

Published in final edited form as:

*Soc Sci Med.* 2012 November ; 75(9): 1673–1684. doi:10.1016/j.socscimed.2012.06.025.

## Heavy agricultural workloads and low crop diversity are strong barriers to improving child feeding practices in the Bolivian Andes

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### Abstract

Most nutrition initiatives to date aimed at improving infant and young child feeding (IYCF) have emphasized addressing knowledge gaps through behavior change messaging with less focus on addressing the underlying environmental barriers that may shape these behaviors. This research integrates an analysis of longitudinal dietary data with qualitative data on barriers to improved child feeding to identify the nature and extent of the barriers caregivers face to improving IYCF practices in a farming region of the Bolivian Andes, and to determine the relative influence of these barriers on caregivers' abilities to improve IYCF practices. Sixty-nine caregivers were selected from a sample of 331 households that participated in a longitudinal survey assessing changes in IYCF practices among caregivers with children aged 0–36 months from March 2009 to March 2010. Forty-nine barriers within 12 categories of barriers were identified through semi-structured interviews with the 69 caregivers. The most frequently reported barriers were those related to women's time dedicated to agricultural labor, the limited diversity of household agricultural production, and lack of support for child feeding from spouses and mothers-in-law. In multivariate analyses controlling for several variables that could potentially influence IYCF practices, these barriers were negatively associated with changes to the diversity of child diets, child dietary energy intake, and child meal frequency. While knowledge gaps and individual-level influences affected IYCF practices, physical and social caregiving environments in this region of Bolivia were even more important. Behavior change communication alone will likely not address the social and environmental barriers to improved child feeding that often prevent translation of improved knowledge into action. Particularly in rural regions, agriculture may strongly influence child feeding, not only indirectly through household food security, but also directly by affecting women's caregiving capacity.

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## Introduction

Over the past two decades, the nutrition community has increasingly recognized the importance of “care” for mothers and children as a critical underlying determinant of child nutrition. This concept of “care” refers to many different practices that caregivers, mostly women, perform that influence the nutrition, health, and cognitive development of children (Engle et al., 1997). A central component of care is infant and young child feeding (IYCF), a set of practices that includes breastfeeding, complementary feeding and the multiple factors that inform these practices (Dewey, 2003).

This increasing recognition of the importance of IYCF is reflected in the many recent nutrition initiatives that have included IYCF as an explicit focus or key component of their programs (Caulfield et al., 1999; Penny et al., 2005; AED, 2006; Menon et al., 2007; Dewey and Adu-Afarwuah, 2008). These programs frequently employ behavior change communication (BCC) strategies (Finnegan and Viswanath, 2008), targeting individual pregnant and lactating mothers, or groups of these women, for behavior modification through counseling and media messages.

Many of these programs have documented improvements to child diets and child growth, yet it is not clear that insufficient knowledge or poor attitudes and perceptions about IYCF are the most important limiting factors to improving how young children are fed and cared for in low income settings. A recent *Lancet* review of interventions that work to reduce maternal and child under nutrition revealed that complementary feeding support and educational strategies benefited populations with adequate incomes and sufficient access to appropriate foods, while in food-insecure populations, these strategies were effective only when combined with food supplements (Bhutta et al., 2008). This suggests that some foundation of food and livelihood security must exist to adequately capture the benefits of behavior change communication efforts. Indeed, as compared to normative systems of beliefs and knowledge, environmental influences on food and livelihood security as well as social constraints on individuals’ actions may play equally important or even dominant roles in determining behaviors (Bronfenbrenner, 1979; Pepitone, 1981; McLeroy et al., 1988; Stanton et al., 1992; Stokols, 1996).

The fields of public health and health promotion, as well as nutritionists in high-income countries researching obesity, often use ecological models for addressing health-related behaviors (Killingsworth, 2003; Merzel and D’Afflitti, 2003; Kaufman and Karpati, 2007; Sallis et al., 2008; Hermstad et al., 2010; Miller, 2011). Some intervention programs focused on IYCF have recognized the importance of physical, social, and policy environments in shaping behaviors (Paul et al., 2011; Briscoe and Aboud, 2012), yet the operational activities of most IYCF programs to date have emphasized behavior change messaging and provision of fortified or improved complementary foods.

This research examines the barriers that caregivers face to improving IYCF practices in the northern Potosí region of Bolivia, a rural farming and herding region located in the central highlands of the country. For individuals in communities that depend on agriculture as their principal source of livelihood, like those in northern Potosí, agriculture and the natural environment influence many aspects of daily life, particularly for women. Women comprise 25 percent of the agricultural labor force in South America and 43 percent in all developing countries (FAO, 2011). In many countries, including Bolivia, the percentage of women involved in agriculture has increased in the past 30 years (in Bolivia the percentage has risen from 33 percent in 1980 to 42 percent in 2010) (FAO, 2011).

Agriculture may affect IYCF practices in several ways. For example, agricultural labor may take time away from child care (Paolisso et al., 2001), or force caregivers to feed children in

work environments that are not amenable to nurturing interactions between the mother and child (Ukwuani and Suchindran, 2003; Narayanan, 2008). High agricultural workloads, occupational health risks, as well as exposure to toxins and disease through agricultural activities (Hoddinott, 2011) can deleteriously affect women's health and nutrition which may have important negative consequences for maternal lactation (Rasmussen, 1992) and child feeding behaviors. Despite recent attention to the linkages between agriculture and nutrition, both in the academic literature (Arimond et al., 2010; Masset et al., 2012) and in high-level policy circles (Fanzo, 2011), the implications of changes to agricultural production systems and rural livelihoods on caregiving and IYCF practices have received less attention than the potential for agriculture to influence nutrition by increasing food availability and household incomes.

This research seeks to identify the nature and extent of the barriers caregivers face to improving IYCF practices in northern Potosí, Bolivia and to determine the relative importance of these barriers by examining the association between barriers and caregivers' abilities to improve IYCF practices.

## Subjects & Methods

### Setting

Northern Potosí is a geographically and economically isolated area of the Bolivian Andes, home to semi-subsistence agropastoralist families (i.e. families that engage in both farming and herding and whose diets consist mostly of foods that they produce themselves). The indigenous, Quechua-speaking communities in the region cultivate fields near to and far from their homes. Land nearer to homesteads is intensively managed (i.e. fertilized with manure, cropped yearly) while distant plots are managed as blocks of fields that are fallowed after three or four years of synchronized crop rotations (Morlon, 1992; Pestalozzi, 2000; Vanek, 2011). Plots at sharply different altitudes form a type of "vertical archipelago" (Murra, 1975) wherein risk is diversified and crop varieties, planting seasons and workloads are staggered throughout the year. Households at all elevations in the region grow potato, but especially at elevations above 3200 meters above sea level (masl). Maize is grown at lower elevations (i.e. from approximately 2650 to 3500 masl), wheat below about 3600 masl, and barley at higher elevations (up to 4200 masl). Nearly all households also raise mixed herds of sheep and goats with llama entering these flocks at higher elevations (i.e. above 3800 masl). These herds provide meat, manure to fertilize crops, and serve as a "bank account" which families can draw upon by selling animals. Families often own land near the homestead, but also rent plots for cultivation. Pasture land surrounding communities is widely held communally. The declining availability of pasture, depletion of soil fertility, and pervasive soil erosion across the region (Vanek, 2011) contribute to poor agricultural production for many households.

Women are generally responsible for tending to animal herds and maintaining crops (e.g. planting, weeding) while men engage in heavier labor tasks (e.g. plowing, harvesting). Men also migrate to cities or nearby communities for temporary and seasonal labor (e.g. construction, mining, agriculture). This migration is ubiquitous in the region and most men are absent from home for one to two months or more throughout the year. Transportation infrastructure is exceedingly poor. During the rainy season, landslides frequently wash away entire mountain roads. Local market access is therefore limited, however, households do purchase some staple goods such as vegetable oil, lard, sugar, and salt and engage in formal and informal trade, usually across agroecological zones (e.g. farmers at higher elevations trade potatoes for maize with farmers from lower elevations). The potato-based diets of adults and children in the region have been shown to be deficient in multiple micronutrients

and fat content (Berti et al., 2010), and few caregivers follow recommended breastfeeding and complementary feeding practices (Cruz et al., 2010).

Households rely largely on government-provided health services, though because of poor access and mistrust of health staff, traditional home remedies are also often used. Health services are inadequate, in large part due to poorly-equipped staff, low retention rates, and the difficulty in reaching communities scattered among the distant mountains and foothills. All of these factors contribute to the high prevalence of extreme poverty, household food insecurity, and high rates of child mortality throughout the region (Comité Técnico del Consejo Nacional de Alimentación y Nutrición, 2006).

### **Strengthening Livelihoods and Community Support for Improved Child Feeding**

This study was part of a larger programmatic and research initiative focused on improving the IYCF practices of farming households through an ecological model of behavior change. The initiative, “Strengthening Livelihoods and Community Support for Improved Child Feeding”, was carried out between June 2009 and February 2010 (Jones, 2011). Communities were visited five to six times each, with a first visit focused on identifying with caregivers improved complementary feeding recipes for young children and promoting proper IYCF practices (e.g. exclusive and continued breastfeeding, proper diversity and consistency of complementary foods, and frequent and responsive feeding) while all subsequent visits sought to reinforce these practices by addressing context-related barriers to child feeding. Through participatory activities with communities, households and individuals, caregivers and program staff collaboratively identified strategies to improve IYCF practices that included: 1) pooling community agricultural resources and food baskets, often leveraging existing connections between households and neighboring communities, to maximize the diversity of foods available to households with young children, 2) sharing responsibilities, particularly for pasturing animals, within and between households and communities to free up caregivers’ time for child care, 3) designing recipes amenable to field feedings, supporting designated times and spaces for child feeding during farming and herding, and allocating nearby communal pastures to women with young children, 4) involving spouses, mothers-in-law, and grandmothers in child feeding promotion, decision-making, and activities, 5) promoting homestead vegetable production and legume cultivation for child consumption, and 6) strengthening intercommunity social networks, in part through participatory video methods (Lunch and Lunch, 2006).

### **Data collection & sampling**

**Household surveys**—In March 2009, a baseline survey of households with children aged two years and younger was conducted in eight health post jurisdictions of northern Potosí. Using community census data from these health posts and confirming household roster data with community authorities, all communities containing five or more households with children aged 24 months or younger, 44 in total, were included in the sample. The survey was administered again in March 2010 to all households in these same communities with children aged three years or younger, thus allowing follow up of the households from baseline and including new households with children born after March 2009. In total, 331 households were included in the baseline sample and 390 households were included in the March 2010 follow-up survey (Figure 1) representing 91% and 96% of eligible households, respectively. The survey collected data on many topics including household demographic composition, socioeconomic status, agricultural production, health-seeking behavior, food security, as well as caregiver knowledge of feeding practices, infant and young child feeding practices, child illness and child anthropometry. Following the baseline survey, communities were assigned to treatment groups (i.e. 13 communities to receive the intervention and 31 communities to serve as control communities) (Figure 1). Child-, maternal- and household-

level baseline characteristics, identified *a priori* as potentially influential determinants of caregivers' abilities to improve IYCF practices, were balanced between treatment groups prior to assignment (please see supplementary materials online for more information regarding data collection and sampling design for the survey).

**Semi-structured interviews**—The 13 intervention communities included 125 households with children aged 24 months or younger at baseline. From these households, the research team established a subsample of households to participate in semi-structured interviews, using baseline survey data and information from key informants to sample households in each of the 13 communities (proportionate to the size of the community) along a continuum from adequate to poor IYCF practices.

Assuming a single barrier would be associated with only a modest negative change in any of the IYCF indicators, we conservatively calculated that a sample size approximately one-third the size of the baseline sample (n=44) would be sufficiently large for subsample analyses. However, more than 44 households were eventually sampled—69 in total—as some key informant households who did not participate in the baseline survey were included (see below and Figure 1). Figure 1 shows that the subsample of 69 households was identified in June 2009. Interviews with 52 caregivers were conducted in mid-July 2009. Seventeen caregivers who were not available during the July interviews were interviewed in early October 2009. A trained public health nutritionist and ethnographer (YC) conducted the interviews in the local Quechua language. Interview topics included: caregiver experiences with attempts to improve IYCF practices, infant and child experiences with IYCF practices, caregiver health-seeking behaviors, household structure and gender roles, time and labor allocation, caregiver knowledge and education, household resources and food security, household sanitation environment and hygiene practices, and caregiver support from family members and the community. Semi-structured interview guides were informed in part by locally-adapted materials from the Process for the Promotion of Child Feeding, or ProPAN, project (PAHO, 2004) (please see supplementary materials online for more information regarding the sampling strategy and methodology used for semi-structured interviews).

### Sample sizes

Data are reported for two different samples: 1) the 69 caregivers interviewed (n=69), and 2) a subset of the 69 for whom data were available from both the March 2009 baseline and March 2010 follow-up surveys (n=50) (Figure 1). Ten of the 69 caregivers did not participate in either survey round because their children were older than two years of age at baseline. However, these women were chosen for the subsample because they had a child less than three years of age and were identified by their peers as key informants within communities on nutrition and health issues. Seven of the 69 women did not participate in the baseline survey because at the time they did not have a child less than two years of age. These women did, however, give birth to a child prior to the start of the interviews in July 2009 and were included in the March 2010 follow-up survey. These women were included in the subsample so as to gain the perspective of mothers rearing especially young infants. Two of the 69 women participated in the baseline survey, but emigrated from the region before the endline survey.

### Infant and child diets and feeding practices

Four indicators were measured to assess the quality of child diets and IYCF practices: 1) 24-hour dietary diversity, 2) 24-hour feeding frequency, 3) 7-day food group frequency, and 4) energy intake in the previous 24 hours (kcal). These indicators are based on those provided by the World Health Organization (WHO, 2008) as well as indices used to measure the

quality of IYCF practices (Arimond and Ruel, 2002; Moursi et al, 2008). The 24-hour dietary diversity indicator, based on the WHO “minimum dietary diversity” indicator, measures the number of different food groups fed to the child in the previous 24 hours (maximum of seven: grains, roots and tubers, legumes and nuts, dairy products, flesh foods, eggs, vitamin-A rich fruits and vegetables, other fruits and vegetables). The 24-hour feeding frequency indicator, based on the WHO “minimum meal frequency” indicator, measures the number of times the infant or child received solid, semi-solid, or soft foods in the previous 24 hours. The 7-day food group frequency indicator measures the number of food groups (maximum of 7 as above) fed in the previous 7 days. The 24-hour dietary data and 7-day food group frequency consumption data were collected during both baseline and follow-up surveys using quantitative questionnaires (Jones, 2011). Child energy intakes were estimated using these data combined with data from the Bolivian Food Composition Table (Ministerio de Salud y Deportes, Gobierno de Bolivia, 2005) (please see supplementary materials online for more information regarding collection of dietary data and use of IYCF indicators).

### Data analysis

Content analysis of semi-structured interviews followed systematic coding procedures (Strauss and Corbin, 1998). Interview notes were coded by the primary interviewer (YC) immediately following interviews to identify initial themes in the data. Interview notes and observations from the entire research team were then discussed jointly each night to identify the key barriers and their determinants reported by caregivers. Following each round of interviews, interview notes were re-coded by the primary interviewer while translated interview notes were independently re-coded (AJ) for thematic content using a constant comparisons approach (Corbin and Strauss, 1990). These separate codings were then compared and discussed by the analysts to identify areas of convergence and divergence. From these analyses, a codebook containing 62 data tags that uniquely identified each reported barrier was developed (Patton, 2002) and interview data were recoded using these standardized codes.

Following a similar analytic process of highlighting similarities and differences in concepts, these 62 barriers were then grouped into 49 thematic areas and further classified into 12 categories. These categories were etic constructs (i.e. categories created by the observer, in contrast to emic constructs, or those emerging from the caregiver herself; Peltó and Peltó, 1978) and may have missed some of the relationships between related barrier categories, several of which interact to create spheres of influence on women’s behavior. Therefore, four barriers “domains” were also created by grouping together interconnected barrier categories (Table 2).

Content analysis of qualitative data was carried out manually and all statistical analyses were conducted in SAS (version 9.1, SAS Institute, Cary, NC). The PROC MIXED procedure was used for linear regression analyses and multiple regression analyses that incorporated the random effect of community in models. The PROC TTEST procedure was used to compare means between samples for continuous variables and the PROC FREQ procedure was used for Chi-square tests of nominal variables. Two-way interactions between covariates and the number of barriers reported were also tested in multiple regression analyses. Associations are reported at  $p < 0.05$  significance level.

The study protocol was approved by the Cornell University Institutional Review Board for Human Participants.

## Results

### Sample characteristics

Table 1 presents data on select household-, maternal- and child-level characteristics for the subsample of caregivers with whom semi-structured interviews were conducted and for whom survey data were available at both baseline and follow-up (n=50). Data on these characteristics from the entire intervention group baseline sample (n=125), as well as from those households in the baseline sample who were not part of the subsample (n=75) are also presented for comparison purposes. Two-sided t-tests revealed no significant differences in the mean values of any of these characteristics (at a significance level of  $p < 0.05$ ) between the subsample of caregivers selected for further interview (n=50) and those not a part of this subsample (n=75). This suggests that the subsample was representative of the larger survey sample as well as the variation in community and household characteristics captured in the survey sampling design.

### Reported barriers to improved IYCF practices

Caregivers reported 49 barriers to improving IYCF practices (Table 2). Figure 1 shows the number of times these barriers were reported during interviews with caregivers, grouped according to the barrier categories and domains shown in Table 2. For example, five barriers were identified from the barrier category “women’s time dedicated to agriculture” (Table 2). Figure 1 shows that these five barriers were reported 59 and 43 times during interviews from the full and smaller samples of caregivers, respectively (a barrier was only counted once per interview even if the caregiver reported it more than once). The most frequently reported barriers were related to 1) women’s time dedicated to agricultural labor, 2) the limited diversity of household agricultural production, 3) lack of support for child feeding from spouses and mothers-in-law, and 4) poor maternal self-efficacy. These four barrier categories accounted for more than one-half of all the barriers reported, in both the full and smaller samples.

The two most commonly reported categories of barriers are linked to agriculture. Families with a limited diversity of agricultural production reported being frequently unable to improve weaning foods by diversifying potato-based dishes with ingredients such as cereal grains, legumes, fruits, vegetables and animal-source foods. Women also repeatedly reported the substantial burden pasturing animals placed on their daily work schedules, forcing them to condense household chores, food preparation, and child care responsibilities into the early morning and late evening hours. One woman stated,

“If I didn’t have the animals, I would have more time to take care of my children. [My family] doesn’t even eat meat often, so why do we keep the animals?”

Another mother noted,

“I spend so much time with the animals I don’t have time to make special foods for the children. I give the children whatever I cook for the whole family.”

A common strategy reported by women while in the pastures was to carry their young ones on their backs in a homespun blanket and feed them passively by handing them whole potatoes or *chuiño*, freeze-dried potatoes. Many children, of course, are unable to handle or even chew such unwieldy foods without special assistance. One woman recognized this as a poor feeding strategy and described how she feeds her child when pasturing animals. She said,

“When watching the animals, I can’t feed [my child] how I like. If you don’t watch the sheep they will run off somewhere, maybe to someone else’s field and that shouldn’t happen. When I see the sheep are eating for a moment, I take [my child]

from my back and feed her quickly until the sheep start moving again. You have to do this. When you're with the animals, you can't move about in peace."

Caregivers from households with more animals did not report more barriers related to time dedicated to agriculture. Women bear the burden of pasturing animals daily and the time required to walk to the pastures and allow the animals to feed changes little whether the household owns 20 or 60 animals. Caregivers from households with more cropped land, however, did report more barriers related to time dedicated to agriculture (Table 3). This suggests that increasing agricultural productive capacity may have important negative consequences on maternal caregiving capacity in areas where women are responsible for carrying out much of the crop maintenance labor. Community elevation was not a significant determinant of any agriculture and environment related barrier. This indicates that, despite differences in the kinds of crops cultivated and the agronomic challenges encountered, the magnitude of the agriculture-related limitations is similar throughout the different elevation zones of northern Potosí (i.e. similarly limited production diversity, high work burdens, and biophysical constraints).

Agricultural and environmental factors, however, represented only one domain of influence on mothers' abilities to care for young children. Family conditioning and support also played an important role. Women reported not receiving support from spouses, relatives and in-laws for improving feeding practices; rather, many were actively discouraged from changing behaviors by spouses and/or mothers-in-law who resisted acquiescing control of any household-related decisions. Rearing several young children simultaneously was also frequently reported as a barrier to improving feeding practices and mothers often expressed that they had little control over the size of their families. Mothers, few of whom finished primary school, often reported difficulties retaining new information and lessons learned during intervention activities, and demonstrated little confidence in their own abilities to improve IYCF practices. Low maternal self-efficacy also extended to women reporting frequent "sadness", often linked to spousal interactions or relationships with mothers-in-law, and despondent outlooks on their own futures and those of their children.

The health-seeking behavior of caregivers, as well as livelihood factors (e.g. few income-earning opportunities, poor access to markets and services, difficulty with labor-intensive tasks) were two other key barrier domains identified.

### Validity of caregiver reports

Using the smaller sample of caregivers (n=50) for whom baseline and follow-up survey data were available, Table 3 presents the relationships between the number of barriers caregivers reported from the given barrier category and related measures of these barriers assessed during the household surveys. Many of the relationships observed are strongly in the expected direction, strengthening the evidence that caregiver reports of barriers reflect actual conditions. For example, caregivers reporting barriers related to limited diversity of agricultural production were more likely to have planted a lower diversity of crops in the previous sowing season. Likewise, caregivers reporting poor access to health services (e.g. because of poor access to facilities or discrimination by health staff) attended fewer prenatal health checkups during their most recent pregnancy according to health card data assessed during household survey visits. Those caregivers reporting geographic isolation as a barrier to accessing more diverse foods through markets required longer travel times to reach markets. In some cases, the relationships observed were not as strong. For example, women reporting child feeding preferences and traditions that run counter to recognized best practices, did not necessarily score more poorly on a ten-point assessment of knowledge of appropriate IYCF practices. This suggests that lack of knowledge is not the most critical



factor limiting feeding preferences and practices. Relevant survey data were not available to assess the validity of caregiver reports of IYCF barriers for all barrier categories.

### **Associations of changes to IYCF practices with reported barriers**

To determine the relative influence of the reported barriers on child feeding in this region of Bolivia, we analyzed the relationship between reported barriers and changes to four indicators of child feeding practices between baseline and follow-up surveys among the subsample of mothers (n=50) for which these data were available at both time points. These indicators included: 1) the diversity of child diets in the previous day, 2) the diversity of food groups fed in the previous week, 3) the number of times solid or semi-solid foods were fed in the previous day, and 4) the dietary energy intake of children in the previous day. Table 4 shows the results of multivariate analyses, controlling for the effect of several variables that could also have influenced changes to child diets and feeding practices, namely: child age, child sex, the baseline IYCF practice, the frequency of child illness, household socioeconomic status, maternal age, mother's education level, maternal knowledge of appropriate IYCF practices, and level of participation in the nutrition and livelihoods initiative. The interaction of child age at baseline with the number of barriers reported, as well as the two-way interactions of the other covariates in the model with the number of reported barriers, were tested but were not strongly associated with the outcomes and were therefore not included in final models.

The nutrition and livelihoods initiative sought to address many of the barriers reported by caregivers in this study. One might expect that the low intensity of the program (i.e. no physical inputs) and its relatively short duration might not yield sweeping changes to underlying environmental and social barriers. While the initiative certainly did not eliminate these barriers, improvements in feeding practices observed during the evaluation period (Jones, 2011) indicate that caregivers were able to mitigate some of these barriers. Program participation among this subsample, however, as well as the interaction of participation with the number of barriers reported, was not strongly related to changes in IYCF practices. This is likely because of the limited variation in participation among the subsample of mothers. Nearly all mothers in the sample (92%) participated in 2–5 intervention activities. In analyses using a larger sample of women, this variation did not show a dose-response relationship with changes in IYCF practices over the one-year intervention period, possibly because of intra-community diffusion of intervention outputs (Jones, 2011).

The absolute number of barriers or barrier categories reported by caregivers was not associated with changes to any of the IYCF indicators. Likewise, for most barrier categories, the number of barriers reported from within a given category was not significantly associated with changes to any of the IYCF indicators that were assessed. However, the “family conditioning and support” barrier domain and one of the barrier categories within this domain, “lack of familial support”, were significantly negatively associated with changes to two of the indicators: 7-day food group frequency and 24-hour feeding frequency. Likewise, the “agriculture and environment” domain was significantly negatively associated with changes in all four IYCF indicators. The three categories of barriers within this domain, “limited diversity of agricultural production”, “women's time dedicated to agriculture”, and “the biophysical and ecological environment” were also significantly negatively associated with changes in the IYCF indicators.

## **Discussion**

Caregivers in northern Potosí, Bolivia reported multiple barriers to improving IYCF practices. Those barriers most frequently reported, however, emerged from two spheres of influence in caregivers' lives: agricultural livelihoods and environmental influences, and

family support. Barriers related to agricultural and environmental factors were consistently associated with declines in IYCF indicators during a one-year evaluation period. Barriers related to family conditioning and support also reflected this relationship, though not as consistently. Other barrier domains and categories were not significantly associated with changes in IYCF indicators.

The absolute number of barriers or barrier categories reported by caregivers was not associated with changes to any of the IYCF indicators. This is perhaps not surprising given that caregivers reported facing multiple, simultaneous barriers to improving IYCF practices. When faced with multifarious difficulties, achieving measurable improvement might not entail eliminating the largest number of obstacles, but rather removing those obstacles offering the most resistance to change. The data indicate that agricultural production challenges and women's roles in agriculture may represent the critical hurdle to improved child feeding in this region of Bolivia.

### **Women in agriculture in northern Potosí**

Women in northern Potosí, like most poor regions of the world, bear the burden of responsibility for many household productive tasks (e.g. farming, herding, caregiving, domestic labor, food preparation, and child bearing). Studies from many countries indicate that women, especially poor women, allocate much more time to domestic work than men and that in most regions of the world, women spend more total time than men in agricultural, market and home production activities combined (Brown and Haddad, 1995; Ilahi, 1999; Levine et al., 2001; Kes and Swaminathan, 2006). Women's agricultural labor, particularly animal herding, detracts from the quantity and quality of time spent feeding and caring for young children and may have a strong, negative impact on maternal nutritional status (Panter-Brick, 1989; Wandel and Holmboe-Ottesen, 1992; Higgins and Alderman, 1993; Panter-Brick, 1996; Levinson et al., 2002; Kashiwazaki et al., 2009).

In northern Potosí, time spent farming and herding clearly limits women's available time for child care. The animal herds that nearly all households manage in northern Potosí require constant care throughout the year, a burden which falls primarily on women. Women leave their homes in the early morning to guide their animals to pasture and usually return only at sundown. Soil erosion and unsustainable rangeland management practices have increased the time women spend traveling with the animals to find adequate pastures. Moving to and from different pastures throughout the day, chasing straggler sheep, and negotiating difficult terrain limit women's ability to provide adequate care to young children while in the field.

Agricultural production efficiency and diversity are also limited in northern Potosí in part due to farmer crop choices, management practices and the harsh highlands environment. Farming systems in this region of Bolivia predominantly rotate potato, maize and wheat at lower elevations (i.e. below 3000 masl) and potato, barley, wheat and forage oats at higher elevations. Legumes such as fava beans, peas and Andean lupin also sometimes enter rotations (Bentley et al., 2005). These systems may make available a larger diversity of foods than the mono-cropped maize systems common in southern Africa (Snapp et al., 2002) or even the rice wheat systems of South Asia (Lauren et al., 2001), but food production is still focused on one to two staple crops in a given agroecological zone. This dependence on one or two food crops is reflected in the potato-based diets of the households managing these systems, and in the diets of children in particular. At baseline, potatoes alone contributed on average more than half (54%) of young children's daily dietary energy intake (Jones, 2011). Extremely low dietary fat intakes as well as low intakes of riboflavin, calcium and vitamin A have been identified in the diets of both adults and children in the region (Berti et al., 2010).

### Caregiving among the agriculture-nutrition pathways

Recent literature reviews and conceptual papers examining pathways from agriculture to improved nutrition have emphasized that agriculture primarily operates to improve nutrition outcomes through increases in production which lead to increases in food availability and income (World Bank, 2007; Arimond et al., 2010). These authors and others do not neglect to highlight the critical role of women in these pathways, but analyses tend to focus on the constraints women face to raising agricultural yields and the importance of women's knowledge and control of household resources to improving child nutrition outcomes, mainly through women's improved productivity and earnings. These discussions do not always emphasize the critical issue of women's multiple roles within households (McGuire and Popkin, 1989) and the trade-offs involved, particularly between agricultural labor and child feeding.

Efforts to make women more productive farmers by providing them with resources such as land, labor-saving technologies, agronomic inputs, credit, and access to education, markets, and support networks can lead to improved yields, higher incomes and better time-use efficiency (Quisumbing and Pandolfelli, 2010). Yet, these gains will not necessarily lead to improved nutrition. Women's time saved through improved efficiency may be reallocated to child care, but it is more likely to be invested in domestic chores, or even other types of agricultural labor or income-generating activities (Holmboe-Ottesen et al., 1988; Blackden, 2002) unless efforts are made to purposefully transform caregiving environments and guide time use decisions toward child and maternal care. Trade-offs between agricultural gains and nutritional concerns must also be recognized. Improving agricultural output by increasing land under cultivation may result in women spending more time working in the fields and less time providing care to children. In northern Potosí, women from households with more cultivated land, for example, were more likely to report caregiving barriers related to time constraints from agriculture. Properly assessing context, identifying strategies to “do no harm”, and providing the right incentives (e.g. ensuring that work burdens are equitably distributed, that women are able to control the resources produced from their labor, and that nutritionally vulnerable households can access new knowledge and technologies; see Herforth et al., in press) can help to generate win-win situations, wherein efforts to improve women's agricultural livelihoods may simultaneously contribute to positive nutrition outcomes for children.

### Involving families and communities in behavior change

Despite the crucial role that they play as the nutritional gatekeepers of households, targeting interventions to exclusively involve women would be a mistake. Men have a vested interest both in increasing the productivity of their family farm (to secure the economic welfare of their household) and in contributing to the proper care of their children (to secure their healthy growth and development and ensure that they will contribute labor and income to the household in the future). Culturally ingrained attitudes toward women, gender divisions of labor, poverty and lack of education may, however, prevent men from supporting women. The nutrition and livelihoods initiative described in this study largely failed to involve men. Though invited, when community meetings began to be seen as gatherings of women to discuss child care issues, men became disinterested. For many of them, the subject did not seem relevant to the daily livelihood difficulties they faced. And indeed, this research revealed that lack of support from spouses was a key barrier caregivers cited and was negatively associated with improvements to child diets and feeding practices.

Future programmatic work must be smarter in its attempts to “sell” communities, men in particular, on the importance of proper maternal and child care by linking these outcomes to shared goals, values and priorities (e.g. securing a consistent income, maintaining a

productive farm, feeling self-respect and pride in one's life and livelihood, and raising a healthy family). The support of other family and community members such as mothers-in-law and grandmothers should also be leveraged to create an enabling environment for mothers to properly feed and care for their young ones (Aubel et al., 2004; Bezner Kerr et al., 2008; Aubel, 2011). In northern Potosí, mothers-in-law were especially important decision-makers within households regarding child feeding practices. Social marketing and social-ecological approaches might be employed to make explicit the linkages between women's agricultural labor, their health and nutrition, the health and nutrition of young children, and the long-term impacts of undernutrition not only on children, but on the entire household.

### Study limitations

Selection bias is a potential limitation to this study because of the lack of random household selection. The potential for sample selection bias was reduced, however, by 1) conducting semi-structured interviews with a subsample of households representative of both the larger survey sample and a wide range of child feeding experiences in each community, 2) measuring and controlling for potential confounding variables in analyses, and 3) achieving near full participation of eligible households in baseline and follow-up surveys. No differences in household-, maternal- or individual-level characteristics were observed between participating and non-participating eligible families for which data were available (from previous or subsequent survey rounds) suggesting that bias introduced by self-selection for participation in the surveys was limited.

The 17 caregivers interviewed in early October 2009 had a longer exposure to intervention activities than those 52 caregivers interviewed in mid-July 2009. It is possible that the underlying barriers caregivers reported facing changed between these two periods and therefore biased reporting. Communities were visited twice for program activities between mid-July and early October. Though this may have influenced their ability to cope with barriers to improving IYCF practices, it is not likely that the underlying barriers caregivers reported facing would have changed so rapidly, especially considering the relatively slow participatory social change process the "Strengthening Livelihoods and Community Support for Improved Child Feeding" program employed. Indeed, the proportion of barriers by domain reported by the caregivers interviewed in mid-July and early October was nearly identical. Both mid-July and early October also fall in the lean season in northern Potosí and livelihood activities do not vary greatly in this time period (please see supplementary materials online for a further discussion of study limitations).

### Conclusion

Sufficient caregiving knowledge is only one of several domains that must be attended to when considering the resources caregivers require to care for and feed young children properly. Programs and policies built around individual behavior change communication, should serve as components of more comprehensive approaches that seek to explicitly address the sociocultural and environmental contexts of child feeding and care. The renewed interest of the international community in examining agriculture and nutrition linkages may serve as an opportunity for testing such approaches, by assessing not only the potential for agriculture to improve household food security, but by also examining how agriculture might enhance or diminish caregiving environments, resources, and capacities.

### Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgments

We are grateful to Drs. Peter Berti, Jere Haas, Rebecca Nelson and Rebecca Stoltzfus for their comments on earlier drafts of this manuscript. We would also like to thank World Neighbors, Bolivia for its support and the mothers and families in northern Potosí, Bolivia who generously gave their time to participate in this research.

This research was supported by the National Institutes of Health National Research Service Award Training Grant and the McKnight Foundation.

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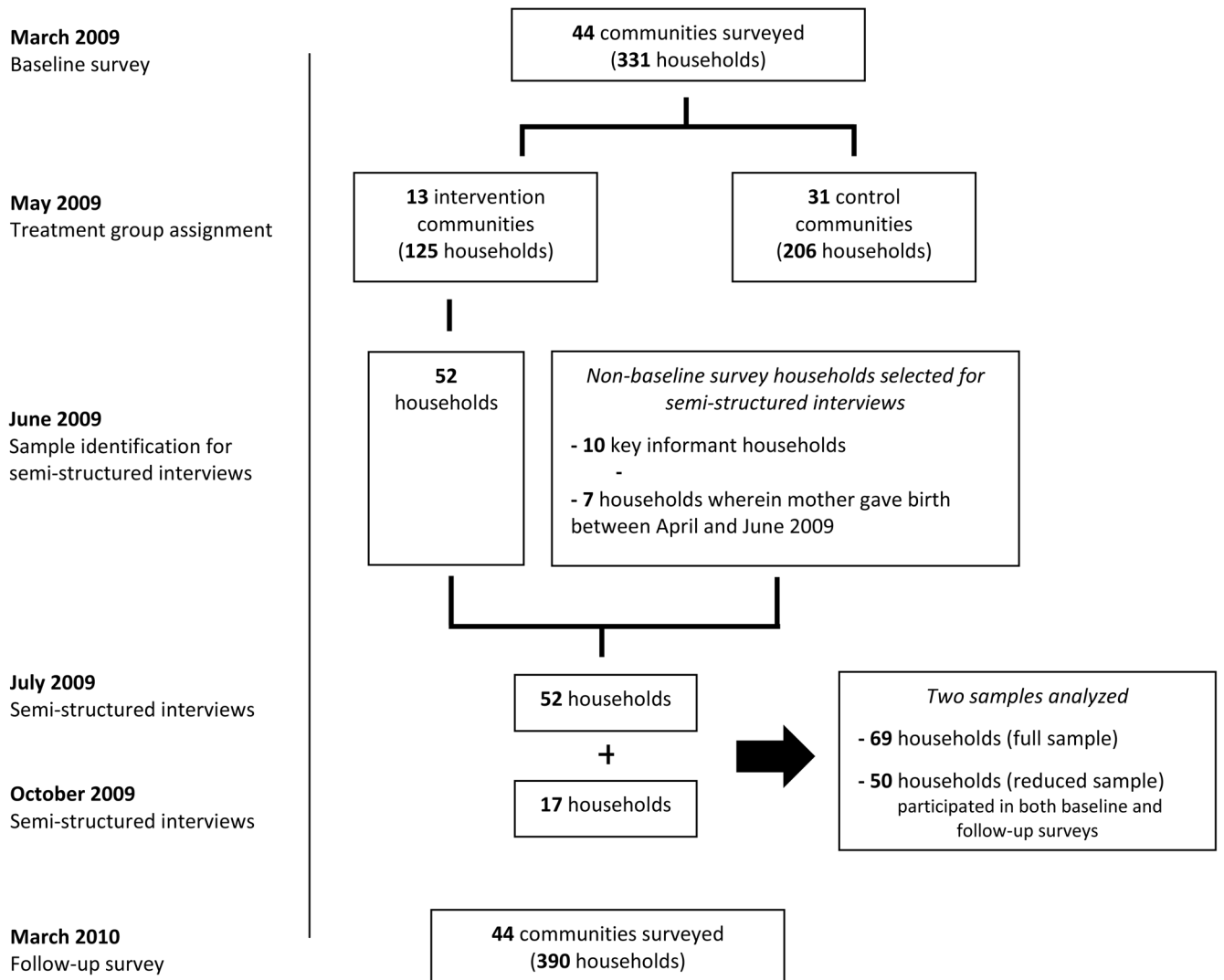
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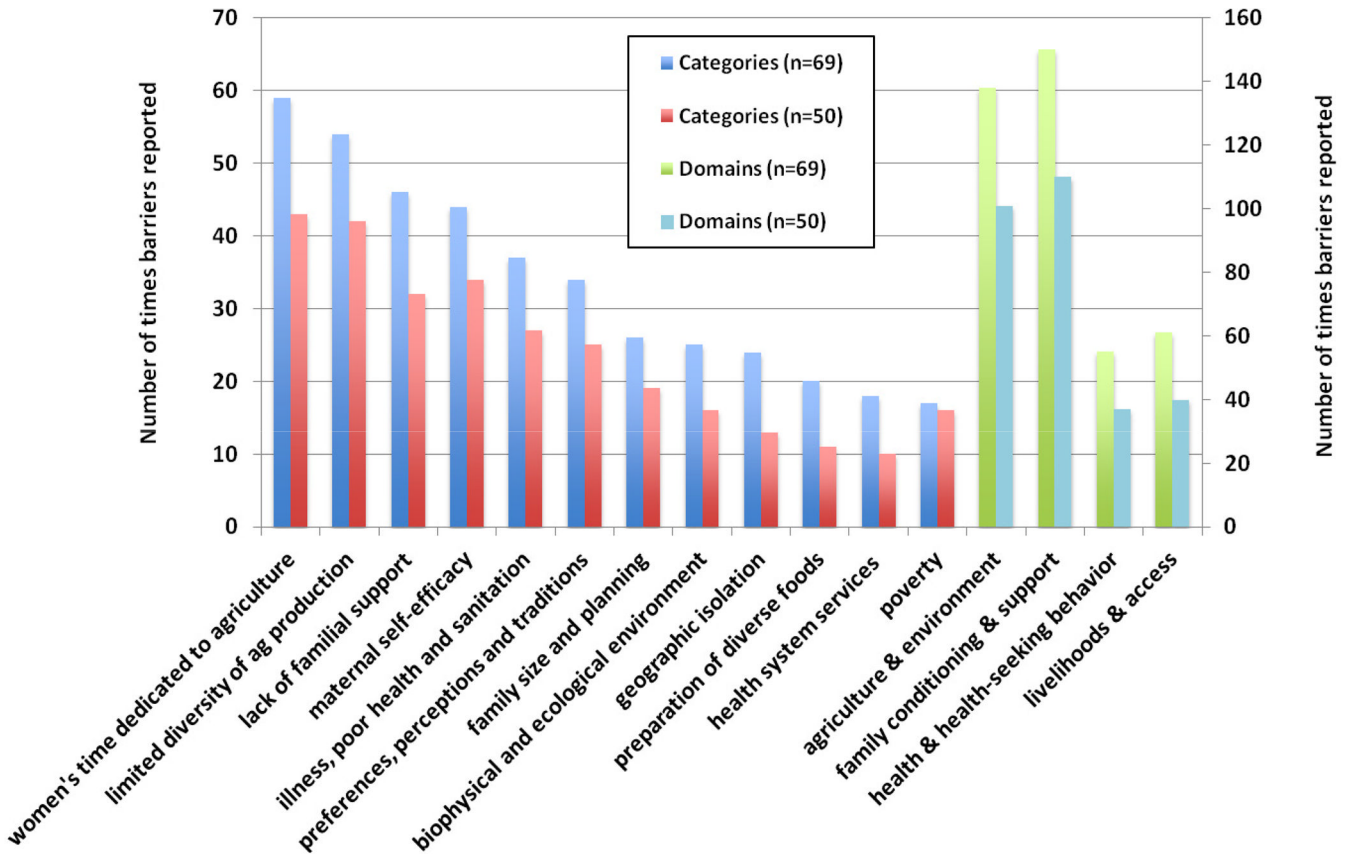


### Research highlights

- This research integrates an analysis of longitudinal dietary data with qualitative data on barriers to improved child feeding.
- Environmental barriers to behavior change are rarely addressed in programs aimed at improving young child feeding.
- Agriculture influences nutrition not only through food security, but also by affecting women's caregiving capacity.
- Family support is perhaps more important to young child feeding than an individual mother's caregiving knowledge.
- Behavior change communication alone will likely not address social and environmental barriers to improved child feeding.



**Figure 1.** Flow diagram showing the timing and sample sizes of household surveys and semi-structured interviews conducted between March 2009 and March 2010.



**Figure 2.** The number of times barriers to improving IYCF practices were reported by caregivers (from each of 12 barrier categories and 4 barrier domains). Data from a full and reduced sample of interview respondents are presented (n=69 and n=50, respectively).

**Table 1**

Household-, maternal- and child-level characteristics of caregivers from the intervention group baseline sample.

	Baseline sample	Subsample	Remaining households
<i>Households</i>	125	50	75
<i>Child characteristics</i>			
Age (months)	12.3 ± 7.0	12.5 ± 6.9	12.2 ± 7.1
Sex (% female)	48.8%	46.0%	50.7%
Height-for-age Z-score	-1.8 ± 1.2	-1.9 ± 1.2	-1.8 ± 1.2
Weight-for-age Z-score	-1.0 ± 1.0	-0.9 ± 1.0	-1.0 ± 1.0
<i>Maternal characteristics</i>			
Age (years)	29.2 ± 7.8	30.2 ± 7.8	28.6 ± 7.7
Height (cm)	150.0 ± 5.4	149.4 ± 5.7	149.7 ± 5.3
Education (% not completing primary school)	90.4%	90.0%	90.7%
Number of different food groups (7 maximum) fed in previous 24 hours	2.7 ± 1.4	2.7 ± 1.4	2.7 ± 1.5
Number of different food groups (7 maximum) fed in previous 7 days	2.8 ± 1.9	2.5 ± 1.7	2.9 ± 2.0
Number of times solid or semi-solid foods fed in previous 24 hours	2.3 ± 1.0	2.2 ± 0.88	2.3 ± 1.1
Feeding knowledge score (1–10 scale)	4.2 ± 1.9	4.0 ± 1.9	4.3 ± 1.9
<i>Household characteristics</i>			
Number of children and adolescents (<18 years)	3.4 ± 2.0	3.6 ± 2.1	3.4 ± 2.0
Land area accessible for raising crops (ha)	0.8 ± 1.1	0.75 ± 0.44	0.84 ± 1.4
Distance to nearest market (hours by foot)	2.2 ± 1.2	2.3 ± 1.2	2.2 ± 1.2
Number of sheep and goats owned	26 ± 19	26 ± 17	27 ± 19
Household Dietary Diversity Score (HDDS) (1–12 scale)	5.4 ± 1.7	5.4 ± 1.5	5.1 ± 1.8
Household Food Insecurity Access Scale (HFIAS) Score (1–27 scale)	5.0 ± 3.8	5.2 ± 3.8	4.8 ± 3.9

Means ± SD are shown (please see supplementary materials online for further details of table components).

**Table 2**

Barrier domains, categories and specific barriers to improving IYCF practices reported during semi-structured interviews, and the nutritional and child feeding implications of these barriers.

barrier domain	barrier category	specific barriers reported by caregivers	nutritional and child feeding implications
agriculture and environment	limited quantity and diversity of agricultural production	families do not cultivate a large diversity of crops and infrequently slaughter animals	the diversity of foods available to families is limited (especially legumes, vegetables, fruits, meat)
		consistent low yields from cultivated staple crops	families do not diversify away from key staple crops (e.g. potato) when risk of growing even existing crops is high
		families do not have access to their own land	families may hold no control over decisions about what crops are planted on land they work or how much is allocated to individual family members
agriculture and environment	women's time dedicated to agriculture	families lack access to irrigation water and water for preparing some foods	food supplies from own production for family consumption are unreliable; diversifying diets with cereal grains and legumes is difficult
		women dedicate large amounts of time to pasturing animals	women do not have enough time to care for children
		mothers are fully occupied in the field tending to their animals	mothers are not able to appropriately feed and care for children that they bring with them to the fields
		young children are left in the care of others throughout the day	young children may receive no or inadequate breast milk or complementary foods throughout the day
		mothers will stay for extended periods of time in distant grazing lands or cultivated fields	access to diverse food is more limited at these remote field sites and resources for food preparation are not as abundant
		women dedicate large amounts of time to maintaining crop cultivation	mothers are unable to dedicate sufficient time to childcare and feeding, particularly during sowing and harvest times
family conditioning and support	maternal self- efficacy	mothers do not retain new information	IYCF practices remain unchanged without continuing education, frequent external support and encouragement to remember and put into practice new behaviors
		mothers lack confidence in their own ability to adopt new practices	
		mothers have a despondent outlook on the future and doubt the possibility of positive change in their life or in those of their children and family members	
		mothers are not motivated to improve upon existing feeding and care practices	
family conditioning and support	lack of familial support	husbands do not help with household chores, childcare or anything perceived as "women's work"	mothers bear responsibility for household chores and therefore have less time to dedicate to childcare and feeding
		husbands work wage labor or reciprocal labor jobs away from the community for much of the year	
		husbands have abandoned the family	
		mothers do not receive help from and must care for aging parents, in-laws or ill spouses	

barrier domain	barrier category	specific barriers reported by caregivers	nutritional and child feeding implications
		<p>husbands are domineering, unfaithful, disrespectful and/or abusive</p> <p>mothers-in-law are domineering, disrespectful and/or abusive</p>	<p>mothers have little control over household resources, decisions or face emotional stress caused by physical and emotional abuse that impairs their ability to function normally</p> <p>mothers are unable to make decisions about food preparation, meal content and child feeding and are burdened with tending to the chores and animals of their mothers-in-law</p>
family conditioning and support	preferences, perceptions and traditions	<p>weaning foods are inappropriate, contributing to monotonous, nutrient-poor diets (e.g. potatoes, <i>chuto</i>, white rice and/or noodles)</p> <p>food aid provided to local schools and preschool day care programs from charitable organizations consists mainly of white flour and rice</p> <p>potatoes and <i>chuto</i> are culturally valued and families have a difficult time regularly eating other foods; other nutritious foods are fed to animals</p> <p>mothers perceive that they have insufficient breastmilk</p> <p>mothers believe that feeding newborns colostrum and breastfeeding children during pregnancy harm the child</p> <p>mothers believe older children (1.5–3 years of age) do not require frequent meals and all children, regardless of age, should receive the same nutritional priority</p> <p>mothers are not convinced of the value of promoted nutrition messages</p>	<p>child preferences for these few, nutritionally-limited foods and aversions to other foods become embedded and are difficult to change</p> <p>nutrient-dense midday meals for young children are absent and child preferences for white bread and polished rice are reinforced</p> <p>diversity of child (and adult) diets is severely limited</p> <p>beliefs and perceptions lead to poor IYCF practices</p>
health and health-seeking behavior	illness, poor health and sanitation environment	<p>children fall ill frequently (e.g. diarrhea, respiratory infections)</p> <p>mothers are chronically ill from disease or injuries (e.g. lightning strikes, falling, accidents with animals)</p> <p>households are in unsanitary environments (e.g. no latrine access, animals live in close quarters with the family, untreated water and dirty environments inside homes)</p>	<p>mothers report that children eat poorly or not at all during illness (including breastmilk)</p> <p>mothers are unable to adequately perform daily responsibilities, including child feeding and care activities</p> <p>children are commonly exposed to pathogens in their daily environment</p>
family conditioning and support	family size and planning	<p>middle-aged mothers who have already raised many children are averse to changing embedded feeding behaviors</p> <p>mothers have many children and must rear several children simultaneously</p>	<p>poor IYCF practices remain unchanged for all children</p>
livelihoods & access	preparation of diverse foods	<p>milling and peeling cereal and legume grains is labor-intensive</p> <p>husbands' help is needed for milling, but this help is often lacking or only sporadically available</p>	<p>mothers lack the time to care for anyone child; they face difficulty breastfeeding more than one child</p> <p>caregivers are discouraged from incorporating foods other than potatoes, such as cereal grains and legumes, into family foods</p>

barrier domain	barrier category	specific barriers reported by caregivers	nutritional and child feeding implications
agriculture and environment	biophysical and ecological environment	<p>no hand mill is available at home, therefore, families must take grains to water- and industrial mills for processing, sometimes over long distances</p> <p>soaking some grains, as a necessary step before consumption, requires several days</p> <p>harsh weather events (e.g. frost, hail storms, increasingly unpredictable rains, extreme heat) disrupt agricultural production</p> <p>degrading pasture land</p> <p>crop pests and diseases</p> <p>altitude and temperature</p> <p>cultivated fields are located far from homesteads</p>	<p>damage to crop harvests results in reduced quantity and diversity of available food</p> <p>women walk long distances to find adequate pasture, resulting in high energy expenditures and less time for childcare; pasturing animals on steep slopes makes child feeding while herding even more difficult</p> <p>pests and diseases lower yields and reduce the quantity and diversity of available food</p> <p>highland communities cannot grow the same diversity of crops as those households at lower elevations</p> <p>food reserves are stored away from the home and are brought in from field storage sites only periodically</p> <p>mothers do not access health services frequently</p>
livelihoods & access	geographic isolation	<p>mothers must walk 2-5 hours (with children in tow) to reach health posts and hospitals</p> <p>mothers are not able to retrieve their twice monthly allotment of <i>Nutribel</i>; the fortified complementary food provided free by the government to families with young children</p> <p>communities and/or homesteads are far from regional markets; roads are poor quality or non-existent</p>	<p>households spend large amounts of time and resources traveling to markets and therefore infrequently purchase foods only available at markets</p> <p>mothers are mistrustful and afraid of the formal health system, or perceive prohibitively high barriers to accessing health services</p>
health and health-seeking behavior	health system services	<p>mistreatment by health staff (e.g. discrimination against peasant mothers through refusal to treat or requiring such mothers to wait longer than others for treatment)</p> <p>mothers associate allopathic medicine with poor health outcomes</p> <p>health staff are not reliably found at health posts and hospitals</p> <p>birth certificates or health cards, required for delivery of services, are lost or weren't issued</p> <p>health staff provides poor nutrition information to caregivers</p>	<p>mothers adopt poor feeding and care practices based on misinformation</p> <p>households are unable to purchase or trade for sufficient quantities of basic food commodities (e.g. oil, sugar) or other</p>
livelihoods & access	poverty	households have low incomes	

barrier domain	barrier category	specific barriers reported by caregivers	nutritional and child feeding implications
		households have few assets (e.g. animals, valuables)	foods (e.g. fruits, vegetables, meat, eggs, cereal grains) to consume these items frequently or at all throughout the year



**Table 3**

Relationships between caregivers' reporting of barriers to improving IYCF practices and related measures of these barriers assessed during the baseline household survey.

Household survey measures (response variables)	Barrier categories	Regression coefficient	p value
	<b>Agriculture &amp; environment domain</b>		
Number of different crops sown	Limited diversity of agricultural production	-0.55	0.046
Amount of cultivated land (hectares)	Women's time dedicated agriculture to	0.19	0.002
	<b>Family conditioning &amp; support domain</b>		
Knowledge of appropriate feeding practices (1–10 scale)	Preferences, perceptions and traditions	-0.13	0.78
Number of children and adolescents (<18 years) in the household	Family size and planning	1.53	0.01
	<b>Health &amp; health-seeking behavior domain</b>		
Number of antenatal checks attended during most recent pregnancy (maximum 4)	Health system services	-1.88	0.02
Duration of child illness (diarrhea, cough and/or fever) in the past two weeks (number of days)	Illness, poor health and sanitation environment	3.31	0.01
	<b>Livelihoods &amp; access domain</b>		
Distance to nearest market by foot (in hours)	Geographic isolation	0.99	0.01
Household Dietary Diversity Score (1–12 scale)	Preparation of diverse foods	-0.75	0.11

Regression coefficients from bivariate analyses are shown with corresponding p values.

**Table 4**

Adjusted mean change in four IYCF indicators between baseline and follow up by the number of barriers reported from each barrier domain and category.

	Change in IYCF variables from baseline to follow up			
	24-hr dietary diversity	7-d food frequency	24-hr feeding frequency	24-hr energy intake (kcal)
<b>Independent variables</b>				
<b>Agriculture &amp; environment (5)</b>	<b>-0.44 (0.01)</b>	<b>-0.57 (0.002)</b>	<b>-0.58 (0.005)</b>	<b>-179 (0.003)</b>
Limited diversity of agricultural production (3)	<b>-0.82 (0.03)</b>	<b>-0.85 (0.03)</b>	<b>-1.25 (0.002)</b>	-141 (0.30)
Women's time dedicated to agriculture (3)	-0.35 (0.24)	<b>-0.65 (0.03)</b>	<b>-0.62 (0.04)</b>	<b>-249 (0.01)</b>
Biophysical and ecological environment (2)	<b>-1.38 (0.02)</b>	-1.26 (0.05)	<b>-1.53 (0.008)</b>	<b>-613 (0.003)</b>
<b>Family conditioning &amp; support (8)</b>	-0.25 (0.15)	<b>-0.52 (0.01)</b>	<b>-0.45 (0.01)</b>	-114 (0.07)
Maternal self-efficacy (3)	-0.39 (0.23)	-0.49 (0.19)	-0.52 (0.14)	-200 (0.07)
Lack of familial support (3)	-0.16 (0.67)	<b>-0.95 (0.02)</b>	<b>-0.99 (0.01)</b>	-235 (0.09)
Preferences, perceptions and traditions (2)	-1.07 (0.29)	0.13 (0.81)	-0.32 (0.59)	70 (0.71)
Family size and planning (2)	-0.75 (0.23)	<b>-2.06 (0.001)</b>	-0.94 (0.13)	-40
<b>Health &amp; health-seeking behavior (2)</b>	-0.19 (0.66)	-0.14 (0.75)	-0.33 (0.48)	-45 (0.76)
Health system services (2)	-0.18 (0.85)	0.46 (0.60)	-1.33 (0.15)	-100 (0.71)
Illness, poor health and sanitation environment (2)	-0.19 (0.69)	-0.31 (0.52)	0.01 (0.98)	-18 (0.91)
<b>Livelihoods &amp; access (4)</b>	-0.60 (0.08)	-0.07 (0.84)	-0.42 (0.31)	-80 (0.51)
Poverty (2)	-0.84 (0.20)	-0.23 (0.71)	-0.60 (0.37)	-171 (0.43)
Geographic isolation (2)	-0.74 (0.26)	-0.01 (0.99)	-1.20 (0.11)	-192 (0.40)
Preparation of diverse foods (2)	-0.40 (0.59)	0.02 (0.97)	0.43 (0.57)	100 (0.69)

Regression coefficients and p values (shown below in parentheses) are shown for multiple regression models of the change from baseline to follow up in each of the four IYCF indicators shown.

The maximum number of barriers any single caregiver reported from that category or domain is shown in parentheses after the barrier category or domain name.

See supplementary materials online for further table notes.