 53% of pregnant women. Diet is a likely contributor the maternal undernutrition. While 61% of women ate vitamin-A rich foods in the previous 24 hours, only 37% ate protein-rich foods such as legumes, 35% ate meat/fish/shellfish/poultry/eggs, and 24% consumed liquids including milk, water, and juice [15]. Consumption of iron-rich food occurred in 35% of the population, and this was moderated by education level [15].

Milk may serve as a feasible and acceptable strategy to reduce nutritional deficiencies in Tanzania. The country produces 1.18 billion liters of milk annually, of which 70% is derived from agro-pastoral and pastoral communities [16]. The communities producing the milk are estimated to consume 90% of the milk [16]. Strategies that increase milk production by agro-pastoral and pastoral households and improve stability of milk supplies over the year have the potential to increase milk consumption including among women. Dairy hubs are one strategy being tested by the International Livestock Research Institute to achieve greater milk production among cattle-keepers in Morogoro and Tanga regions of Tanzania. Dairy market hubs are localized groups of small producers with common interests in accessing inputs (feed, breeding, animal health) and services (training, credit, insurance), as a means to achieve a critical mass of supply. Unlike formal systems supplying, often distant, processing plants, hub-based production often serves nearby communities and markets, drawing on local service providers.

The current research uses data from this ongoing dairy in development project to explore the potential contributions of dairy hub interventions and other social and cultural factors to women's milk consumption. This study contributes to the scarce literature about women's milk consumption behavior, and factors that can influence milk consumption.

## Materials and Methods

### Procedures

Data from the Irish Aid-funded *More milk by and for the poor: Adapting dairy market hubs for pro-poor smallholder value chains in Tanzania* (MoreMilkiT) study were used for this study. This five-year research-for-development project coordinated by the International Livestock Research Institute assesses the agricultural strategy of improving milk production through milk cooperatives to address rural poverty, empower women, and improve household nutrition. This study was an exploratory analysis of sociodemographic, nutrition and health data collected from a subsample of 272 women from households in MoreMilkiT control and intervention communities.

### Participants

The MoreMilkiT project is ongoing in two districts in Morogoro Region (Kilosa and Mvomero districts) in the Coastal zone of Tanzania and two districts in Tanga region (Handeni and Lushoto districts) in the Northern zone. These districts were chosen by the MoreMilkiT project for their diverse populations of both pastoralist and sedentary agriculture-based cattle keepers. The sites were selected for the ILRI dairy hubs project because they present contrasting dairy production to consumption value chains. Kilosa and Handeni districts represent mostly pre-commercial rural production for rural consumption, while Mvomero and Lushoto districts represent more commercial rural production for urban consumption.

### Site selection and sampling

The four study districts were identified based on a combination of spatial map overlays, stakeholder consultations, scoping visits, and in-country partner preferences. Within these districts intervention communities were selected using a two-phase process: 1) the development of a village list, based on the available information on the number and type of cattle keepers and cattle population obtained from the district livestock officials; 2) an in-depth study of villages using participatory scoping and observation. From these two activities, a data summary report with recommendations for 35 intervention communities and type of dairy hub interventions was produced; a final sample of 25 communities was selected based on accessibility and community engagement. Participants included those that practice pastoral, agro-pastoral, and business livelihoods to obtain a wide geographical spread over the study area. Stratification occurred according to participation in milk markets, or a market hub. As part of the evaluation strategy, 500 households were randomly selected from the 25 project communities and in four additional communities per district (one per district), where no intervention was implemented for longitudinal follow up study of household milk production. Household socio-demographic and milk production data were collected from surveys conducted in June and July of 2014 and July and September of 2015. An additional nutrition and women's empowerment survey was implemented July/August 2015 with 373 of these households that had a child < 24 months or a

woman of reproductive age; of these 272 included women of reproductive age and are included in the current analyses.

### Household sociodemographic survey

The household sociodemographic survey, conducted in June and July 2014, collected detailed socio-demographic data on each household member including age, religion, ethnicity, marital status (married in polygamous marriage, married in monogamous marriage, single, widow, other), status in the household (head of household, wife of head of household, mother of head of household), years of education, wealth status, and livelihood strategy (pastoralist, agricultural, agro pastoralist, farming and business).

### Nutrition and decision making household survey

The same households used for the sociodemographic survey were targeted for the nutrition and decision making household survey in June and August 2015[1]. Data were collected through both paper-based and electronic (tablet) data collection techniques. Information about women's and children's dietary diversity, milk intake, nutritional status and morbidity as well as household food security, and intra-household food prioritization were collected as part of this survey.

#### *Anthropometric measures*

Anthropometric measures, including length, weight and mid-upper arm circumference were collected in duplicate for women and children < 2 years, following standardized measures [17]. Discrepancies of more than 0.5 cm or 0.5 kilograms cued a third measurement. Length/ height was measured using an infant / child / adult Schorr Board, weight using a SECA mother-baby scale (model 874) and MUAC using a UNICEF non-stretchable tape.

#### *Diet Diversity*

Dietary diversity was assessed using an open recall method of all foods consumed in the previous 24 hour and subsequently categorization into food groups following the approach recommended by the Food and Agriculture Organization (FAO) [18]. These data were used to estimate milk consumption in the previous 24 hours, frequency of milk consumption in the previous 24 hours and milk consumption in the previous 7 days.

#### *Adequacy of milk supply in last 12 months*

An adapted months of adequate household milk provisioning scale was developed based on the Food and Nutrition Technical Assistance Technical Assistance (FANTA) Months of Adequate Household Food Provisioning (MAHFP) measurement for Household Access [19]. Participants were asked during which months of the year milk for household consumption was insufficient, sufficient, or more than sufficient in the previous 12 months. Participants were then asked to approximate the amount of milk in liters for the household for each month over the same recall period.

[1] Due to the inclusion of diet data in the 2015 survey, data collection ceased during Ramadan and resumed one week following Eid.

### *Intra-Household Food Allocation*

We assessed food allocation priorities by presenting the respondent with a list of potential household members and asking who in the household would be prioritized to receive specific foods in times when there is insufficient food available in the household for all members to consume that food. The food allocation queried animal source foods specifically, including milk but also staples, fruits and vegetables. Household members included elder men; elder women; nonpregnant / lactating adult women; pregnant women, lactating women, children under five; school age boys; school age girls; male adults; day laborers; household visitors.

### *Household food insecurity*

Household food insecurity was assessed using the Household Food Insecurity Access Scale and the months of adequate food provisioning tool. [19, 20].

### *Morbidity*

Participants were asked about the presence of the following illnesses in the in the previous seven days: diarrhea, fever, vomiting, acute respiratory disease, as well as other illness whose symptomology did not match the four standardized options.

### *Analysis*

Descriptive statistics were generated for all categorical and continuous variables. The age variable was modified to show age in five year increments. The ethnicity and type of marriage variables were modified to combine people that represented less than 3% of the population into an 'other' category; any variable that did not fit a common description was included in "Other" [2]. Livelihood strategies were classified into agro-pastoral, which included livestock ownership plus crop farming; pastoral; and diversified, which included any combination of livelihood that included salaried work or non-agriculture income such as mechanics, traders, shop-keeping. Chi-square, Cochran–Mantel–Haenszel and ANOVA were used to assess bivariate associations for continuous and categorical data, respectively. Differences at $p < .05$ were considered significant for all tests. Graphical analyses of milk and food adequacy were conducted in Microsoft Excel version 16.0 using monthly adequacy data as well as liters of milk consumed per month Logistic regression was used to identify sociodemographic factors independently associated with milk consumption and associations between milk consumption and health outcomes, adjusted for potential covariates due to the substantial differences in milk consumption by region and tribe observed in bivariate analysis, we examined determinants of milk consumption stratified on each of these indicators. Analyses were conducted using SAS 9.4 software.

## Ethical considerations

Study protocols were approved by ILRI ethics review committee and all participants provided informed consent. Emory University approved analysis of de-identified data in December 2015.

[2] Ethnic tribes included in the "Other" category included: Pare, Hagga, Mburu, Kaguru, Nguu, Irawq, Muarusha, Mkwizu, Mng'washu, Mklinidi, Nyamwezi, Kinga, Nyaturu, Zigua, Mfipa, Hehe, and Mngoni. Marital status types that were included in the "Other" category included: single, other.

## Results

Analysis were restricted to 232 women, aged 15 to 45 that participated in both the sociodemographic and nutrition/empowerment surveys. Mean participant age was 32 years and mean BMI for non-pregnant women was healthy at 23.2 (13% underweight, 60% healthy, 20% overweight, 8% obese). Most women were either in monogamous (63%) or polygamous partnerships (31%). Data showed that 99 (37%) participants reported suffering from illness in the previous seven days. The majority of women (91%) were not pregnant, and of the population with children aged 6-24 months (n=92), 86% were breastfeeding. The Morogoro region was heavily populated by Masaai (70% in Mvomero and 85% in Kilosa).

A large minority of respondents reported shared housing with other families (37.8%). Firewood was used by 86% of participants for cooking fuel and 75% used traditional stone stoves for cooking. Adult women were primarily responsible for collecting cooking fuel (54%), followed by adult women and girl children combined (31%). For water, participants used a borehole (22%), a well (39%), and a tap/piped water (28%). Nearly half practiced open defecation while 27% used a pit latrine without slab; 14% used a pit latrine with cement or ceramic slab. Among those that shared toilet facilities (22%), 37% of women indicated they shared with one family, 17% of with two families, and 13% with three families. Half (49%) used thatch/straw for their roofing and 46% used iron sheets. Use of soap as a means to measure access to markets and financial security demonstrated that 33.7% were always able to use soap when wanted, 26% were often/usually able to use soap, 35% were able to use soap sometimes, and 6% were never able to use soap.

Food insecurity was highly prevalent with 50% of households reporting severe or moderate food insecurity in the previous month. Household food inadequacy was highly prevalent year-round with more than 60% of respondents reporting inadequate food in all months of the year (Figure A). The months of highest reported household food inadequacy were June, July, August and September with more than 70% of respondents reporting inadequate household food provisions for these months (Figure 1).

### Annual household milk adequacy

Analysis of annual milk adequacy demonstrated that there is high variation in adequacy over 12 months. Inadequacy was reported to be highest from September to November in the general population and more than adequate milk was reported to occur most often from February to May. Number of liters consumed per household ranged from 2.4 liters to 14.6 liters per household with a median of 7.4 liters; in terms of what constituted adequacy, households indicated that a median of 2.54 liters (IQR =0.51) was considered inadequate; 6.71 liters (IQR= 1.28) was considered adequate; was considered adequate and 13.25 liters (IQR= 1.62) (Figure 1).

Analysis of annual milk adequacy by tribe shows that those self-identifying as Masaai reported seasonal milk inadequacy more often than other tribes and experienced greater seasonal variability (Figure 2).

### Milk consumption by women

Husbands and fathers received first priority for drinking milk (44.5%), followed by young children (29.2%). Equal distribution was documented in 10.7% of households, and 8.6% of households said that school-aged children received first priority. Women, including pregnant, breastfeeding, rarely reported receiving first priority (2% of households). No significant differences between milk prioritization were identified between religions, districts, and ethnic groups.

Of the total sample of women, 76% reported drinking milk in a 24-hour period and milk was most often consumed in tea or coffee (52%), followed by plain (33%,) in food (22%), and fermented (5%). Among those consuming milk in the previous 24 hours, consumption occurred between one and four times a day with 33% drinking once a day, 28% consumed twice, 34% consuming three times, and 5% consuming four times. Among those reporting consumption in the previous 7 days (82%), 53% reported consuming on all 7 days, 21% consumed on no days, and 22% reported consuming 5 days or less in the previous 7 days. Because the rate of milk consumption in the 24-hour period had greater variation than milk consumption in in the previous 7 days, further analyses consider only consumption in the previous 24 hours.

### Sociodemographic variables associated with milk consumption in the previous 24 hours

There were significant differences in any milk consumption and the frequency of milk consumption in the previous 24 hours by sociodemographic characteristics (Table 1). Notably, the proportion reporting milk consumption in the previous 24 hours was greater among residents of Morogoro ($p<0.01$), among those self-identifying as Masaai ($p<0.01$), and among those self-identifying as non-Seventh Day Adventist Christians (non-SDA, $p<0.01$). Additionally, women residing in pastoral households ($p<0.01$), women residing in food insecure households ($p=0.02$), women in the experiment group ($p<0.01$), and women who were breastfeeding ($p=0.01$) more frequently reported consuming any milk in the previous 24 hours. In terms of frequency of consumption in the previous 24 hours, those residing in Morogoro ($p<0.01$), those self-identifying as Masaai ($p<.01$), those residing in food insecure households ($p=0.02$), and breastfeeding women ($p=.03$) reported greater frequency of milk consumed in the previous 24 hours (Table 1). Milk consumption and frequency did not differ by respondents' pregnancy status, whether the household was female headed, or respondent age.

### Factors associated with milk consumption in multivariate analyses - Overall

In adjusted models, inclusion of both tribe and region in models resulted in over specification and unstable point estimates likely because 96% of women identifying as Masaai reported milk consumption and the majority of Masaai (96%) resided in Morogoro. Given milk consumption is more likely due to the socio-cultural and livelihoods distinctions of tribes as opposed to the geographic boundaries of region, we dropped region and retained tribe in the adjusted analysis. Additionally, given the high prevalence of milk consumption among Masaai (96%), stratified analyses were conducted to further explore different factors associated with milk consumption among Masaai and non-Masaai tribes.

In adjusted analyses of the overall sample, identification as Masaai (OR 16.10, 95% CI) and residing in an intervention community (OR 3.14, 95% CI) significantly increased the odds of

consuming any milk in the previous 24 hours (Table 2). In adjusted analyses of the overall sample, residing in an intervention community also significantly increased the odds of consuming milk more frequently (3-4 times compared to 1-2 times) in the previous 24 hours (OR 14.44, 95% CI). No other covariates were significantly associated with frequency of milk consumption in adjusted models.

### Factors associated with milk consumption in multivariate analyses – By Tribe

In adjusted models, residing in an intervention community was significantly associated with any milk consumption in the previous 24 hours among non-Masaai, (OR 3.45 95% CI). No factors were associated with frequency of milk consumption among women who were not Masaai. Given 96% of women identifying as Masaai consumed any milk in the previous 24 hours, we only explored frequency of milk consumption among this group. In adjusted analyses, the odds of Masaai women consuming milk 3-4 times a day compared to 1-2 times were 9.96 times greater if they were in the experiment group compared to the control, (95% CI 1.03 - 96.09). A full description of analysis of frequency of milk consumption adjusting for variables can be found in Table 2.

### Milk consumption and associations with health outcomes

Neither any milk consumption nor frequency of milk consumption in the previous 24 hours were associated with morbidity outcomes or underweight in bivariate or adjusted analysis. No associations were observed in overall or in stratified analyses. (Table 4)

## Discussion

As shown in previous studies, the results of these analysis confirm that the Masaai consume more milk more frequently compared to other ethnic groups [21]. This study also demonstrates that milk consumption is associated with living location, religion, breastfeeding, and marital status, but the relationship between milk consumption and these variables is due to the fact that the Masaai tribe served as a significant covariate. Among the Masaai, we were unable to examine factors associated with frequency of consumption given the small sample size and the limited variability in the outcome variability. Among the Sambaa/Ziguia/Other tribes, only presence in the experiment group was associated with increased milk consumption.

Our results show that presence in the intervention group is associated with increased odds of consuming milk among non-Masaai, and with increased frequency of consumption among a tribe that traditionally consumes a substantial amount of milk. While some research indicates that participation in milk cooperatives results in lower milk consumption other research demonstrates that access to markets and additional disposable income to purchase supplemental food is associated with better ability to consume a variety of foods that may improve nutrition [22, 23]. Traditionally, dairy projects have targeted high potential areas with better-off farms to supply high quantities of milk, but even under these conditions, development has not always been successful [24]. Because highly capitalized cold chain supplies are not suitable where transportation challenges exist and where occasional and opportunistic marketing prevails, this project sought to evaluate the impact of dairy hubs to complement smallholder dairying [25]. The results suggest that a pro-poor, hub approach to milk production may improve milk consumption among women.

Women's status in the household did not appear to play a role in milk consumption. While this study did not look at socioeconomic status, it did analyze women's status in relation to the head of the household. Research indicates that children living in female-headed households have reduced malnutrition, but this better health outcome is contingent upon having adequate financial resources [26, 27]. This study had very few women as heads of their own households (7%) as the vast number of women surveyed were the wives of the head of the household. Women serving as the head of the household did drink milk most frequently (2.27) compared to other women, but this difference was not statistically significant (p=.06) in bivariate analysis likely due to small sample sizes.

Women who were breastfeeding children aged 6-24 months were more likely to consume milk than those who were not breastfeeding their child. This was true across ethnicities, religions, and the two districts. Some research indicates that among pastoralist communities, milk consumption is associated with better health, especially for children; for example, in the Somali region of Ethiopia, child malnutrition is defined by the term '*cano la'an'* or the 'suffering due to lack of milk' [28]. Other research indicates that the majority of pastoralist communities choose to breastfeed, and that once a Masaai child begins eating solid food, animal milk is consumed as part of the diet [23, 29]. It may be that breastfeeding women are consuming more milk to ensure their children are healthier. Our results demonstrated that children under five are prioritized for milk consumption after husbands, and so perhaps women consume milk while breastfeeding because they recognize the importance of milk for child nutrition. Interestingly, while breastfeeding women consume more milk, they are not prioritized for first consumption of the household milk supply. Furthermore, our results showed that pregnant women do not consume significantly more milk than non-pregnant women. This may indicate a cultural norm that undermines the importance of maternal nutrition for fetal development and for maternal health.

As documented in other research, seasonality of milk adequacy occurs in our study, but the impact of this seasonality on morbidity and health status is unclear for our study [13, 14]. This study uses data during a season when milk was more than adequate. While milk has immune boosting properties, milk consumption was not significantly associated with morbidity or healthy BMI in our study [30-33]. Furthermore, while food security is associated with higher dietary diversity and improved nutrition [22, 34, 35], food insecurity status was not associated with milk consumption in this study. In fact, milk consumption occurred more frequently among food insecure households (p=.02) compared to the food secure ones. Previous research indicates that pastoralist communities are heavily reliant upon milk for nutrients, but that milk seasonality can play a large role in annual food security [13, 14]. Because of this, the seasonality of milk production likely contributes to food insecurity among groups that are highly dependent upon milk.

## Limitations

This study serves as a descriptive analysis of the factors associated with women's milk consumption in pastoral and agro-pastoral communities in Tanzania and the effect of milk consumption on women's health indicators. While we noted a significant association between milk consumption and residing in dairy hub intervention communities, this finding should be

interpreted with caution. Baseline data on milk consumption were not collected and so we cannot say these differences were not present at baseline. Further the control communities represent a small, non-randomly selected sample and there likely is insufficient power to estimate effect sizes; indeed, while confidence limits were suggestive of statistical significance, they were wide. This cross-sectional study demonstrates statistics at one-point of time and does not capture the variance in milk consumption based on seasonality of milk production. This study utilized an open 24-hour recall of foods consumed but did not estimate quantities of food consumed; as such we cannot estimate the proportion of macronutrients and micronutrients contributed by milk. Furthermore, because the sample is small, restricted to cattle-keepers and not representative of all communities in Morogoro and Tanga or household findings are not generalizable to the broader population.

## Recommendations

This study aligns with previous work that tribal affiliation is a strong determinant of milk consumption among women and suggests the importance for dairy interventions for women's milk consumption. This data serves as a preliminary assessment of sociodemographic variables associated with milk consumption. It is recommended that similar research be conducted longitudinally, starting with a baseline survey, and on a larger scale, using broader population-based data. Longitudinal data that tracks women's livelihood strategies and milk consumption over a period of time can better determine the impact of livelihood strategy and the impact of changes to livelihood strategy to women's milk consumption. This information can be used for women's nutrition and empowerment program planning and policy development, in order to develop sustainable projects to best target women as project participants.

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| Table 1: Sociodemographic characteristics of 269 Tanzanian women aged 15-45 in Tanga and Morogoro regions | | | | | | |
|---|---|---|---|---|---|---|
| ***Characteristic*** | ***Overall (N= 270)*** | ***Consumed any milk in previous 24 hours (N= 233)*** | | ***P value[1]*** | ***Frequency of milk intake in previous 24 hours (N=176)*** | ***P value [2]*** |
| | **N (%)** | **No** | **Yes** | | **Mean (SD)** | |
| **District (N=270)** | | | | | | |
| Mvomero (Morogoro) | 65 (24.16%) | 4 (7.14%) | 50 (92.59%) | P<0.01 | 2.46 ± .88 | P<0.01 |
| Kilosa (Morogoro) | 69 (25.65%) | 0 (0%) | 60 (100%) | | 2.35 ± .84 | |
| Handeni (Tanga) | 58 (21.56%) | 15 (28.85%) | 37 (71.15%) | | 1.83 ± .88 | |
| Lushoto (Tanga) | 77 (28.62%) | 37 (56.06%) | 29 (43.94%) | | 1.23 ± .43 | |
| **Ethnic group (N=254)** | | | | | | |
| Masaai | 117 (46.25%) | 4 (3.77%) | 102(96.23%) | P<0.01 | 2.44 ± .88 | P<0.01 |
| Sambaa | 64 (25.31%) | 26 (48.15%) | 28 (51.85%) | | 1.43 ±.63 | |
| Ziguia | 32 (12.65%) | 10 (35.71%) | 18 (64.29%) | | 1.32 ±.47 | |
| Others | 40 (15.81%) | 10 (30.30%) | 23 (69.70%) | | 1.95 ± .86 | |
| **Religion (N= 270)** | | | | | | |
| Muslim | 101 (37.55%) | 41 (46.59%) | 47 (53.41%) | P<0.01 | 1.39 ± .60 | P<.01 |
| Non-SDA Christians | 152 (56.16%) | 11 (8.59%) | 117(91.41%) | | 2.37 ± .88 | |
| Not religious | 11 (4.09%) | 2 (20.00%) | 8 (80.00%) | | 2.12 ± .99 | |
| Other | 6 (2.23%) | 2 (33.33%) | 4 (66.67%) | | 2.25 ± .95 | |
| **Marital status (N= 270)** | | | | | | |
| Monogamous | 170 (63.20%) | 35 (24.14%) | 110(75.86%) | P=0.04 | 1.89 ± .91 | P<.01 |
| Polygamous | 84 (30.86%) | 15 (19.74%) | 61 (80.26%) | | 2.43 ±.86 | |
| Other | 16 (5.95%) | 6(54.55%) | 5 (45.45%) | | 2.20 ±. .83 | |
| **Status in household (N=270)** | | | | | | |
| Head | 19 (7.06%) | 5 (31.25%) | 11 (68.75%) | p=0.41 | 2.27 ± .78 | p=0.61 |
| Wife of head | 211 (78.44%) | 44 (23.78%) | 141(76.22%) | | 2.057 ± .92 | |
| Mother of head | 3 (1.12%) | 0 (0%) | 3 (100%) | | 2.00 ± 1.00 | |
| Daughter of head | 21 (7.81%) | 6 (35.29%) | 11 (64.71%) | | 2.00 ± 1.09 | |
| Other | 15 (5.58%) | 1 (9.09%) | 10 (90.91%) | | 2.5 ± .84 | |
| **Age (N=210)** | | | | | | |
| 15-25 | 118 (56.19%) | 30 (28.57%) | 75 (71.43%) | P=0.65 | 2.12 ± .91 | p=0.36 |
| 26-35 | 79 (37.62%) | 15 (22.06%) | 53 (77.97%) | | 1.98 ± .89 | |
| >35 | 13 (6.19%) | 5 (62.50%) | 3 (37.50%) | | 2.66 ± .57 | |
| **Household Food Insecurity Access Category (N=270)** | | | | | | |
| Secure | 86 (31.97%) | 20 (27.03%) | 54 (72.97%) | P=0.02 | 1.91 ± .91 | P=0.02 |
| Mildly secure | 50 (18.59%) | 15 (36.59%) | 26 (63.41%) | | 1.77 ± .86 | |
| Moderately secure | 72 (26.77%) | 16 (24.62%) | 49 (75.38%) | | 2.29 ± .91 | |
| Severely insecure | 61 (22.68%) | 5 (9.62%) | 47 (90.38%) | | 2.29 ± .91 | |
| **Livelihood strategy (N=268)** | | | | | | |
| Pastoral | 63 (14.13%) | 0 (0%) | 31 (100%) | P<0.01 | 2.25 ± .91 | P=0.21 |
| Agro-pastoral | 313 (70.18%) | 41 (24.26%) | 128(75.74%) | | 2.11 ± .85 | |
| Diversified[3] | 70 (15.70%) | 15 (48.39%) | 16 (51.61%) | | 1.68 ± 1.01 | |
| **Maternal status (N=225)** | | | | | | |
| Pregnant | 23 (8.65%) | 7 (33.33%) | 14 (66.67%) | P=0.31 | 2.23 ± 96 | p=0.66 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Not pregnant | 243 (91.35%) | 49 (23.44%) | 160(76.56%) | | 2.23 ± .92 | |
| Breastfeeding if have a child 6-24 months (n=92) | 79 (91.14%) | 11 (16.18%) | 57 (83.82%) | P=0.01 | 2.21 ± .83 | P=0.03 |
| Not breastfeeding | 145 (64.89%) | 41 (32.54%) | 85 (67.46%) | | 1.95 ± .92 | |
| **BMI (N=194)** | | | | | | |
| <18 | 25 (12.89%) | 6 (24.00%) | 19 (76.00%) | P=0.92 | 2.47 ± .90 | p=0.14 |
| 18-25 | 116 (59.79%) | 29 (25.00%) | 87 (75.00%) | | 1.96 ± .92 | |
| 26-30 | 36 (18.56%) | 8 (22.22%) | 28 (77.78%) | | 2.21 ± .84 | |
| >30 | 17 (8.76%) | 4 (23.53%) | 13 (76.47%) | | 2.07 ± 1.11 | |
| **Morbidity in the previous 7 days (N= 264)** | | | | | | |
| No | 165 (62.50%) | 36 (23.84%) | 115(76.16%) | P=0.41 | 2.66 ± .57 | P=0.32 |
| Yes | 99 (37.22%) | 20 (24.69%) | 61 (75.31%) | | 2.10 ± .97 | |
| Diarrhea | 6 (6.06%) | 3 (60%) | 2 (40%) | P=0.05 | 1 .00 ± 0 | |
| Fever | 45 (45.55%) | 7 (20%) | 28 (80%) | P=0.39 | 2.29 ± 1.10 | |
| Respiratory infection | 23 (23.23%) | 7 (36.84%) | 12 (63.16%) | P=0.16 | 2.09 ± 1.04 | |
| **Village type (N=269)** | | | | | | |
| Control | 41 (15.24%) | 15 (50.54%) | 22 (59.46%) | p=0.01 | 1.61± .66 | P=0.01 |
| Experiment | 228 (84.76%) | 41 (21.03%) | 154(78.97%) | | 2.15 ± .93 | |

[1] P value estimated from CMH/Chi-square

[2] P value estimated from ANOVA

[3] Diversified livelihoods include any form of livelihood that included salaried work

| Table 2: Factors associated with milk consumption among women of reproductive age in Tanzania | | |
|---|---|---|
| **Variable** | **Adjusted Odds Ratio (95% confidence limit)** | |
| ***Overall (n=269)*** | Any Milk Consumption | Frequency of milk consumption (1-2 times vs. 3-4 times) |
| Tribe (non-Masaai is referent) | 16.10 (1.72-150.44) | 0.53 (0.17-1.68) |
| Group (control is referent) | 3.14 (1.03-3.31) | 14.44 (1.60-130.39) |
| Breastfeeding status (breastfeeding is referent) | 0.43 (0.15-1.28) | 0.63 (0.27-1.44) |
| Age (15 years is referent) | 1.90 (0.32-11.47) | 0.14 (0.03-12.75) |
| Religion (non-SDA is referent) | 0.25 (0.08-0.74) | 0.14 (0.03-12.75) |
| Food security status (insecure is referent) | 1.23 (0.47-3.19) | 0.94 (0.36-2.51) |
| Marital status (polygamous is referent) | 1.082 (0.35-3.31) | 0.53 (0.22-1.28) |
| Livelihood strategy: agro-pastoral (pastoral is referent) [+] | | 0.51 (0.17-1.90) |
| Livelihood strategy: diversified (pastoral is referent) [+] | | 0.38 (0.04-3.06) |
| ***Among Masaai (n=58)*** [Δ Φ] | | |
| Group (control is referent) | | 9.96 (1.03-96.09) |
| Breastfeeding status (not breastfeeding is referent) | | 0.60 (0.22-1.60) |
| Religion (non-SDA is referent) | | 0.53 (0.04-8.04) |
| Food security status (secure is referent) | | 0.73 (0.22-2.42) |
| Marital status (polygamous is referent) | | 0.81 (0.30-2.22) |
| Livelihood strategy (Agro-Pastoral vs. Pastoral) | | 0.64 (0.19-2.17) |
| Livelihood strategy (Diversified vs. Pastoral) | | 0.97 (0.07-14.19) |
| ***Among non-Masaai (n=100)*** [Ψ Ω] | | |
| Group (control is referent) | 3.45 (1.07-11.05) | |
| Breastfeeding status (not breastfeeding is referent) | 0.46 (0.16- 1.37) | |
| Age (15 years is referent) | 1.71 (0.27-10.72) | |
| Religion (non-SDA is referent) | 0.23 (0.07-0.72) | |
| Food security status (secure is referent) | 1.40 (0.52-3.78) | |
| Marital status (polygamous is referent) | 1.41 (0.42-4.66) | |

+ Because all women practicing pastoral livelihoods drank milk, incidence of consumption was not included

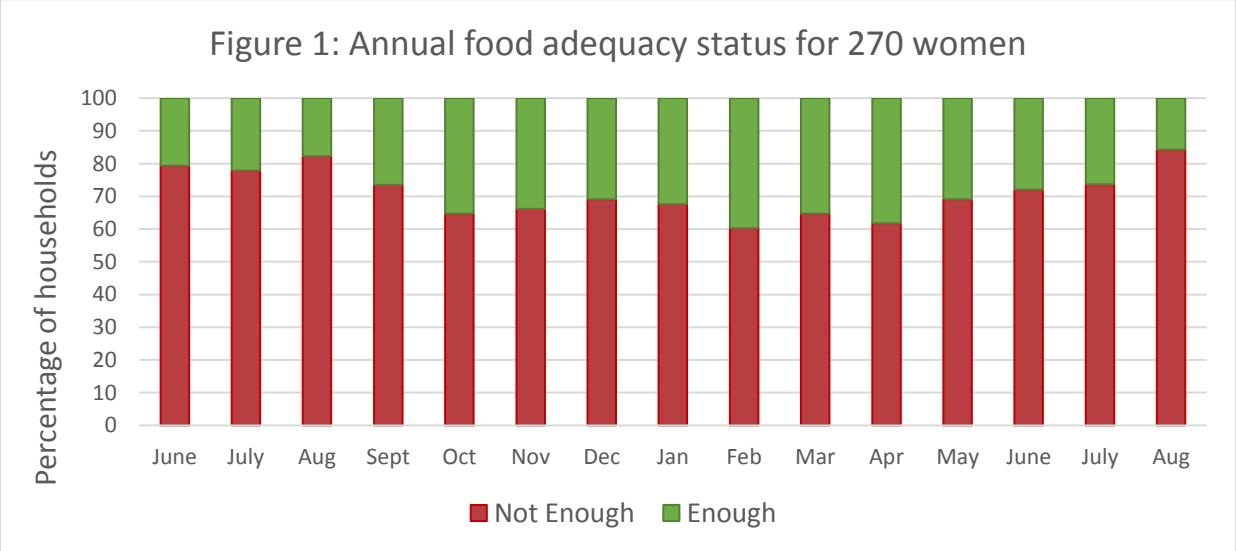
[Δ] Because 96% of Masaai consumed milk, analysis of incidence of consumption is not relevant

[Φ] Because only 3 women are 36 years and older, age is not included

[Ω] Frequency of milk consumption is not relevant for non-Masaai because only 11 non-Masaai consumed milk 3-4 times

[Ψ] Livelihood strategy is not included because 2% of non-Masaai are pastoralists, analysis is not relevant

| Table 3: Factors associated with underweight among 272 women in rural Tanzania | |
|---|---|
| **Variable** | **Adjusted Odds Ratio (95% confidence limit)** |
| ***Overall (N=184)*** | |
| Tribe (non-Masaai is referent) | 1.23 (0.48-3.13) |
| Group (control is referent) | 1.95 (0.41-2.13) |
| Religion (non-SDA is referent) | 0.98 (0.41-2.36) |
| Food security status (insecure is referent) | 0.92 (0.48-1.75) |
| Marital status (polygamous is referent) | 2.55 (0.48-12.63) |
| Livelihood strategy: agro-pastoral (pastoral is referent) | 0.46 (0.18-1.19) |
| Livelihood strategy: diversified (pastoral is referent) | 0.51 (0.14-1.85) |
| Milk consumption (none is referent) | 1.03 (0.47-2.24) |
| ***Among Masaai (N=81)*** | |
| Group (control is referent) | -0.32 (0.41-0.62) |
| Religion (non-SDA is referent) | -0.96 (0.61-2.51) |
| Food security status (insecure is referent) | -0.21 (0.27-0.61) |
| Marital status (polygamous is referent) | -0.02 (0.22-.01) |
| Livelihood strategy: agro-pastoral (pastoral is referent) | -0.24 (0.42-0.31) |
| Livelihood strategy: diversified (pastoral is referent) | -0.10 (0.74-1.46) |
| Milk consumption (none is referent) | 0.14 (0.71-0.04) |
| ***Among non-Masaai (N=105)*** | |
| Group (control is referent) | -0.32 (0.41-0.62) |
| Religion (non-SDA is referent) | -0.96 (0.61-2.50) |
| Food security status (insecure is referent) | -0.21 (0.27-0.61) |
| Marital status (polygamous is referent) | -0.02 (0.22-0.07) |
| Livelihood strategy: agro-pastoral (pastoral is referent) | -0.24 (0.42-0.31) |
| Livelihood strategy: diversified (pastoral is referent) | -0.09 (0.74-0.07) |
| Milk consumption (none is referent) | -0.14 (0.72-0.04) |



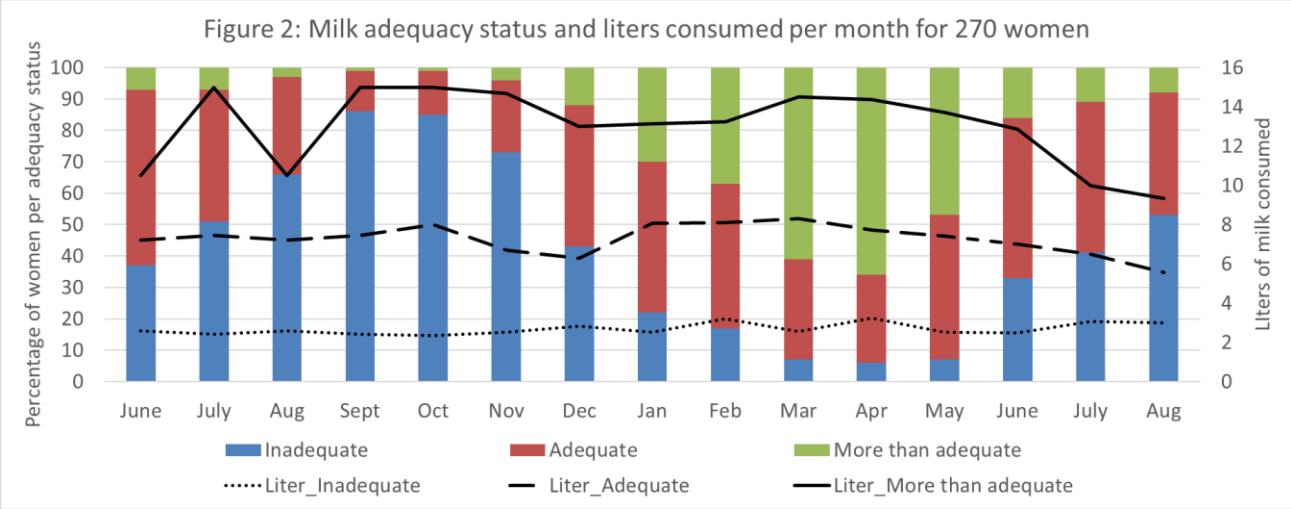


Figure 2: Milk adequacy status and liters consumed per month for 270 women
Percentage of women per adequacy status
Liters of milk consumed
100
90
80
70
60
50
40
30
20
10
0
16
14
12
10
8
6
4
2
0
June
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
July
Aug
Inadequate
Adequate
More than adequate
Liter_Inadequate
Liter_Adequate
Liter_More than adequate

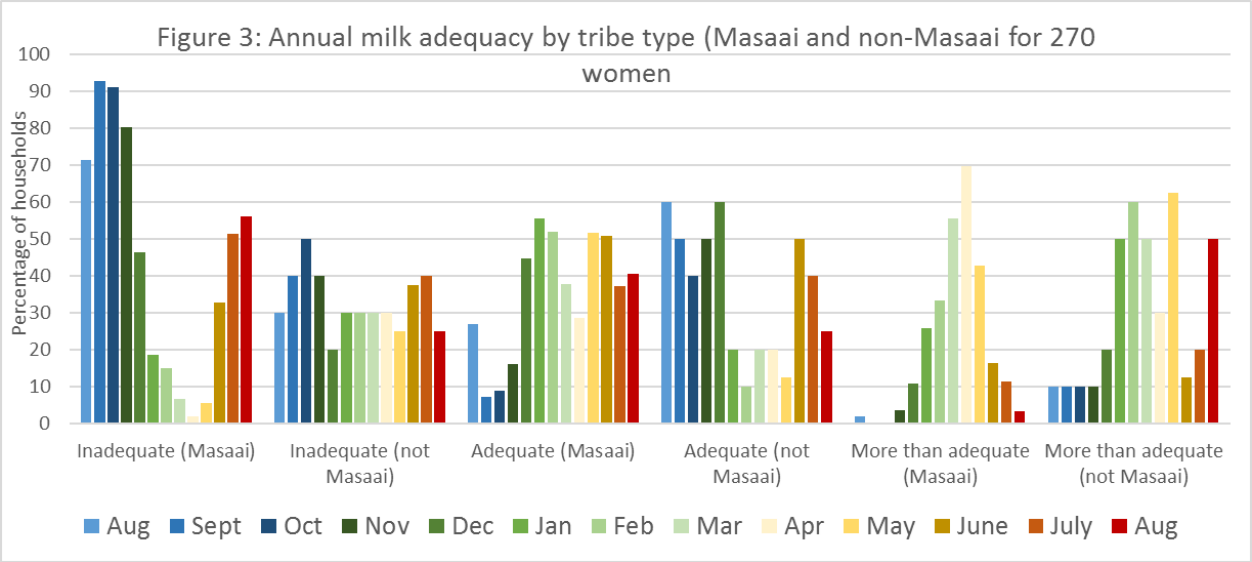


Figure 3: Annual milk adequacy by tribe type (Masaai and non-Masaai for 270 women
Percentage of households
100
90
80
70
60
50
40
30
20
10
0
Inadequate (Masaai)
Inadequate (not Masaai)
Adequate (Masaai)
Adequate (not Masaai)
More than adequate (Masaai)
More than adequate (not Masaai)
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
July
Aug

# Chapter 4: Conclusion and Recommendations

This cross-sectional study demonstrates that a variety of sociodemographic are associated with milk consumption. It focuses on a specific sample of women in rural Tanzania. This data serves as a preliminary assessment providing a quick assessment of how women's life situations result in variances in milk consumption.

This data presents a picture of a diverse country in which multiple factors impact women's consumption of milk. As shown in previous studies, the results of analysis confirm that the Masaai consume more milk more frequently compared to other ethnic groups [65]. This study also demonstrates that milk consumption is associated with living location, religion, breastfeeding, and marital status, but the relationship between milk consumption and these variables is due to the fact that the Masaai tribe served as a significant covariate. Among the Masaai, we were unable to examine factors associated with frequency of consumption given the small sample size and the limited variability in the outcome variability. Among the Sambaa/Ziguia/Other tribes, only presence in the experiment group was associated with increased milk consumption.

Our results show that presence in the intervention group is associated with increased odds of consuming milk among non-Masaai, and with increased frequency of consumption among a tribe that traditionally consumes a substantial amount of milk. While some research indicates that participation in milk cooperatives results in lower milk consumption other research demonstrates that access to markets and additional disposable income to purchase supplemental food is associated with better ability to consume a variety of foods that may improve nutrition [44, 90]. Traditionally, dairy projects have targeted high potential areas with better-off farms to supply high quantities of milk, but even under these conditions, development has not always been

successful [91]. Because highly capitalized cold chain supplies are not suitable where transportation challenges exist and where occasional and opportunistic marketing prevails, this project sought to evaluate the impact of dairy hubs to complement smallholder dairying [92]. The results suggest that a pro-poor, hub approach to milk production may improve milk consumption among women.

Women's status in the household did not appear to play a role in milk consumption. While this study did not look at socioeconomic status, it did analyze women's status in relation to the head of the household. Research indicates that children living in female-headed households have reduced malnutrition, but this better health outcome is contingent upon having adequate financial resources [76, 77]. This study had very few women as heads of their own households (7%) as the vast number of women surveyed were the wives of the head of the household. Women serving as the head of the household did drink milk most frequently (2.27) compared to other women, but this difference was not statistically significant (p=.06) in bivariate analysis likely due to small sample sizes.

Women who were breastfeeding children aged 6-24 months were more likely to consume milk than those who were not breastfeeding their child. This was true across ethnicities, religions, and the two districts. Some research indicates that among pastoralist communities, milk consumption is associated with better health, especially for children; for example, in the Somali region of Ethiopia, child malnutrition is defined by the term '*cano la'an'* or the 'suffering due to lack of milk' [66]. Other research indicates that the majority of pastoralist communities choose to breastfeed, and that once a Masaai child begins eating solid food, animal milk is consumed as part of the diet [90, 93]. It may be that breastfeeding women are consuming more milk to ensure their children are healthier. Our results demonstrated that children under five are prioritized for

milk consumption after husbands, and so perhaps women consume milk while breastfeeding because they recognize the importance of milk for child nutrition. Interestingly, while breastfeeding women consume more milk, they are not prioritized for first consumption of the household milk supply. Furthermore, our results showed that pregnant women do not consume significantly more milk than non-pregnant women. This may indicate a cultural norm that undermines the importance of maternal nutrition for fetal development and for maternal health.

As documented in other research, seasonality of milk adequacy occurs in our study, but the impact of this seasonality on morbidity and health status is unclear for our study [17, 67]. This study uses data during a season when milk was more than adequate. While milk has immune boosting properties, milk consumption was not significantly associated with morbidity or healthy BMI in our study [19-21, 50]. Furthermore, while food security is associated with higher dietary diversity and improved nutrition [39, 40, 44], food insecurity status was not associated with milk consumption in this study. In fact, milk consumption occurred more frequently among food insecure households ($p=.02$) compared to the food secure ones. Previous research indicates that pastoralist communities are heavily reliant upon milk for nutrients, but that milk seasonality can play a large role in annual food security [17, 67]. Because of this, the seasonality of milk production likely contributes to food insecurity among groups that are highly dependent upon milk.

## Recommendations

This data serves as a preliminary assessment of sociodemographic variables associated with milk consumption. It is recommended that similar research be conducted longitudinally, incorporating a baseline survey at the start of the project, in order to better track the ways in which sociodemographic changes including livelihood strategies impact milk consumption over time.

Furthermore, research should be conducted on a larger scale, using broader population-based data in order to better capture how sociodemographic variables impact milk consumption across the country, following a variety of women, which may be more generalizable about milk consumption-related factors in the region. This research contributes to the literature about milk consumption by women and annual milk adequacy in two specific regions of Tanzania. This information can be used for women's nutrition and empowerment program planning and policy development, in order to develop sustainable projects to best target women as project participants.

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