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INVESTIGATING THE MEDIATING ROLE OF MATERNAL PARTICIPATION IN DAIRY INTENSIFICATION PROGRAMS ON YOUNG CHILD NUTRITION IN WESTERN KENYA

By

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INVESTIGATING THE MEDIATING ROLE OF MATERNAL PARTICIPATION IN DAIRY INTENSIFICATION PROGRAMS ON YOUNG CHILD NUTRITION IN WESTERN KENYA

By

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2008

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A thesis submitted to the Faculty of the
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ABSTRACT

INVESTIGATING THE MEDIATING ROLE OF MATERNAL PARTICIPATION IN DAIRY INTENSIFICATION PROGRAMS ON YOUNG CHILD NUTRITION IN WESTERN KENYA

By Claire M. Marchetta

BACKGROUND: Dairy intensification programs create an opportunity for smallholder farmers to generate income and produce nutrient dense foods for household consumption, thereby alleviating poverty and malnutrition in resource poor settings. Potential adverse effects of intensification programs on certain household members, specifically women and young children, are not well understood. Increased dairying often requires female household members to increase their farm-related workload and in so doing, shift time away from childcare activities. This paper investigates how women's participation and/or time allocation to dairying influences child milk consumption, dietary diversity and breastfeeding.

METHODS: Surveys were conducted in 3 study sites in Rift Valley Province of western Kenya. Households were selected if they had a resident child younger than 5 years old and met the requirements for one of 3 predefined daily milk production levels; No Milk production, Emergent (more than 0 and less than 6 liters of milk produced), or Advanced (6 liters or more of milk produced). Bivariate and multivariate linear regression models, adjusting for potential confounders, were used to estimate the associations between milk production and indicators of child nutrition and to determine whether maternal participation in dairying affected these associations.

RESULTS: Children in households with the greatest milk production consumed more milk and had a higher dietary diversity score than their Emergent and No Milk counterparts. Breastfeeding frequency was lowest in the Advanced milk production group. Adjusting for confounders reduced the advantage of intensification on milk consumption and dietary diversity and reduced the disadvantage of intensification on breastfeeding frequency. Maternal participation in dairying was negatively associated with each of the child nutrition outcomes and control for this negative association yielded an increase in the coefficients of the milk production groups.

CONCLUSIONS: Dairy intensification had a positive association with young child milk consumption and dietary diversity and a negative association with breastfeeding frequency. Maternal participation in dairying was negatively associated with all indicators of child nutritional status. Future efforts to intensify dairying production in western Kenya should provide support to women who have young children so that time allocated to income generating activities does not adversely affect their children's health.

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CHAPTER 1

INTRODUCTION

Malnutrition is the most important risk factor for the burden of disease in poor countries and is the underlying cause of more than half of all deaths in children under 5 years of age globally (1). Coupled with poverty, malnutrition is responsible for a myriad of health and developmental problems, including diarrhea, infection, respiratory disorders, cognitive delays, and death (2). People living in poverty-stricken countries suffer from micronutrient deficiencies primarily because their diet is based on cereal grains (3). Animal-source foods (ASF) are appropriate for curbing malnutrition because they are energy-dense, are good sources of protein, and contain a large number of key micronutrients. In many cases, nutrients in ASF, such as iron and zinc, exhibit greater bioavailability than those from plant sources (4). At low to moderate intakes, meat, milk and egg products are highly beneficial, providing essential amino acids, minerals and vitamins. Increases in the consumption of animal products in poor countries are highly desirable in combating malnutrition (5). Additionally, the high-nutrient density of ASF makes them attractive as a food-based intervention for populations, including very young children, that have difficulty consuming large amounts of food.

Livestock intensification intervention programs have the potential to promote consumption of ASF and alleviate poverty within farming communities in low-resource agricultural settings where micronutrient malnutrition is common and ASF intakes are normally low (6). Livestock ownership currently supports and sustains the livelihoods of an estimated 675 million rural poor, and it is one of the few rapidly growing markets that poor people can join in the absence of substantial resources or training (5). Owning livestock offers the opportunity for smallholder farmers both to generate income through

the sale of animal products as well as to increase household consumption of animal milk and animal meat. However, the effects of livestock programs on farming households, and in particular on young child nutrition, remain understudied. Understanding this potential impact will provide an opportunity to increase the value of livestock interventions and improve their potential to reduce poverty (3). To achieve this potential requires a comprehensive understanding and appreciation of the multifaceted role that livestock play in the smallholder system (7).

An important potential pathway linking livestock ownership to child nutrition involves changes in the time that mothers or children's primary caregivers allocate to infant and young-child feeding practices and dietary diversity. Increased dairying, at least in the initial stages, often requires female household members to increase their daily workload. Such increases may negatively affect young children if mothers must shift their time away from childcare activities. To explore this pathway and understand how dairy intensification affects the nutrition of children under 5 years, a study in collaboration with the International Livestock Research Institute (ILRI) based in Nairobi, Kenya was conducted in three study sites in Rift Valley Province, Kenya during the summer months of 2010.

BACKGROUND AND LITERATURE REVIEW

STUDY OVERVIEW

The overall objective of this study was to carry out formative research to inform the efforts of the East Africa Dairy Development project (EADD) in developing an assessment of the impact of dairying on human health and in particular, the nutrition of young children less than 5 years of age. EADD is a Bill and Melinda Gates Foundation funded project working to boost the yields and incomes of small-scale dairy farmers in Kenya, Rwanda, and Uganda. EADD is implemented by Heifer International, in partnership with the International Livestock Research Institute (ILRI), TechnoServe, African Breeders Services (ABS), and the World Agroforestry Center. For this study, the research team collaborated primarily with ILRI, the knowledge arm of EADD.

The study was conducted in Buret and Kipkelion districts of the Rift Valley Province of western Kenya. In this area, the predominant population is the Kipsigis, a Kalenjin-speaking ethnic group. The Kipsigis are a Southern Nilotic pastoralist group, now settled as agro-pastoralists in southwestern Kenya. Families derive their subsistence from the cultivation of maize and the herding of domestic livestock. The Kipsigis were initially encouraged through market incentives to cultivate maize in the 1930s and later began to incorporate tea farming (8). In the study sites, tea farming consists of a combination of large corporate tea estates and smallholder farms.

At present, the Kipsigis are a mixed farming community and focus mainly on dairy and crops, particularly tea, maize, sorghum, and millet. Cattle are an essential source of income and nutrition for a great number of households in Africa (9). Therefore, dairy cattle are common and dairy products are a fundamental component of the diet for both adults and children.

Malnutrition is a major public health problem in poor countries and especially, in Sub-Saharan Africa. Malnutrition in low-resource settings is most often manifested in either protein-energy malnutrition or specific micronutrient deficiencies. In children, protein–energy malnutrition is defined by anthropometric measurements that fall below 2 standard deviations of the normal weight for age (underweight), height for age (stunting) and weight for height (wasting) (1). Stunting reflects the failure to receive adequate nutrition over a long period of time and is an indication of chronic malnutrition. Wasting represents the failure to receive adequate nutrition in the period of time immediately prior to data collection and is thus a measurement for acute malnutrition. In general, micronutrient deficiencies are caused by poor diets that lack animal products and/or are based on cereal grains.

According to the 2008-2009 Kenyan Demographic and Health Survey (10) and based on World Health Organization (WHO) Child Growth Standards, 35% of children under 5 are stunted. Nearly half (46%) of Kenyan children aged 18-23 months are stunted. The lowest percentage (11%) of stunting occurs in children less than 6 months old, a likely reflection of the high percentage of breastfeeding occurring in this demographic group. Proportionately more male (37%) than female (33%) children under 5 years are stunted. The percentage of stunted children in the Rift Valley Province, where this study was conducted, is 36%.

UNICEF and WHO recommend exclusive breastfeeding during the first 6 months of life and the provision of solid or semisolid complementary food in addition to continued breastfeeding from 6 months until 24 months of life or more when the child is

fully weaned. Exclusive breastfeeding is recommended because breast milk is uncontaminated and contains all the nutrients necessary for children in the first few months of life. In addition, the mother's antibodies in breast milk provide immunity to disease. In Kenya, 64% of women initiate breastfeeding within one hour of giving birth (10).

Early initiation of breastfeeding is encouraged for several reasons and benefits both mother and child. Mothers benefit because breastfeeding stimulates breast milk production and facilitates the release of oxytocin, which helps the contraction of the uterus and reduces postpartum blood loss. Additionally, breastfeeding prolongs postpartum amenorrhea and can delay subsequent pregnancies, reducing a woman's lifetime fertility. Newborn babies benefit from immediate breastfeeding, as the first breast milk released contains colostrum, which is highly nutritious and has antibodies that protect the newborn from diseases. Early initiation of breastfeeding also fosters bonding between mother and child.

The median duration of any breastfeeding for Kenyan children living in the Rift Valley Province is 21 months with an average of 1.7 months of exclusive breastfeeding. Ninety-seven percent of children less than 6 months are breastfed 6 or more times each day (10).

In addition to duration and frequency of breastfeeding, diversity of complementary foods is an important indicator of nutritional status for infants and young children, beginning at about 6 months of age. Such indicators are informative for assessing dietary quality in populations that do not regularly consume fortified foods, such as the rural poor. An index based on eight food groups was used in this study. The

food groups include 1) grains, roots and tubers, 2) legumes and nuts, 3) dairy products, 4) flesh foods (meat, fish, poultry, and liver/organ meats), 5) eggs, 6) vitamin A-rich fruits and vegetables, 7) other fruits and vegetables, and 8) fats and oils.

These food groups were developed for use in the Food and Nutrition Technical Assistance (FANTA) Project study. The results from the FANTA study show the mean micronutrient density adequacy (MMDA) of children increased with increasing food group diversity and that the absence of animal source foods in the diet is a predictor for a poor quality diet (11). The use of dietary diversity scores has been found to be a simple and sufficient measurement for assessing dietary adequacy of young children in poor countries by several sources (12,13,14).

LIVESTOCK IN POOR COUNTRIES

Farm animals are a vital, sustainable and renewable natural resource. Throughout the developing world, they are a means for hundreds of millions of people to escape absolute poverty. According to the International Livestock Research Institute, livestock in developing countries contribute up to 80% of agricultural GDP and more than 600 million rural poor people rely on livestock for their livelihoods and even survival (15).

The mechanism by which livestock ownership promotes poverty alleviation is two pronged; ownership can influence human nutritional and health status as owning animals increases the amount of ASF available, which can increase ASF consumption, dietary intake and nutritional status. Animals owned increase animal production, animal and livestock product sales, and household incomes (3). Combined, improved human physical capacity and increased income has the potential to enhance productivity and thus reduce poverty among smallholder farmers in resource poor settings (16).

FEMALE WORKLOAD AND IMPLICATIONS ON CHILD CARE

While there is evidence that livestock ownership and livestock intensification programs can reduce poverty in resource poor settings through increased income and better health, these programs carry potential adverse effects for some household members, specifically females and young children (4). Livestock ownership and maintenance often translates into increased total household labor demands. Often this increase in labor falls on female household members, who already are responsible for a variety of other household and childcare tasks (17). The primary pathway by which livestock intervention programs can negatively affect young child nutrition is if mothers must reduce the time and quality of care and feeding of their children in order to meet the labor demands of livestock keeping. This relationship is affected by potential confounding factors such as household wealth, maternal education, and the age and sex of the child (figure 1).

In an effort to understand the risk factors for child malnutrition in poor countries, several studies have examined the relationship between maternal workload and indicators of child nutrition. In many cases, children whose mothers must shift time away from childcare activities to meet the labor demands of income-generating activities suffer from increased levels of malnutrition as a result of poor feeding practices (17). Such labor demands affect feeding practices and therefore child health in several ways; physical work is taxing on the mother and may reduce her nutritional and health status and therefore affect the quality of her breast milk and childcare. Maternal work often requires the mother to be physically absent from her child, reducing supervision during feeding as well as reducing the frequency of breastfeeding for those children who have

not yet been weaned. This relationship remains understudied and previous research has produced conflicting results.

Caring practices, such as exclusive breastfeeding and appropriate complementary feeding, play a key role in child nutritional status in Sub-Saharan Africa. Whether women have the physical capacity and enough time within their household and other economic duties to provide such care is an important factor to be explored (16). One way to look at indicators of child nutrition, and the method utilized in this study, is to examine breastfeeding duration and frequency for children under 24 months old and the dietary diversity of complementary feeding for children older than 6 months of age. Studies, which focus on exploring maternal workload and levels of child nutrition using these dietary measurements, remain sparse. A study from Bangladesh found that working women, engaged in cultural and informal work, breastfed for slightly longer compared to their non-working counterparts (18). On the contrary, women's work outside of the home was found to be a risk factor for early weaning in a low income Brazilian population (19). In regard to dietary diversity, maternal income-generating activities and per capita livestock assets in Mali were negatively associated with children's animal-source protein intake when controlling for household size, per capita livestock assets, and child's age (20).

Another method of examining child malnutrition, one that is more widespread in the literature, involves taking anthropometric measurements and evaluating levels of stunting, wasting and underweight in the population. In a study that looked at household dependence on women's income, the researchers found that there was a negative association with child height-for-age measurements (21). Indonesian children of mothers

who did not work had significantly higher ($p < 0.05$) height-for-age z scores than children of mothers who held informal work (such as a tailor, maid or street vendor) positions (22). Children of mothers who had a formal job, such as a factory or government employee, had better nutritional status than their informal and non-working counterparts (22). This could be a reflection of higher household income for families in which the mother held a formal position.

The results outlined above suggest a negative relationship between maternal workload and child nutrition, manifested through lower quality care practices. In the context of this study, increased dairying, at least in the initial stages requires female household members to increase their daily workload and may reduce time spent providing childcare. This study investigates if maternal workload, defined by any maternal participation in dairying, time allocated to childcare activities and time away from child on most days, mitigates any positive relationship between livestock intensification and indicators of young child nutrition. The indicators for child nutrition that will be explored are milk consumption in cups in the prior 24 hours, dietary diversity in the prior 24 hours based on the FANTA study food groups and breastfeeding frequency in the prior 24 hours. The results of this study will provide insight into the household dynamics that must be considered when promoting and implementing dairy intensification programs in smallholder farming communities in poor countries.

CHAPTER 2: MANUSCRIPT

ABSTRACT

INVESTIGATING THE MEDIATING ROLE OF MATERNAL PARTICIPATION IN DAIRY INTENSIFICATION PROGRAMS ON YOUNG CHILD NUTRITION IN WESTERN KENYA

By

Claire M. Marchetta

BACKGROUND

Dairy intensification programs create an opportunity for smallholder farmers to generate income and produce nutrient dense foods for household consumption. Potential adverse effects of intensification programs on household members are not well understood. Increased dairying often requires female household members to increase their farm-related workload and in so doing, shift time away from childcare activities. This paper investigates how maternal participation in dairying influences child milk consumption, dietary diversity and breastfeeding.

METHODS

Households (n= 92) were selected for inclusion if they had a resident child younger than 5 years old and met the requirements for one of three predefined milk production levels; No Milk, Emergent, or Advanced. Bivariate and multivariate linear regression models were used to estimate the association between milk production level and child nutrition and to determine if the association was affected by maternal participation in dairying.

RESULTS

Children in households with the greatest level of milk production consumed more milk and had a higher dietary diversity score than their Emergent and No Milk counterparts. Breastfeeding frequency was lowest in the Advanced milk production group. Maternal participation in dairying was negatively associated with each of the child nutrition outcomes.

CONCLUSIONS

Dairy intensification had a positive association with young child milk consumption and dietary diversity and a negative association with breastfeeding frequency. Maternal participation in dairying was negatively associated with all indicators. Future efforts to intensify dairy production in smallholder farming communities should consider the potential effects of the program on women and young children.

INTRODUCTION

Malnutrition is the most important risk factor for the burden of disease in poor countries and is the underlying cause of more than half of all deaths in children under 5 years of age globally (1). Coupled with poverty, malnutrition is responsible for a myriad of health and developmental problems, including diarrhea, infection, respiratory disorders, cognitive delays, and death (2). People living in poverty-stricken countries suffer from micronutrient deficiencies primarily because their diet is based on cereal grains (3). Animal-source foods (ASF) are appropriate for curbing malnutrition because they are energy-dense, are good sources of protein, and contain a large number of key micronutrients. In many cases, nutrients in ASF, such as iron and zinc, exhibit greater bioavailability than those from plant sources (4). At low to moderate intakes, meat, milk and egg products are highly beneficial, providing essential amino acids, minerals and vitamins. Increases in the consumption of animal products in poor countries are highly desirable in combating malnutrition (5). Additionally, the high-nutrient density of ASF makes them attractive as a food-based intervention for populations, including very young children, that have difficulty consuming large amounts of food.

Livestock intensification intervention programs have the potential to promote consumption of ASF and alleviate poverty within farming communities in low-resource agricultural settings where micronutrient malnutrition is common and ASF intakes are normally low (6). Livestock ownership currently supports and sustains the livelihoods of an estimated 675 million rural poor, and it is one of the few rapidly growing markets that poor people can join in the absence of substantial resources or training (5). Owning livestock offers the opportunity for smallholder farmers both to generate income through

the sale of animal products as well as to increase household consumption of animal milk and animal meat. However, the effects of livestock programs on farming households, and in particular on young child nutrition, remain understudied. Understanding this potential impact will provide an opportunity to increase the value of livestock interventions and improve their potential to reduce poverty (3). To achieve this potential requires a comprehensive understanding and appreciation of the multifaceted role that livestock play in the smallholder system (7).

An important potential pathway linking livestock ownership to child nutrition involves changes in the time that mothers or children's primary caregivers allocate to infant and young-child feeding practices and dietary diversity. Increased dairying, at least in the initial stages, often requires female household members to increase their daily workload. Such increases may negatively affect young children if mothers must shift their time away from childcare activities. To explore this pathway and understand how dairy intensification affects the nutrition of children under 5 years, a study in collaboration with the International Livestock Research Institute (ILRI) based in Nairobi, Kenya was conducted in three study sites in Rift Valley Province, Kenya during the summer months of 2010.

METHODS

RESEARCH QUESTION AND HYPOTHESIS

The primary research question under investigation asks if maternal participation in dairying activities mediates the relationship between dairy intensification and indicators of childhood nutrition, specifically dietary diversity, milk consumption and breastfeeding frequency.

The researchers hypothesized that as households intensify dairy production, mothers initially will be more likely to participate and will allocate more time to dairying. Maternal participation in and/or time allocated to dairying will be negatively associated with child nutrition, and thus will mitigate the positive effects of the dairy intensification program on the outcome.

STUDY DESIGN

In each site, 30 households were surveyed, sampling ten households from each intensification level. Three intensification levels were defined:

1. No Milk – no household milk production for the last 30 days
2. Emerging – current daily milk production of best cow is < 6 liters
3. Advanced – current daily milk production of best cow is ≥ 6 liters

For each site, 15 GPS points were randomly generated using OSI Explorer, within a 5 kilometer radius from the site hub. Once the point was located, the nearest household was screened for the presence of a child under five years old and milk production based on the defined intensification levels. If the household did not qualify based on screening criteria and/or the quota had been met for the specific intensification level, the team used snowballing to identify other nearby households. If, once the 15 GPS points were

exhausted and the ten household quota per intensification level was not met, five new, random GPS points were generated and households were identified using the previously mentioned method (23).

In Kipkelion and Kebenet, household identification occurred first, followed by the administration of the interview on a subsequent visit. Local community members accompanied each of the four teams, each consisting of an Emory student and a Kenyan field assistant, to introduce the team members to the households. The purpose of the study and participant confidentiality was explained and informed consent was obtained. Appointments to administer the household questionnaire were then made for later that same week. In Cheborge, identification and administration of the questionnaire occurred on the same day. When available, EADD interns accompanied the four teams (23).

The interviews were conducted in a number of settings, including in and around the respondent's home, in tea fields, and as the respondent worked in the family garden. Surveys were administered by the Kenyan field assistants in Kiswahili or Kalenjin, in the presence of the Emory team member. On average, each interview took 1½ hours to complete (23).

The sample size consisted of 94 households from all three sites. One interview from Kipkelion and one from Kebenet were removed from analysis, leaving 92 households for analysis (table 1). The surveys were discarded because upon review it was determined that the respondents and the households did not meet the selection criteria.

The household questionnaire consisted of two parts. Part A was administered to the head of household or primary caregiver of the index child if the head was not

available and the primary caretaker could answer the questions. Part B was administered to the primary caregiver of the index child. The index child was defined as the youngest child in the household less than 5 years of age. The survey instrument included questions on information on basic demographics, household income and investments, milk production and dairy inputs, dairy consumption with a focus on the youngest child, dietary diversity and food security, time allocation of the primary caregiver, and household health-seeking behavior and practices (23).

IRB AND ETHICS

The study was considered social-humanist behavior research, with no more than minimal risk to participants and was approved as an exemption by the Institutional Review Board (IRB) of Emory University. In all phases of research, informed consent was verbal and given in the participant's language of choice.

ANALYSIS

The data was analyzed using SAS 9.2 software. Bivariate analyses were conducted and multivariate linear regression models were estimated to address the primary research question. The variables used in the models included the outcomes, total daily child milk consumption in cups in the prior 24 hours, dietary diversity based on an 8 food group score in the prior 24 hours, and frequency of breastfeeding in the prior 24 hours. The dietary diversity index was a composite score based on the following food groups: 1) grains, roots and tubers, 2) legumes and nuts, 3) dairy products, 4) flesh foods (meat, fish, poultry, and liver/organ meats), 5) eggs, 6) vitamin A-rich fruits and vegetables, 7) other fruits and vegetables, and 8) fats and oils. Logistic regression was

conducted to estimate the association between maternal participation in dairying and each food group, separately.

Not all outcomes were appropriate for all children 0-5 years old, therefore each outcome was restricted to the sample of children in which the outcome was applicable. The milk consumption and dietary diversity score were restricted to children 6 months and older, while breastfeeding frequency was limited to children 24 months and younger. These cutoff ages were based on WHO recommendations for breastfeeding and complementary feeding. In these samples, one child was missing data for total milk consumption and 16 children had missing values for breastfeeding frequency and were therefore excluded from analysis.

The exposure of interest was household intensification level based on daily milk production by best cow in the past 30 days. Maternal participation in dairying, defined as a binary variable based on the primary caretaker's response to her primary activity, served as the mediating variable of interest. Covariates included in the multivariate models included total land holdings in acres as a proxy measurement for underlying household wealth, child's age in months, child's sex, and mother's highest level of education in years. Potential confounding factors were selected because they were associated with the outcome and exposure and/or mediating variables. The median value of mother's education, 8 years, was imputed for 3 observations with missing values. Imputation was conducted to reduce further loss of power in the already small study sample.

Other covariates, such as mother's age and total household assets, were considered for the analysis. However, concerns of precision, variability, and

measurement error were reasons why these variables were excluded from the analysis and the previously specified variables were selected. Child's age and sex, mother's education and total land holdings were found to be better predictors of the outcomes. Other proxy measurements for participation in dairying, such as total time away from the child and total time spent dairying for the Emergent and Advanced groups were also explored. There was found to be high variability in the reported time spent dairying and the No Milk households were not asked about their time spent dairying, further limiting the sample size. Therefore, the binary definition of dairying was selected as the mediating variable for the primary analysis.

The importance of the observed associations was based on clinical significance and statistical significance at the 0.1 level due to the small sample size.

RESULTS

DESCRIPTIVE STATISTICS

The study population consisted of 92 households, 30 in the No Milk production group, 31 in the Emerging milk production group, and 31 in the Advanced milk production group. The mean number of household members for each group was about 6 people. The average age of the head of household was 40 years, and literacy was above 80% for these respondents across intensification levels. The predominant ethnicity for each group was Kalenjin and most were Protestants. The average age of the primary caregiver was around 30 years, with some variation across intensification level groups. Additionally, the mother's level of education ranged from under 8 years of schooling for the No Milk group to more than 9 years of schooling for the Advanced group. The average age of the index child was 20 months in the No Milk and Emerging groups and nearly 27 months in the Advanced group. Table 2 shows the variation in demographic variables across intensification levels as well as the association of each variable with each of the nutritional indicator outcomes.

Descriptive analyses of the outcome variables across intensification levels showed that milk consumption and dietary diversity generally increased as dairy production intensified, while breastfeeding frequency declined as dairy production increased. When breaking down the dietary diversity index into its component groups, it became clear that grains, dairy products and vegetables were predominant in the daily diet of young children in this region of western Kenya. Flesh foods and Vitamin A-rich fruits and vegetables were the least consumed foods across all intensification levels. Children whose mothers participate in dairying were less likely to consume flesh foods, eggs, vitamin A-rich fruits and vegetables, and fats and oils than the children whose mothers do

not participate in dairying. Children of mothers who participate in dairying were almost twice as likely to have consumed legumes and nuts in the prior 24 hours than their non-dairying counterparts. Table 3 exhibits these results.

Maternal participation in dairying activities was greatest among the women belonging to emergent households, although the percentage of participation in dairy-related activities was high across all levels of intensification (Appendix Table 1). Women in the Emergent households reported the greatest average amount of time engaged in dairying (1.9 hours), two times as much as women in the Advanced households. Additionally, the average time away from child was also greatest among the caregivers in Emergent households, followed by women in the No Milk households and then least among the women belonging to the Advanced households.

Regression Analysis

According to the results in Table 4 of the unadjusted milk consumption model, children of households in the Emergent milk production group consumed about a quarter cup more of milk than their No Milk counterparts. Children of Advanced households consumed about one more cup of milk compared to the No Milk, or reference group, a significant finding ($p = 0.08$). These results translate to 3 and 3.7 cups of milk consumed daily for Emergent and Advanced children respectively, compared to 2.7 cups consumed by children in the No Milk group. When controls for child's age and total land holdings were added to the model, the positive effect of dairy intensification on milk consumption lessened; however, children of Emergent and Advanced households still consumed more milk than the children in the No Milk households. Child's age and land ownership were

significant positive predictors of child milk consumption (p = 0.007 and p = 0.004, respectively).

When maternal participation in dairying was controlled for in the model, it had a significant negative association with milk consumption (p = 0.02). The coefficients of the intensification levels both increased compared to the other multivariate model not controlling for maternal participation in dairying. Children in the No Milk household consumed 2.9 cups of milk while children in the Emergent households consumed about 3.1 cups of milk and those in the Advanced households consumed 3.2 cups of milk.

The unadjusted dietary diversity score for children in the reference group was 4.8 food groups, 4.7 for children belonging to Emergent households and 5.2 for children in the Advanced households. In the adjusted model, maternal education and being male were significant positive predictors of dietary diversity score (p = 0.03 and p = 0.008, respectively). Dietary diversity score for No Milk and Advanced children was about 3.5 food groups, while the children in the Emergent households consumed about 3 food groups. Maternal participation in dairying was negatively associated with dietary diversity score and when controlled for in the model, the dietary diversity score increased slightly for children in all groups. Children in Emergent households had the lowest dietary diversity score in the sample. The regression results for the dietary diversity score outcome are summarized in Table 4.

The bivariate and multivariate models for breastfeeding frequency are also found in Table 4. The frequency of breastfeeding was lowest among children in the Advanced household, 6.3 times a day, compared to 7.5 times a day for children in Emergent households and 8 times a day among children in the No Milk households. When

controlling for child's age, a significant negative predictor of the outcome, the frequency of breastfeeding increased for all groups, but still showed the same trend of decreasing frequency with increasing intensification level. Advanced dairy intensification had a significant negative association with breastfeeding frequency ($p = 0.10$). Consistent with the results for the other outcomes, maternal participation in dairying had a negative association with breastfeeding.

A secondary analysis investigated the mediating role of maternal time, in hours, allocated to dairying activities. Because time data was not collected for the No Milk households, this analysis compared Emergent households to Advanced households only, using the Emergent group as the reference group (Appendix Table 2). Controlling for child's age and land holdings, milk consumption was about 1/6 of a cup greater among Advanced children compared to Emergent children. Maternal time spent dairying had a small negative association with milk consumption and when controlled for in the model, milk consumption was greater among both groups than when it is not included in the model, 2.0 and 2.2 cups of milk for Emergent and Advanced children, respectively. Child's age and total land holdings remained significant positive predictors of milk consumption.

In the unadjusted model, children in the Advanced group had significantly higher dietary diversity scores than the children in the Emergent group ($p = 0.03$). The difference between groups remained significant in the adjusted model ($p = 0.04$) and when adjusted for maternal participation in dairying ($p = 0.02$). Maternal participation in dairying displayed a slightly positive effect on dietary diversity, which was not what was expected.

When adjusting for child's age, children in the Emergent group breastfed more than 1 time per day more than their Advanced counterparts, 9.2 times compared to 8 times per day. Child's age was a significant negative predictor of breastfeeding frequency in both adjusted models ($p = 0.06$ and $p = 0.04$, with and without maternal participation in dairying, respectively). Maternal participation in dairying also had a slightly positive association with breastfeeding frequency, opposite from what was expected.

Mother's time away from child, measured in hours, was explored as a mediator as well. For each indicator of nutrition, hours away from child had very little to no effect on the outcome. These results can be found in Appendix Table 3.

DISCUSSION

CONCLUSIONS

When maternal participation in dairying was considered as a binary variable, the patterns in the results were consistent with the hypothesis. Maternal participation in dairying activities was negatively associated with all child nutrition outcomes and was significantly negatively associated with child milk consumption. When the negative effect of this mediator was controlled for in each multivariate model, the magnitude of the positive effect of dairy intensification on milk consumption and dietary diversity increased, while the magnitude of the negative effect of intensification on breastfeeding decreased. Maternal education and being male were significant positive predictors of child's dietary diversity score, while child's age and total land holdings were significant positive predictors of child milk consumption. Child's age was the only significant predictor of breastfeeding frequency. When adjusted for confounders, children in the Advanced milk production group had a significant negative association with breastfeeding frequency.

Total time spent dairying was only collected for the Emerging and Advanced milk producing groups. The No Milk group could not be used as a reference group when investigating the continuous time variable of time spent dairying as the mediator. Participation in dairying, as a continuous variable, was negatively associated with milk consumption but not with the other nutrition outcomes. The use of hours away from child as the mediating variable had no effect on the outcomes.

STRENGTHS AND LIMITATIONS

The results of this study suggest that dairy intensification in poor smallholder farming communities in western Kenya has a positive effect on child milk consumption

and dietary diversity and a negative effect on infant breastfeeding frequency. Maternal participation in dairying activities may negatively affect this relationship between intensification and child nutrition indicators and mitigate the positive effects of the program. A study of this nature, which investigates the relationships between dairy production, child health and maternal workload, has not previously been done. This study can be used to inform future livestock intensification efforts and will encourage these efforts to consider how the program may affect women and young children. Future programs can include educational outreach by community health workers to inform dairying women about proper nutrition and methods of managing work and feeding schedules for their children. Perhaps these programs can also help women find appropriate substitute care if they must leave their child to pursue market activities.

The limitations in this study may contribute to the observed results, in particular the lack of power to see a statistically significant effect between intensification groups and the outcomes due to the small sample size. Also, the binary variable used to describe maternal participation in dairying was not ideal for measuring time allocation to dairying, however it did provide for little misclassification of engagement in dairying practices. A continuous time variable measuring the amount of time women spent conducting dairying activities for all groups would have enhanced this investigation. Based on the reports given by the caregivers, dairying is a primary activity regardless of level of milk production, therefore, it would be appropriate to collect this data for all groups in the future. To enhance such a measurement and limit inaccuracy, researchers should directly observe the participants and record the time they spend engaged in various household and income generating activities.

Due to the cross-sectional nature of data collection, it was impossible to ascertain a causal relationship in this study. Additionally, both selection bias and recall bias posed potential challenges. The primary caregivers may not have accurately recalled everything their child had eaten in the last 24 hours and how much time they either spent away from their child or the amount of time they spent conducting dairying related activities. The 24-hour recall of foods consumed may not describe a complete picture of children's dietary quality. While the sites were part of an on-going diary intensification project, they were not selected randomly, creating selection bias and limiting the generalizeability of the study sample. The sites were purposively selected because they were available during the summer months of June and July when the research team would be able to collect the data.

FUTURE DIRECTIONS

The results of this study suggest a potential negative effect of the role mothers have in dairy production on indicators of child nutrition and this relationship should be explored with additional research. Future studies with a larger sample size and a prospective study design should be conducted. An attempt to measure accurately child nutritional intake and maternal time engaged in dairying activities through direct observation instead of depending on recall alone would also enhance the study. Other cut off values of milk production, which may serve as better measurements of intensification level, can be explored to determine if there is a specific threshold at which increased milk production affects the outcome. Additionally, the dietary diversity index may be masking a specific effect maternal workload has on child consumption of certain foods. In particular, it would be interesting to compare foods sourced from the home and foods that

must be purchased at the market as these foods may have a differential effect on maternal time and workload.

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TABLES

TABLE 1: STRATIFICATION OF SURVEYED HOUSEHOLDS BY INTENSIFICATION LEVEL AND SITE, RIFT VALLEY PROVINCE, KENYA (N=92)

SITE	LEVEL OF MILK PRODUCTION			
	NO MILK	EMERGING	ADVANCED	TOTAL
CHEBORGE	10	10	10	30
KEBENET	10	10	9	29
KIPKELION	10	11	12	33
TOTAL	30	31	31	92

TABLE 2: CHARACTERISTICS OF STUDY POPULATION BY INTENSIFICATION LEVEL AND ASSOCIATION WITH NUTRITIONAL OUTCOMES, RIFT VALLEY PROVINCE, KENYA

CHARACTERISTICS	INTENSIFICATION LEVEL			OUTCOME[1]		
	NO MILK	EMERGING	ADVANCED	MILK CONSUMPTION	DIETARY DIVERSITY	BREASTFEEDING FREQUENCY
	N=30	**N=31**	**N=31**	**N= 79[2]**	**N= 80**	**N= 44[3]**
HOUSEHOLD						
Milk Production, liters	0	3.0	8.4	0.11**	0.05**	-0.15
Household Size[4]	5.3	6.3	6.3	-0.01	-0.08*	0.07
Land Owned, acres	1.2	3.1	5.5	0.12**	0.02	0.02
Kalenjin (vs. other)	73.3%	96.8%	100.0%	0.87	-0.25	1.52
Protestant (vs. other)	60.0%	80.7%	77.4%	0.31	0.10	1.70*
PRIMARY CAREGIVER						
Mean Age, years	28.7	32.6	31.9	0.04*	-0.02	0.02
Mean Education, grades	7.7	8.4	9.6	0.07	0.08**	0.05
INDEX CHILD						
Male (vs. Female)	46.7%	38.7%	54.8%	-0.54	0.50**	-0.36
Mean Age, months	20.1	19.7	26.7	0.04**	0.01**	-0.11*

*Significant at the 0.1 level, ** Significant at the 0.05 level

[1] Linear regression coefficients of covariates were estimated for each outcome

[2] 1 observation from the eligible subset was missing data for total milk consumption

[3] 16 observations from the eligible subset were missing data for breastfeeding frequency

[4] Household size was measured in total family members living in the home

TABLE 3: NUTRITION INDICATOR OUTCOMES ACROSS INTENSIFICATION LEVELS AND ASSOCIATION WITH PARTICIPATION IN DAIRYING, RIFT VALLEY PROVINCE, KENYA

OUTCOME	INTENSIFICATION LEVEL			PARTICIPATION IN DAIRYING
	NO MILK	EMERGING	ADVANCED	YES
MILK CONSUMPTION (CUPS)				
6 MONTHS AND OLDER (RANGE 0.5-11)	**N=25**	**N=27**	**N=27**	**N=79[1]**
Mean Daily Consumption	2.7	3.0	3.7	-1.35**
DIETARY DIVERSITY INDEX (SCORE)				
6 MONTHS AND OLDER (RANGE 3-7)	**N=25**	**N=28**	**N=27**	**N=80**
Mean Score	4.8	4.7	5.2	-0.33
INDIVIDUAL COMPONENTS OF INDEX				PREVALENCE ODDS RATIO ESTIMATE[2]
Grains, Roots, Tubers	100.0%	96.4%	100.0%	-
Legumes and Nuts	56.0%	46.4%	70.4%	1.76
Dairy Products (Milk)	100.0%	100.0%	100.0%	-
Flesh Foods	24.0%	7.1%	14.8%	0.40
Eggs	16.0%	25.0%	25.9%	0.45
Vitamin A rich Fruits and Vegetables[3]	16.7%	10.7%	14.8%	0.60
Other Fruits and Vegetables	100.0%	100.0%	100.0%	-
Fats and Oils	72.0%	82.1%	92.6%	0.43
BREASTFEEDING FREQUENCY (TIMES)				
24 MONTHS AND YOUNGER (RANGE 3-16)	**N=19**	**N=15**	**N=10**	**N=44[4]**
Mean Times in Last 24 hours	8.1	7.5	6.3	-0.16

*Significant at the 0.1 level, ** Significant at the 0.05 level

[1] 1 observation from the eligible subset was missing data for total milk consumption

[2] POR could not be estimated for grains, milk, or fruits and vegetables because 100% of children had consumed these foods

[3] 1 observation was missing from this food group outcome, the sample was 79

[4] 16 observations from the eligible subset were missing data for breastfeeding frequency

TABLE 4: SUMMARY OF REGRESSION RESULTS FOR CHILD MILK CONSUMPTION, DIETARY DIVERSITY SCORE, AND BREASTFEEDING FREQUENCY IN THE PRIOR 24 HOURS USING BINARY DEFINITION FOR PARTICIPATION IN DAIRYING, RIFT VALLEY PROVINCE, KENYA

***NO MILK HOUSEHOLDS ARE REFERENCE GROUP**

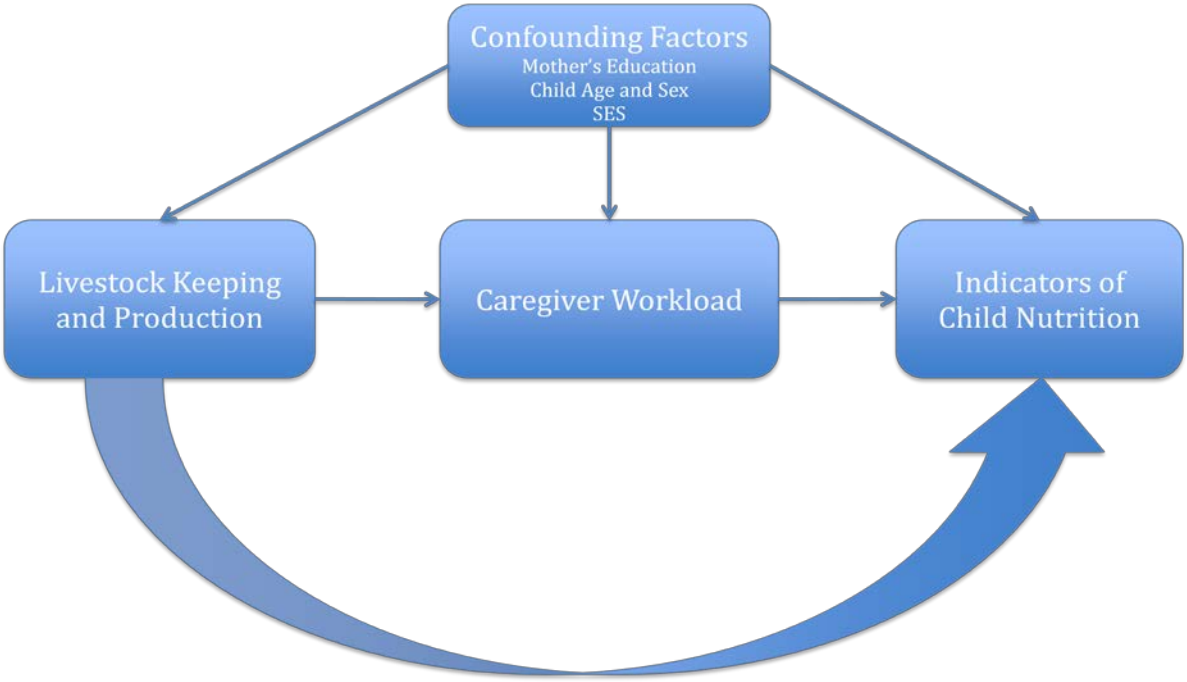
MILK CONSUMPTION IN PRIOR 24 HOURS (CUPS)	VARIABLE	COEFFICIENT	P-VALUE	95% CI
Bivariate Model, N=79				
	Emerging	0.27	0.63	(-0.83, 1.37)
	Advanced	0.97	0.08*	(-0.13, 2.07)
Multivariate Model[1], N=79				
	Emerging	0.18	0.73	(-0.84, 1.19)
	Advanced	0.31	0.57	(-0.76, 1.37)
Multivariate with Mediator Model, N=79				
	Emerging	0.23	0.64	(-0.76, 1.22)
	Advanced	0.31	0.55	(-0.72, 1.35)
	Participation in Dairying	-1.41	0.02**	(-2.56, -0.25)
DIETARY DIVERSITY IN PRIOR 24 HOURS (SCORE)				
Bivariate Model, N=80				
	Emerging	-0.16	0.52	(-0.66, 0.34)
	Advanced	0.35	0.18	(-0.16, 0.85)
Multivariate Model[2], N=80				
	Emerging	-0.24	0.31	(-0.70, 0.23)
	Advanced	0.21	0.39	(-0.28, 0.70)
Multivariate with Mediator Model, N=80				
	Emerging	-0.23	0.33	(-0.70, 0.24)
	Advanced	0.22	-0.38	(-0.28, 0.71)
	Participation in Dairying	-0.08	0.78	(-0.64, 0.48)

FREQUENCY OF BREASTFEEDING IN PRIOR 24 HOURS (TIMES)				
Bivariate Model, N=44				
	Emerging	-0.59	0.56	(-2.59, 1.41)
	Advanced	-1.75	0.13	(-4.01, 0.51)
Multivariate Model[3], N=44				
	Emerging	-0.62	0.52	(-2.57, 1.33)
	Advanced	-1.83	0.10*	(-4.03, 0.37)
Multivariate with Mediator Model, N=44				
	Emerging	-0.50	0.63	(-2.56, 1.56)
	Advanced	-1.77	0.12	(-4.02, 0.48)
	Participation in Dairying	-0.58	0.69	(-3.51, 2.35)

*Significant at the 0.1 level, ** Significant at the 0.05 level
[1]Milk consumption model is adjusted for age of index child and total land holdings
[2]Dietary diversity model is adjusted for age and sex of index child and maternal education
[3]Breastfeeding frequency is adjusted for age of index child

FIGURES

FIGURE 1: PATHWAYS BETWEEN LIVESTOCK KEEPING AND INDICATORS OF CHILD NUTRITION



CHAPTER 3: SUMMARY

Livestock intensification programs have the potential to alleviate two major problems, poverty and malnutrition, in smallholder farming communities in poor countries. Livestock ownership and maintenance may contribute to an increase in workload for female household members, which can negatively affect child nutritional status. The purpose of this study was to explore this pathway and determine the association between dairy intensification and child nutritional outcomes, and to see if maternal participation in dairying affected that relationship.

When maternal participation in dairying was considered as a binary variable, the patterns in the results were consistent with the hypothesis. Maternal participation in dairying activities was negatively associated with all child nutrition outcomes. When the negative effect of this mediator was controlled for in each model, the magnitude of the positive effect of dairy intensification on milk consumption and dietary diversity increased, while the magnitude of the negative effect of intensification on breastfeeding decreased. Maternal education and being male were significant positive predictors of child's dietary diversity score, while child's age and total land holdings were significant positive predictors of child milk consumption. Child's age was the only significant predictor of breastfeeding frequency.

The results of this study suggest a potential negative effect of the role mothers have in dairy production on indicators of child nutrition and this relationship should be explored with additional research. Future studies with a larger sample size and a prospective study design should be conducted. An attempt to measure accurately child nutritional intake and maternal time spent conducting dairying activities through direct

observation instead of depending on recall alone would also enhance the study. Other cut off values of milk production, which may serve as better measurements of intensification level, can be explored to determine if there is a specific threshold at which increased milk production affects the outcome. Additionally, the dietary diversity index may be masking a specific effect maternal workload has on child consumption of certain foods. In particular, it would be interesting to compare foods sourced from the home and foods that must be purchased at the market as these foods may have a differential effect on maternal time and workload.

The results of this study and of future research will help inform organizations, such as EADD, in enhancing livestock interventions in smallholder farming communities in poor countries. The design of future interventions must consider women's role in livestock keeping and market activities and the effect their role has on feeding and care practices for young children. Future programs can include educational outreach by community health workers to inform dairying women about proper nutrition and methods of managing work and feeding schedules for their children. Perhaps these programs can also help women find appropriate substitute care if they must leave their child to pursue market activities. Consideration of these relationships will allow livestock interventions to more closely achieve the goal of poverty and malnutrition reduction among the rural poor.

APPENDIX

TABLE 1: MATERNAL WORKLOAD ACROSS INTENSIFICATION LEVELS

	INTENSIFICATION LEVEL		
	NO MILK	EMERGING	ADVANCED
PARTICIPATION IN DAIRYING	**N=30**	**N=31**	**N=31**
Mean Daily Hours		1.9	0.9
Dairying as Primary Activity	83.3%	90.3%	87.1%
TIME AWAY FROM CHILD	**N=29**	**N=31**	**N=31**
Mean Daily Hours	3.2	3.6	3.5

TABLE 2: SUMMARY OF REGRESSION RESULTS FOR CHILD MILK CONSUMPTION, DIETARY DIVERSITY SCORE, AND BREASTFEEDING FREQUENCY IN THE PRIOR 24 HOURS USING CONTINUOUS TIME (HOURS) VARIABLE FOR PARTICIPATION IN DAIRYING, RIFT VALLEY PROVINCE, KENYA
***EMERGING HOUSEHOLDS ARE REFERENCE GROUP**

MILK CONSUMPTION IN PRIOR 24 HOURS (CUPS)	VARIABLE	COEFFICIENT	P-VALUE	95% CI
Bivariate Model, N=54				
	Advanced	0.70	0.19	(-0.35, 1.76)
Multivariate Model, N=54				
	Advanced	0.15	0.76	(-0.84, 1.14)
Multivariate with Mediator Model, N=54				
	Advanced	0.12	0.81	(-0.88, 1.12)
	Participation in Dairying	-0.06	0.68	(-0.35, 0.23)
DIETARY DIVERSITY IN PRIOR 24 HOURS (SCORE)				
Bivariate Model, N=55				
	Advanced	0.51	0.03**	(0.05, 0.97)
Multivariate Model, N=55				
	Advanced	0.50	0.04**	(0.02, 0.97)
Multivariate with Mediator Model, N=55				
	Advanced	0.58	0.02**	(0.09, 1.06)
	Participation in Dairying	0.11	0.11	(-0.03, 0.24)
BREASTFEEDING FREQUENCY IN PRIOR 24 HOURS (TIMES)				
Bivariate Model, N=25				
	Advanced	-1.17	0.26	(-3.25, 0.92)
Multivariate Model, N=25				
	Advanced	-1.22	0.21	(-3.19, 0.74)

Multivariate with Mediator Model, N=25				
	Advanced	-0.83	0.39	(-2.81, 1.15)
	Participation in Dairying	0.40	0.13	(-0.13, 0.92)

*Significant at the 0.1 level, ** Significant at the 0.05 level

[1]Milk consumption model is adjusted for age of index child and total land holdings

[2]Dietary diversity model is adjusted for age and sex of index child and maternal education

[3]Breastfeeding frequency is adjusted for age of index child

TABLE 3: SUMMARY OF REGRESSION RESULTS FOR CHILD MILK CONSUMPTION, DIETARY DIVERSITY SCORE, AND BREASTFEEDING FREQUENCY IN THE PRIOR 24 HOURS USING TIME AWAY FROM CHILD (HOURS) AS MEDIATOR, RIFT VALLEY PROVINCE, KENYA

***NO MILK HOUSEHOLDS ARE REFERENCE GROUP**

MILK CONSUMPTION IN PRIOR 24 HOURS (CUPS)	VARIABLE	COEFFICIENT	P-VALUE	95% CI
Bivariate Model, N=79				
	Emerging	0.27	0.63	(-0.83, 1.37)
	Advanced	0.97	0.08*	(-0.13, 2.07)
Multivariate Model[1], N=79				
	Emerging	0.18	0.73	(-0.84, 1.19)
	Advanced	0.31	0.57	(-0.76, 1.37)
Multivariate with Mediator Model, N=79				
	Emerging	0.17	0.75	(-0.86, 1.19)
	Advanced	0.31	0.57	(-0.77, 1.38)
	Time Away	0.02	0.83	(-0.14, 0.18)
DIETARY DIVERSITY IN PRIOR 24 HOURS (SCORE)				
Bivariate Model, N=80				
	Emerging	-0.16	0.52	(-0.66, 0.34)
	Advanced	0.35	0.18	(-0.16, 0.85)
Multivariate Model[2], N=80				
	Emerging	-0.24	0.31	(-0.70, 0.23)
	Advanced	0.21	0.39	(-0.28, 0.70)
Multivariate with Mediator Model, N=80				
	Emerging	-0.24	0.32	(-0.70, 0.23)
	Advanced	0.21	0.39	(-0.28, 0.71)
	Participation in Dairying	0.00	0.90	(-0.08, 0.07)

FREQUENCY OF BREASTFEEDING IN PRIOR 24 HOURS (TIMES)				
Bivariate Model, N=44				
	Emerging	-0.59	0.56	(-2.59, 1.41)
	Advanced	-1.75	0.13	(-4.01, 0.51)
Multivariate Model[3], N=44				
	Emerging	-0.62	0.52	(-2.57, 1.33)
	Advanced	-1.83	0.10*	(-4.03, 0.37)
Multivariate with Mediator Model, N=44				
	Emerging	-0.63	0.52	(-2.62, 1.36)
	Advanced	-1.83	0.11	(-4.06, 0.40)
	Participation in Dairying	0.02	0.93	(-0.34, 0.37)

*Significant at the 0.1 level, ** Significant at the 0.05 level
[1]Milk consumption model is adjusted for age of index child and total land holdings
[2]Dietary diversity model is adjusted for age and sex of index child and maternal education
[3]Breastfeeding frequency is adjusted for age of index child