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Agriculture-Nutrition Linkages and Child Health in the Presence of Conflict in Nepal

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ABSTRACT

Much policy and research attention has focused on the relationship between agriculture and nutrition. We extend this analysis to the context of Nepal's decade-long civil conflict. Understanding how conflict or similar stress mitigates the agriculture-nutrition linkage is essential to developing impactful agriculture and nutrition policy in potential conflict zones. To our knowledge, there is no prior empirical work on the link between agriculture and nutrition in the context of conflict. We find a robust relationship between milk consumption and anthropometric outcomes. We also show a positive link between milk production and milk consumption at the household level. We find significant negative relationships between conflict and milk consumption for households owning few livestock while such relationships do not exist for larger holders. We attribute these heterogeneous effects to conflict-related productivity declines and milk price increases, both of which disproportionately affect households with fewer livestock and lower milk-production capacity. Among rural households in Nepal, milk production could serve as a nutritional buffer in times of conflict or other stress, and thus, policies that promote households' livestock production could be effective measures in improving resilience of the rural poor against shocks that negatively affect child health outcomes.

Keywords: agriculture, nutrition, Nepal, dairy

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1. INTRODUCTION

As the impacts of malnutrition in the early stages of life are increasingly understood and many of the poor in developing countries are small farmers, policy and research attention is shifting toward the relationship between agriculture and nutrition. This paper focuses on this agriculture-nutrition link in Nepal in the context of the country's decade-long civil conflict. To the best of our knowledge, there is no prior empirical work on how the relationship between agriculture and nutrition is mediated by conflict. Moreover, research on agriculture-nutrition linkages is hampered by cross-sectional data that have limited ability to account for household unobservables that may simultaneously influence consumption and production decisions at the household level (Haddad 2013; Masset et al. 2012; Webb 2013).

Using panel household data from the Nepal Living Standards Survey (NLSS), combined with conflict data from the Informal Sector Service Centre (INSEC) and the International Committee of the Red Cross (ICRC), we assess the relationship between livestock ownership, milk consumption, and child anthropometric outcomes in the context of conflict. We provide rich empirical evidence that furthers understanding of previously unexplored relationships. Our paper contributes to the existing literature on agriculture, nutrition, and conflict in three ways. First, we study the relationship between livestock ownership, milk consumption, and child anthropometric outcomes in Nepal, where meat consumption is limited and milk pays a particularly important role in children's nutritional status. Second, we fill a research gap by exploring the impacts of conflict on the production-consumption linkage between livestock ownership and milk consumption. Finally, while the INSEC deaths data are commonly used in studies of Nepal's conflict, we know of no prior work that combines them with ICRC data on civilian disappearances, an understudied dimension of conflict intensity.

Our findings show a strong link between child anthropometric outcomes and milk consumption as well as between milk production and milk consumption. Households with relatively low milk-production potential see stronger negative relationships between conflict and milk consumption. Declines in milk consumption for these households during conflict may be associated with reduced livestock productivity and increases in consumer price. These results suggest that promotion of milking herds may help rural households not only in income generation but also in directly improving child nutrition, given the strong production-consumption link with respect to milk. Milk production also can serve as a nutritional buffer in times of conflict or other stress. Hence, policies that promote households' increasing livestock holdings and milk production, particularly among those with few animals, could be effective in improving the resilience of the rural poor against shocks.

The rest of the paper proceeds as follows. The next section provides background on agriculture-nutrition linkages and child health during Nepal's civil conflict and describes three testable hypotheses. We then discuss the data, paying particular attention to the challenges of conflict measurement and descriptive statistics, after which we outline our empirical strategy and present our estimation results. The final section concludes.

2. BACKGROUND

Agriculture-Nutrition Linkages

Several pathways linking agriculture to nutrition are broadly defined in the literature (see, for example, Hawkes et al. 2007; Haddad 2000; Berti, Krasevec, and FitzGerald 2003). Five pathways are particularly important: (1) income effects on nutrition from the sale of agricultural products, (2) direct consumption-production linkages at the household level, (3) intrahousehold effects through empowerment of key players in household nutrition, (4) indirect effects on nutrition through food prices, and (5) effects of broad agricultural growth and associated economywide growth on nutrition. While all these pathways are important, this paper focuses on the second pathway by recognizing a basic fact that, in Nepal, separability between production and consumption decisions generally does not hold among rural households. Many smallholder rural households are likely to purchase certain items, produce others for own consumption, and even buy items they produce, depending on the season and market availability (Singh, Squire, and Strauss 1986; de Janvry, Fafchamps, and Sadoulet 1991). Once production and consumption decisions are not perfectly separable, direct production-consumption links and income-mediated links between agriculture and nutrition can exist simultaneously.

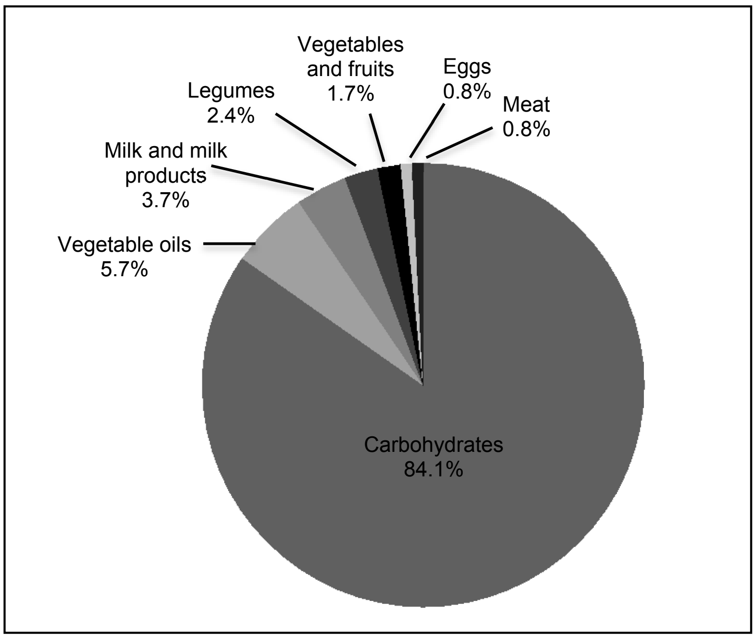
Empirically linking agriculture and nutritional outcomes is notoriously difficult. Indeed, Haddad (2013), Masset et al. (2012), Webb (2013), and other reviews emphasize that, despite a strong interest in the topic, most studies have significant methodological shortcomings and there is a lack of evidence of causal impacts of agricultural interventions designed to affect nutrition, such as home gardens; aquaculture; and animal husbandry. Ex post assessment of the role of household agricultural production on nutrition outcomes faces several conceptual and technical challenges. First, production of high-nutrient foods is not exogenously determined. Household preferences relating to nutrition or health would influence that household's likelihood of cultivating nutritious agricultural products such as vegetables, legumes, and milk so that estimates of the impacts of production of these products on nutritional outcomes would be biased. Household preferences also can influence other household behaviors associated with health outcomes of household members, such as hygiene or family planning.

Until recently, little research convincingly tackled these challenges, in part due to the lack of household panel datasets in many developing countries. Several recent studies attempt to understand the relationship between livestock, agricultural production, and child nutrition using cross-sectional household data. Kabunga (2014) and Rawlins et al. (2014) both use propensity-score matching to determine that adoption of dairy breeds increases milk consumption in Uganda and Rwanda, respectively. Similarly, Hoddinott, Headey, and Dereje (2015) find a positive relationship between anthropometric outcomes of children and dairy cattle ownership in Ethiopia, all while controlling for potential income effects, thereby suggesting that the production-consumption linkage is a primary pathway between dairy cattle and child outcomes. Specific to Nepal, Shively and Sununtnasuk (2015) find a positive relationship between production diversity and child anthropometric outcomes, while Malapit et al. (2015) examine the role of maternal empowerment as a mediator between production diversity and child outcomes, suggesting that maternal empowerment has a stronger relationship with child outcomes in households with low production diversity. All of these studies use cross-sectional data, which, in the absence of credible instruments, limit their ability to account for selection into agricultural production associated with unobserved household characteristics. In an attempt to address this, Hirvonen and Hoddinott (2014) find a positive relationship between agricultural production diversity and child dietary diversity in Ethiopia, instrumenting production diversity with temperature and topographical characteristics of study villages and controlling for income effects. In Uganda, Azzarri et al. (2015) use panel data to examine the link between livestock ownership and consumption of different animal-source foods, finding positive effects of large ruminant ownership on milk consumption, but not beef consumption, and a strong positive relationship between poultry ownership and chicken consumption. Overall findings suggest the existence of agriculture-nutrition linkages, particularly in livestock production, and highlight the importance of the direct production-consumption linkage among smallholder farmers.

Milk and Nutrition

While a variety of agricultural products and associated productive assets may be used to understand the relationship between agriculture and nutrition, milk and livestock are best suited to the Nepalese context. Nothing is as nutritious and as widely consumed in Nepal as milk and milk products such as butter, cheese, and ghee (collectively referred to hereafter as "milk"). According to nationally representative data from 1996 and 2003, 75 and 89 percent of households consumed milk (World Bank 1996, 2003). Vegetarianism is common in Nepal and is associated with Hindu and Buddhist communities, which make up 93 percent of the population in total. While not all Hindus and Buddhists practice strict vegetarianism, meat consumption is extremely limited, with less than 1 percent of total calories coming from meat (Figure 2.1). Milk is the primary animal-source food in the Nepalese diet, and there appears to be a stronger preference for buffalo's milk, which has a higher fat content than cow's milk. During the conflict period, buffalo milk was the most common milk in Nepal, making up 65 percent of total production, followed by cattle at 29 percent and sheep/goats, which are primarily raised for fiber, manure, and meat, making up 6 percent (Food and Agriculture Organization of the United Nations [2015]).

Figure 2.1 Household dietary composition, by food group, 2003 (in percentage of total calories)



Source: World Bank (2003).

Many studies document the benefits of milk consumption to child nutrition and development. Neumann, Rogers, and Harris (2002) thoroughly review the relationship between child nutrition, child health, and animal-source foods in the developing world. They note that milk is an extremely efficient source of fats, protein, and micronutrients including calcium, vitamins A and B-12, and riboflavin. Because children have a smaller gastric capacity, nutrient-dense foods are particularly important. In addition to milk's superior nutrient density, there is evidence that consumption of cow's milk stimulates the production of an insulin-like growth factor that increases the magnitude and velocity of linear growth in infants and children (Hoppe, Mølgaard, and Michaelsen 2006). Linear growth is associated with positive cognitive and educational outcomes in the near and long terms (Richards et al. 2002; Alderman, Hoddinott, and Kinsey 2006). Also of particular importance is vitamin B-12, which occurs naturally only in animal-source foods. Vitamin B-12 deficiency is common among people who eat little or no meat and can negatively affect cognition, iron absorption, blood formation, and neurological development. Because of its role in neurological development, vitamin B-12 deficiency affects not only children but developing fetuses and breast-feeding infants if the mother is deficient herself. This vulnerability is greater for vegetarians and those who consume very little meat (Koebnick et al. 2004; Antony 2003).

The Implication of Conflict on the Agriculture-nutrition Linkage in Nepal

Nepal's civil conflict began in 1996 and ended in 2006, but the origins of the conflict can be traced through the second half of the 20th century as the country vacillated between the interests of the monarchy and prodemocracy movements beginning in the 1950s. A series of political reforms were met with pushback from the monarchy, culminating in the Maoist insurgency in 1996, which escalated into a full military conflict involving state security forces. The 10-year guerilla war was fought mainly in rural, agricultural areas and reportedly led to disruption of agricultural production, cash income through vegetable sales, and agricultural wage labor (World Food Programme–Office for the Coordination of Humanitarian Affairs [WFP-OCHA] 2007). Infrastructure damage occurred throughout the country but was concentrated heavily in the western and mountain areas where conflict intensity was higher. The best available documentation of infrastructure damage catalogs damaged and destroyed buildings and facilities in approximately half of Nepal's 75 districts and finds that hundreds of central government buildings were targeted during the conflict, including police and army posts, government offices, and post offices (WFP-OCHA 2007). As of 2007, 57 percent of the population lived more than a 30-minute walk from an all-season road (World Bank 2013). Whether difficult access to roads is due to conflict or simply limited infrastructure development in the first place is unclear due to a lack of comparable preconflict data.

With respect to poverty and nutrition, Nepal has seen improvement in many standard measures since the onset of the civil war. However, it is important to note that prior to the war Nepal was near the bottom globally on many measures, including child stunting and underweight (World Bank 2006), and aggregate reductions in poverty and malnutrition measures do not necessarily reflect the heterogeneous experiences within the country. Indeed, real average per capita expenditures rose 4.5 percent per year throughout the conflict period, but inequality and the gap between the middle and upper classes also deepened (World Bank 2006). One might expect that such heterogeneous effects of conflict also exist with respect to production and consumption of nutritious foods, such as milk. Conflict may affect the productivity of agriculture, including milk production from livestock, by restricting access to inputs, storage, or transportation. This can affect nutrition directly by leaving households with less milk for home consumption or indirectly by leaving them with less milk for sale. Alternately, for households with high milk-production capacity, conflict may decrease their marketing opportunities, potentially increasing household consumption. In addition, conflict-induced changes in food prices due to infrastructure damage or otherwise limited supply may disproportionately affect segments of the population that purchase nutritious foods, such as milk, in the market.

Hypotheses

Given the relevance of the production-consumption linkage for many smallholders, the value of milk to child health, and its importance in the Nepalese diet, combined with the heterogeneous effects of conflict on the Nepalese population, we use the remainder of this paper to explore how civil conflict disrupts the relationship between livestock ownership, milk consumption, and child anthropometric outcomes in Nepal. Our hypotheses are as follows:

1. Consumption of milk is positively associated with child anthropometric outcomes in Nepal.
2. After accounting for income effects, there is a positive relationship between milk consumption and ownership of buffalo and cattle, indicative of a direct production-consumption linkage.
3. Conflict has heterogeneous effects on the production-consumption linkage, depending on the level of livestock ownership of the household.

3. DATA AND KEY VARIABLES

Data

We use three rounds of NLSS from 1996, 2003, and 2011 (hereafter NLSS1, NLSS2, and NLSS3, respectively), each of which contains a cross-sectional sample and a panel sample. NLSS1 data were collected just prior to the beginning of the civil conflict, while NLSS2 data were collected during the height of the conflict; we use the panel elements of these data for panel analysis. We do not include NLSS3 panel data in conflict-related panel analysis because the conflict concluded five years prior to the collection of NLSS3 data, leaving a substantial lag between the conclusion of the conflict and the household data collection period. The nationally representative NLSS1 panel sample contained 1,232 households, selected after stratification along four geographic/ecological regions of the country: mountains, urban hills, rural hills, and *terai* (low-lying agricultural land). Within each stratum, wards are selected with probability proportional to the population of the ward as measured in the 1991 population census. Within each ward, 12 households are selected with equal probability. Only 961 households were successfully re-interviewed in NLSS2. Two panel households were dropped due to missing values in key variables, leaving a panel of 959 households. Between NLSS1 and NLSS2, 272 households were lost to attrition, 56 of which were explicitly described as having been unreachable due to conflict (World Bank 2003). There is no explanation in the data documentation for the remaining 200 households that were dropped, but attrition analysis suggests that this larger portion of attrition is not directly due to conflict. After attrition, the panel sample covered 60 of Nepal's 75 districts.[1]

In addition to the panel sample, separate cross-sectional samples were drawn in each of the three NLSS rounds using the sampling structure above. Anthropometric data—height and weight—were collected from all households for children ages zero to 59 months in NLSS1 and NLSS3, but not in NLSS2. Children with complete anthropometric data totaled 1,505 and 2,800 in NLSS1 and NLSS3, respectively. Unreliable anthropometric measurements are a documented concern in the NLSS1 data (World Bank 1996); therefore, we focus our anthropometric analysis on the NLSS3 cross-sectional sample of 2,800 children. The NLSS3 dataset contains other child-level data including birth order, parent characteristics, and all relevant household-level variables contained in NLSS1 and NLSS2. Ideally we would link conflict directly to child anthropometric outcomes using panel data, but this is not possible given the timing and quality of the anthropometric data collected; therefore, we opt for a multistep approach described in detail in the next section.

Measuring conflict intensity is notoriously difficult. Most of the existing literature on the topic pertains to questions associated with cross-country comparisons of civil conflict, such as the perils of using casualty thresholds in the definition of civil war and the identification of the beginnings and ends of wars (Sambanis 2004; Anderson and Worsnop 2016). In practice, any measure of conflict intensity is used as a proxy for a latent variable of interest. Political scientists may be interested in a proxy for animus between social or political groups, whereas our concerns hinge on how perceptions of insecurity affect civilian behavior. Arias, Ibáñez, and Zambrano (2014) note in their discussion of agricultural production and conflict in Colombia that only a minority of the population may be directly affected by violent shocks, but the majority are likely to modify their behavior in response to the perceived insecurity in their environment. Rather than using number of deaths due to the ongoing conflict in Colombia at the time, they used the presence of armed groups in a given area, arguing that it captured the civilian sense of insecurity. Prior research on conflict in Nepal relies heavily on conflict deaths data INSEC, a human rights organization that documented human rights violations throughout the civil war (Do and Iyer 2010; Valente 2011, 2014; Gilligan et al. 2011). INSEC documented battle-related deaths of 15,118 individuals during 10 years. This does not include ancillary deaths due to disease, malnutrition, or the consequences of internal displacement. The question of whether battle-related deaths capture the population's sense of insecurity remains open.

[1] Excluded districts are depicted in Figure 3.1. See Table 5.6 for attrition analysis.

An alternative measure of perceived insecurity is civilian disappearances, or kidnappings, which were documented by INSEC and ICRC throughout the conflict. These disappearances were carried out largely as midnight arrests of supposed Maoist sympathizers in their homes or at police checkpoints nearby (Office of the High Commissioner for Human Rights 2012). When family members inquired about the whereabouts of the arrested person, security forces denied that the arrest had taken place, and the person was never seen or heard from again. As of 2014, more than 3,218 persons were reported missing to ICRC, and 1,347 disappearances remained unexplained (ICRC 2014). INSEC, on the other hand, documented 1,007 disappearances.[2] By either measure, there were fewer disappearances than deaths, but a single civilian disappearance could plausibly have a stronger association with civilian fear than the death of a Maoist or state fighter in a battle.

Deaths and disappearances also may capture fear and insecurity among different subpopulations. Disappearances tended to be carried out by state security forces, potentially biasing any effects associated with disappearances toward Maoist supporters. At the same time, the guerrilla nature of the war and the difficult terrain on which it was conducted gave the Maoist fighters a significant advantage, and a majority of casualties were members of state security forces. As such, effects associated with deaths may be biased toward progovernment individuals. In addition, the geographical association with deaths is ambiguous because fighters on both sides of the conflict were likely to be far from their homes at their time of death. The Maoists, in particular, had flexible and highly mobile forces (Gilligan, Pasquale, and Samii 2013). As such, a death in a given district would be associated with fear among those living in the district because violence took place close to them, but it also may have a relationship with civilian fear in the deceased's home district. If the deceased was a Maoist fighter, this was likely to be in a rural area of the country, while government fighters were more likely to have ties to towns and cities. Disappearances, meanwhile, generally took place in or near the victim's home, and victims tended to be civilians who were perceived as Maoist sympathizers. Thus, disappearances do not have the geographic ambiguity that deaths may have, but any effect they do have may be biased toward Maoist supporters.

Given the complexity of the potential biases associated with both of these variables, we opt to include both in our analysis. Because deaths and disappearances are qualitatively different, as described above, and their magnitudes differ dramatically, we consider their effects separately. INSEC's deaths and disappearances data are both at the district level, though deaths data are available monthly while disappearances are aggregated across the entire conflict period. Given the level of aggregation of the disappearances data, we opt to use the ICRC disappearances list from 2008, which contains exact dates of disappearance.[3] To reflect the period of time associated with each NLSS sample, we have further aggregated the INSEC deaths and ICRC disappearances data as follows: conflict-related deaths and disappearances data are zero during the NLSS1 time period because the conflict is thought to have begun in early 1996. In the districts where deaths or disappearances occurred in 1996, NLSS1 data collection had already taken place. For the NLSS2 time period, conflict-related deaths and disappearances are tallied from February 1996 through the month prior to data collection in each district.

Other key variables used in this analysis related to anthropometric outcomes, livestock holdings, and milk consumption are described below.[4] Anthropometric variables, height-for-age *z* (HAZ) scores and weight-for-age *z* (WAZ) scores, are calculated using anthropometric data according to the World Health Organization 2006 growth standards (De Onis and World Health Organization 2006). Household-level milk consumption variables are created using the "typical month" recall structure of the NLSS consumption module. Consumption of a given item is disaggregated into own-produced consumption and purchased consumption. Respondents are asked to give the amount of a given good consumed and the approximate value of that good. We use the data relating to dairy products—milk, butter, ghee, and

[2] One explanation for the discrepancy between ICRC and INSEC disappearance figures is likely due to ICRC's superior resources and ongoing documentation of disappearances, relative to INSEC, which is a much smaller organization and is involved in many other human rights activities in postconflict Nepal.

[3] We replicated our main results using the aggregated INSEC disappearances data, with similar findings. These can be found in Table A.1.

[4] See Table A.2 for descriptions of all other covariates.

curd—to determine the daily consumption of milk separately for own-produced milk, purchased milk, and milk received in kind. Milk consumption variables are expressed in 100-gram units.[5] NLSS does not directly elicit milk production, so we calculate total milk-production levels for a household by combining the amount of own-produced milk consumed with the amount of milk sold, imputed using reported income from sales of milk and milk products. The data explicitly exclude income from adding value to milk products obtained in the market (for example, purchasing milk and reselling it as butter). Unfortunately there are no data on in-kind giving of milk, only receiving, so we do not capture milk that a household has given out. Nonetheless, this serves as an approximation of households' milk production. Main regressions include the number of buffalo and the number of cattle separately. Where milk-producing livestock are aggregated, we consider only milk-producing livestock, weighted by milk-production capacity.[6] The excluded species are yak, goats, sheep, horses, pigs, and donkeys, all of which constitute less than 5 percent of total livestock on average.

Descriptive Statistics

Prior to the civil conflict, Nepal had high rates of malnutrition that persisted throughout the conflict (Ministry of Health and Population 1996, 2006). We see these same poor outcomes in the NLSS3 data. Table 3.1 displays the child-level summary statistics, including means for height-for-age (stunting), weight-for-age (underweight), and weight-for-height (wasting) z scores, along with the proportion of the population that falls more than two standard deviations less than the World Health Organization guideline, indicative of moderate or severe malnutrition. In 2011, nearly 40 percent of NLSS3 children were moderately or severely stunted, with somewhat lower prevalence of underweight (29 percent) and wasting (14 percent). These are consistent with the Demographic and Health Survey (Ministry of Health and Population 2012) estimates of stunting (40 percent), underweight (29 percent), and wasting (11 percent) for Nepal and only marginally better than preconflict rates. Eight percent of children experienced a diarrheal episode in the 10 days prior to the survey, though 81 percent of children live in households that use a piped or covered water source. Household diets are, on average, made up of 79 percent roots, tubers, and cereals.[7] When comparing households that own livestock with those that do not, we see statistically and substantively better outcomes ranging from 0.25 to 0.53 standard deviations across the three child nutrition measures for households that own livestock. Among other differences, we see that the share of calories from carbohydrates is nearly 9 percent higher for households that do not own livestock, suggestive of a positive nutritional contribution associated with livestock, yet at the same time children in livestock-owning households are less likely to have been breast-fed, suggesting substitution of breast milk for other milk. Finally, we note that livestock-owning households have lower education levels, smaller households, and higher dependency ratios.

[5] The density of liquid milk is 1.03 grams per millileter (slightly denser than water).

[6] We calculate milk production capacity using Food and Agriculture Organization of the United Nations data from Nepal on the number of each species in the national herd and total milk production by species. We then measure household herds by cattle equivalents based on milk-production capacity. An alternative approach would be to use Tropical Livestock Units (TLU). TLU standardization accounts for the metabolic weight of different species and for the fact that smaller animals consume more food per unit of body size than do larger animals. TLU is commonly used in studies of rangeland ecology and grazing conditions but is less suitable for milk production because larger animals do not necessarily have greater milk-production capacity. All analyses for this paper were repeated using TLU, and the results are not qualitatively different than those using the weighted livestock variable.

[7] The proportion of the diet made up of calorie-rich but micronutrient-poor foods is another indicator of dietary quality. See Headey and Ecker (2013) for details.

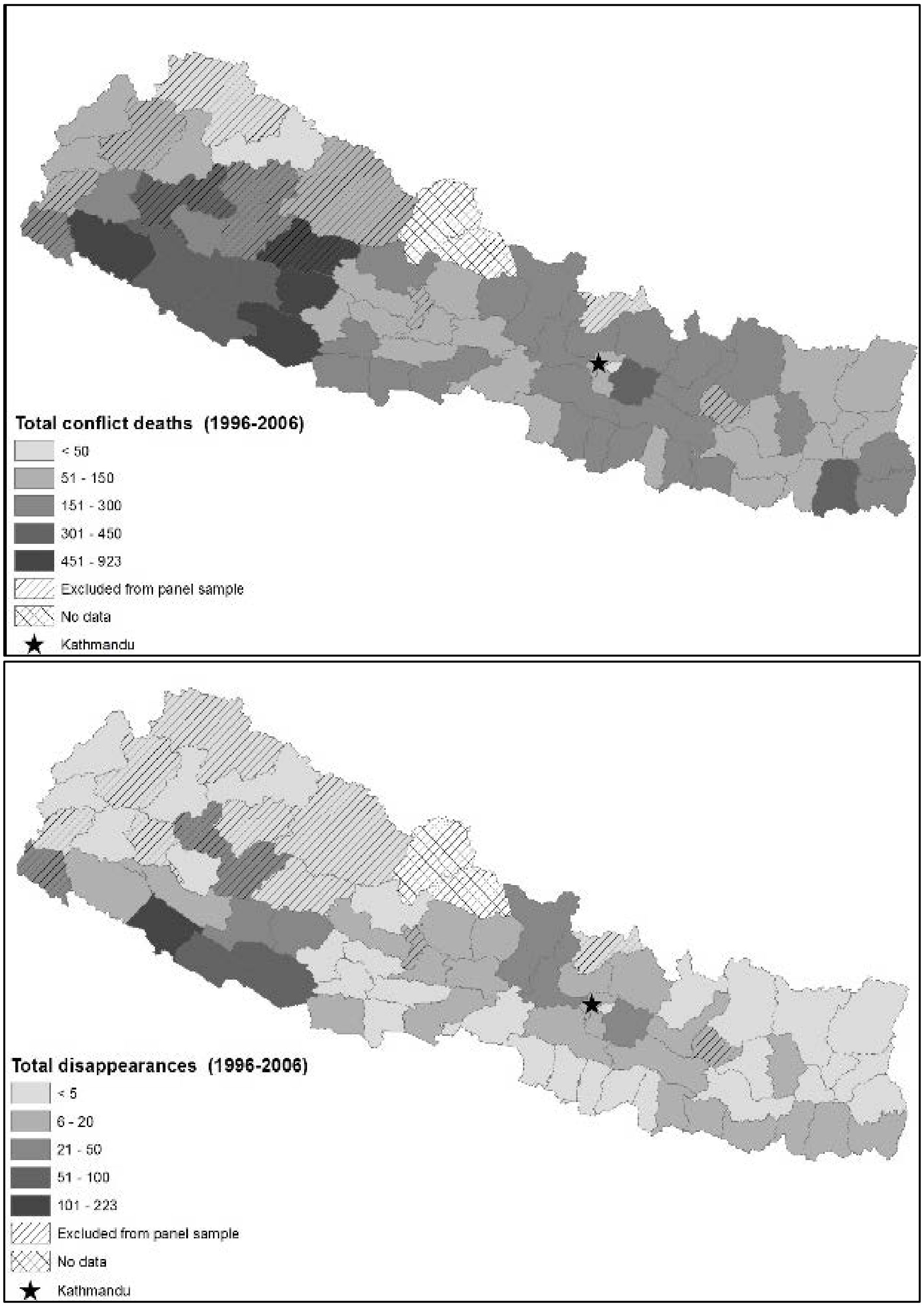
Table 3.1 Anthropometric summary statistics, cross-sectional data

Variable	Mean	Standard deviation	Owners–Nonowners Difference	Owners–Nonowners Standard error
Height-for-age *z* score	–1.48	1.50	0.53***	(0.067)
Percentage of height-for-age *z* score < –2	0.39	0.49	–0.15***	(0.020)
Weight-for-age *z* score	–1.34	1.15	0.46***	(0.053)
Percentage of weight-for-age *z* score < –2	0.29	0.46	–0.13***	(0.018)
Weight-for-length/height *z* score	–0.73	1.24	0.23***	(0.057)
Percentage of weight-for-length/height *z* score < –2	0.14	0.35	–0.0078	(0.015)
Monthly dietary diversity index	11.77	1.49	0.60***	(0.061)
Sanitary water source	0.81	0.39	0.11***	(0.015)
Percentage of total kilocalories from carbohydrates	79.24	10.68	–8.86***	(0.50)
Breast-fed	0.74	0.44	–0.055**	(0.020)
Female-headed household	0.21	0.41	0.077***	(0.019)
Maximum household education (years)	3.55	3.63	–1.11***	(0.16)
Education of female head or spouse of head (years)	0.01	0.33	0.025	(0.018)
Education of male head or spouse of head (years)	0.00	0.19	0.014	(0.014)
Age of mother at child’s birth (years)	24.96	5.90	–0.12	(0.24)
Age of mother at child’s birth squared (years)	657.84	327.88	–16.7	(12.9)
Rural (1 = rural)	0.76	0.43	–0.52***	(0.020)
Housing amenities and durables asset index	0.02	0.87	1.01***	(0.044)
Percentage of household 5 years old and younger	28.76	11.81	1.68**	(0.55)
Percentage of household between 6 and 15 years old	18.49	16.36	–4.56***	(0.69)
Percentage of household between 16 and 65 years old	50.54	16.21	3.59***	(0.72)
Household size	6.71	2.94	–1.45***	(0.12)
Observations	2,782		2,782	

Source: Nepal Living Standards Survey (World Bank 2011).
Note: **p < .05. ***p < .01.

Figure 2.1 displays the spatial distribution of conflict deaths and disappearances. The urban and rural biases suggested in the literature are not immediately evident in these maps, with most deaths and disappearances concentrated in the southwestern part of the country, away from Kathmandu. Nepal’s population is most dense in the southeast and least dense in the northwest, while our measures of conflict suggest the greatest intensity tend to be mid-density regions of the country. The two districts where all data are missing, Mustang and Manang, are mountainous and sparsely populated.

Figure 3.1 Deaths and disappearances during Nepal conflict



Source: Informal Sector Service Center (2011).

Table 3.2 displays household-level summary statistics across a wide range of characteristics. In both 1996 and 2003, households owned, on average, just less than one buffalo, while during the same period, cattle ownership declined slightly from 1.9 to 1.7 animals. Weather and market conditions likely explain much of these changes in herd composition, but Bundervoet (2010) finds that, when conflict is active, animals that can be fed close to home are favored compared to animals that need to graze. While both cattle and buffalo are grazed in Nepal, buffalo are more easily kept in intensive or stall-fed production systems, and cattle are more likely to require extensive grazing (Abington 1992).

Table 3.2 Household summary statistics

Variable	1996 Mean	1996 Standard deviation	2003 Mean	2003 Standard deviation	Difference	Standard error
Conflict						
Total conflict deaths by district (INSEC)	—	—	14.15	24.14	—	—
Total disappearances by district (ICRC)	—	—	0.93	1.40	—	—
Total disappearances by district (INSEC)	—	—	1.69	1.97	—	—
Livestock						
Buffalo	0.96	1.40	0.93	1.40	–0.034	(0.064)
Cattle	1.94	2.35	1.69	1.97	–0.24*	(0.099)
Milk						
Household consumes milk	0.75	0.43	0.89	0.31	0.14***	(0.017)
Household produces milk	0.52	0.50	0.55	0.50	0.025	(0.023)
Daily milk production (100 grams)	3.94	7.26	5.98	10.88	2.04***	(0.42)
Daily milk consumption (100 grams)	4.35	6.02	6.22	7.40	1.87***	(0.31)
Daily own-produced milk consumption (100 grams)	3.16	5.82	6.82	7.82	8.82	9.82
Daily purchased milk consumption (100 grams)	1.15	3.00	1.60	3.41	0.46**	(0.15)
Daily in-kind milk consumption (100 grams)	0.04	0.26	0.06	0.15	0.023*	(0.0096)
Income						
Daily per capita total consumption (2005 Rs.)	59.52	78.19	68.22	108.60	0.13**	(0.045)
Daily cash income (2005 Rs.)	353.35	1933.98	416.26	1845.51	62.9	(86.5)
Gross daily cash income from agriculture (2005 Rs.)	25.33	57.25	24.77	68.60	–0.56	(2.89)
Daily wage income from agriculture (2005 Rs.)	11.95	26.81	8.18	20.70	–3.77***	(1.10)
Markets						
Milk available at local market (always or seasonally)	0.90	0.31	0.89	0.31	–0.0038	(0.015)
Local milk price per 100 grams	2.37	0.71	2.38	0.59	0.0082	(0.033)
Market > 2 hours away	0.30	0.46	0.28	0.45	–0.014	(0.021)
Market > 6 hours away	0.08	0.28	0.12	0.32	0.034*	(0.014)
Household characteristics						
Female head	0.13	0.33	0.19	0.39	0.062***	(0.017)
Head age	44.20	14.29	48.83	13.53	4.63***	(0.64)
Household size	6.00	2.72	5.73	2.70	–0.27*	(0.12)
Percentage of household 5 years old and younger	14.44	15.22	10.87	13.63	–3.57***	(0.66)
Percentage of household between 6 and 15 years old	24.62	18.78	23.19	20.21	–1.43	(0.89)
Percentage of household between 16 and 65 years old	59.04	21.55	61.83	23.59	2.78**	(1.03)
Max educational attainment (years)	5.43	4.35	6.45	4.36	1.01***	(0.20)
Female head education (years)	0.77	2.50	0.99	2.87	0.22	(0.12)
Male head education (years)	2.67	4.28	2.78	4.32	0.11	(0.20)
Rural (1 = rural)	0.82	0.38	0.82	0.39	–0.0069	(0.018)
Observations	955		957		1,912	

Source: Nepal Living Standards Survey household panel data (World Bank 1996, 2003).

Note: ICRC = International Committee of the Red Cross; INSEC = Informal Sector Service Centre. Dashes indicate periods with no conflict occurrences. **p* < .1. ***p* < .05. ****p* < .01.

Household milk consumption increased on both the intensive and the extensive margins between 1996 and 2003. In 2003, 14 percent more households consumed milk, and daily household milk consumption increased by an average of 187 grams per day. More households do not appear to have entered into milk production during the period, but milk production per household increased by roughly 200 grams per day. This increase in productivity can be partly attributed to the introduction of hybrid cattle and buffalo with higher productivity levels (FAO 1992; Nanda and Nakao 2003). Daily milk consumption is slightly higher than milk production, which is likely due to the consumption of imported condensed and powdered milk products, particularly in urban areas. Household consumption of own-produced milk follows the trend of productivity increases, with households consuming, on average, 140 grams more milk in 2003 than in 1996. The large share of total milk consumption that is own-produced highlights the importance of the direct link between livestock production and consumption of milk. However, not all of a household's consumption comes from own-production, suggesting that households are not fully autarkic with respect to milk. Households also purchased slightly more milk in 2003 than in 1996. Consumption of milk received in kind makes up a relatively small portion of total milk consumption, and we see a very slight increase in consumption of milk received in kind between 1996 and 2003.

Per capita total consumption expenditure rose slightly between 1996 and 2003 but remained well below $USD 1 per day, highlighting widespread poverty in the country. Total daily cash income did not change dramatically during the period in question, equaling roughly 3 to 4 times total consumption expenditure, suggesting significant measurement error. Cash income from agriculture hovered around $USD 0.25 per day, while wage income from agriculture increased from $USD 0.12 to $USD 0.21 per day across the study period. Throughout this analysis, we choose to lean more heavily on total consumption expenditure as an indicator of total income, which we believe to be more reliable.

Table 3.2 also reports milk is available at the local market in 90 percent of communities. Not only is it important to understand whether commodities are available to consumers, but it is important to understand consumer access to markets. NLSS collects the travel time between a household and the nearest market. Roughly 30 percent of households lived more than two hours from the nearest market in both 1996 and 2003. In addition, 8 percent of households lived more than six hours from the nearest market in 1996, rising to 12 percent in 2003. This is consistent with a story where key rural infrastructure such as markets or roads are targeted during conflict (WFP-OCHA 2007), further isolating already-isolated communities, but whether this has any bearing on milk consumption is not clear.

The percentage of households that are female headed increased from 13 percent to 19 percent, likely related to increases in male migration due to either conflict or economic change and urbanization or some combination of the two. Possibly for similar reasons, the average age of the household head also increased, but at the same time the proportion of the household of working age increased. Nepal's increasingly educated youth are visible in the maximum household educational attainment, which rose by nearly a year, while the educational attainment of household heads did not change substantially.

The above descriptives highlight the many changes occurring in Nepal between 1996 and 2003, including changes in markets, incomes, livestock portfolios, and consumption patterns. We now turn to multivariate methods to explore the extent to which these changes are associated with conflict intensity, milk consumption, and child health.

4. EMPIRICAL STRATEGY

Our empirical analysis focuses on the relationship between children's anthropometric outcomes, milk consumption, livestock ownership, and conflict. Data gaps do not permit us to directly connect conflict and milk production with anthropometric outcomes due to the lack of anthropometric data collected during the conflict (NLSS2). Therefore we proceed in steps according to our hypotheses. First, we estimate the relationship between milk consumption and anthropometric outcomes (hypothesis 1). After establishing that relationship, we then explore the production-consumption linkage between livestock ownership and milk consumption (hypothesis 2). We then look at the heterogeneous effects of conflict on this relationship along livestock ownership (hypothesis 3). Finally, we conclude with descriptive evidence of potential pathways.

To test our first hypothesis, that there is a relationship between milk consumption and anthropometric outcomes, we apply the following linear model to the NLSS3 cross-sectional data:

$$A_{ih} = \beta_0 + \beta_1 M_h + \beta_2 W_{ih} + \beta_3 Z_h + e_{ih} \tag{1}$$

where A_{ih} represents the anthropometric outcome of interest for child i in household h and M_h represents household-level milk consumption. W_{ih} represents a vector of child characteristics including mother's age at birth and its square and child's sex, current age, and birth order and Z_h represents household characteristics including maximum household educational attainment; education of female head of household; education of male head of household; urban or rural area; household demographic composition; household size; per capita consumption expenditure (logarithm); value of own land (logarithm); an index of housing amenities and durable assets; whether the household uses water from a piped/covered source as opposed to an open well, river, or pond; and location of residence (district dummies). The idiosyncratic error term is e_{ih}.[8] A positive significant estimate of β_1 will support our hypothesis that milk consumption has a positive effect on children's anthropometric outcomes.

Next we test hypothesis 2, the presence of a production-consumption linkage associated with livestock and milk using the NLSS1 and NLSS2 panel data. We start with a linear fixed effects model as

$$M_{ht} = \gamma_1 L_{ht} + \gamma_2 X_{ht} + \gamma_4 D_t + \alpha_h + \varepsilon_{ht} \tag{2}$$

in which L_{ht} represents cattle and buffalo ownership and I_{ht} to predict daily household milk consumption, M_{ht} for household h at time t. We also include a vector of relevant household characteristics X_{ht} including per capita consumption expenditure (logarithm) and time dummy, D_t. The household fixed effect is α_h, and ε_{ht} is the idiosyncratic error term. The parameter of interest is γ_1. A positive and significant γ_1 supports the presence of a production-consumption linkage.

The distribution of total milk consumption is positively skewed with 18 percent of observations at zero. Therefore we also estimate using a Tobit model. Tobit panel methods are limited to random effects, and the key assumption of the random effects model is that X_{ht} is uncorrelated with α_h. Given that this assumption may not hold, we estimate Wooldridge's (2002) correlated random effects (CRE) Tobit model, incorporating within-household means, $\bar{X}_h$, of all time-varying covariates expressed generally as follows:

$$M_{ht} = max(0, \gamma_1 L_{ht} + \gamma_2 X_{ht} + \gamma_3 \bar{X}_h + \gamma_4 D_t + \mu_h + \varepsilon_{ht}) \tag{3}$$

where μ_h is the unobserved household random effect. To the extent that $\bar{X}_h$ is correlated with μ_h, we are able to correct any bias associated with unobserved time-invariant household characteristics.

To understand how conflict mediates the relationship between livestock ownership and household milk consumption (hypothesis 3), we estimate the fixed-effects and Tobit CRE models below:

[8] In estimation, we cluster standard errors at the community level for all regressions except for equation 8.

$$M_{ht} = \delta_1 L_{ht} + \delta_2 C_{ht} + \delta_3 L_{ht} C_{ht} + \delta_4 X_{ht} + \delta_6 D_t + \alpha_h + \varepsilon_{ht} \tag{4}$$

$$M_{ht} = max(0, \delta_1 L_{ht} + \delta_2 C_{ht} + \delta_3 L_{ht} C_{ht} + \delta_4 X_{ht} + \delta_5 \bar{X}_h + \delta_6 D_t + \mu_h + \varepsilon_{ht}) \tag{5}$$

where C_{ht} represent conflict intensity. In this model, X_{ht} includes maximum household educational attainment, female head educational attainment, gender of household head, age of head and its square, urban or rural, household demographic composition, and household size and per capita consumption expenditure (ln), while $\bar{X}_h$ contains the within-household means of L_{ht} and time-varying components of X_{ht}.[9] Note that this and all subsequent regressions include consumption expenditure in X_{ht} and $\bar{X}_h$, allowing us to hold constant any income or wealth effects that may be present. We also include year and agroecological zone and their interaction in all regressions to control for any time trends associated with agroecology. The partial effect of conflict on milk consumption is captured by δ_2 and δ_3. Particularly, δ_3 measures how the effect of conflict depends on livestock holdings.

Last, to explore the channels through which we expect heterogeneous effects across livestock holdings as discussed earlier, we estimate a series of regressions. First, we look at the relationship between conflict and livestock's milk productivity by estimating

$$G_{ht} = max(0, \tau_1 L_{ht} + \tau_2 C_{ht} + \tau_3 X_{ht} + \tau_4 \bar{X}_h + \tau_5 D_t + \mu_h + \varepsilon_{ht}) \tag{6}$$

$$H_{ht} = \tau_1 L_{ht} + \tau_2 C_{ht} + \tau_3 X_{ht} + \tau_5 D_t + \alpha_h + \varepsilon_{ht} \tag{7}$$

where G_{ht} is total daily milk production and H_{ht} is milk production per cattle equivalent (described in note 6), both expressed in 100-gram units. A negative and significant estimate of τ_2 suggests that conflict is associated with declines in milk production. Last, milk price is explored through the following specification:

$$P_{cdt} = \alpha + \beta_1 C_{cdt} + \beta_2 D_t + \beta_3 D_d + \varepsilon_{cdt} \tag{8}$$

where P_{cdt} represents the milk price in community *c* in district *d* at time *t,* which is regressed on conflict, C_{cdt} and a time dummy, D_t. We also include a set of district dummies (D_d) to control for district-level fixed effects. The parameter β_1 measures the association between conflict and milk price.

[9] In any given estimation, we use only one of our two conflict measures (deaths or disappearances) because they are aggregated at the district level and are highly correlated.

5. RESULTS

Anthropometric Results

Using the NLSS3 cross-sectional sample, we estimate equation 1 and find support for hypothesis 1, that milk consumption has a positive relationship with HAZ scores across multiple specifications. Column (1) of Table 5.1 indicates that each 100 grams of milk consumed daily by the household increases HAZ scores of children ages zero to five by 0.012 standard deviations. These results are consistent with previous findings.[10] This relationship is robust to incorporating total daily calories consumed by the household (2) and a dietary diversity index (3), neither of which appears to affect child HAZ scores. Column (4) replaces the dietary diversity index with the percentage of total calories that is obtained from cereals, roots, and tubers. None of these alternative specifications alter the main result that each additional 100 grams of daily milk consumption by the household increases HAZ scores of children by between 0.012 and 0.014 standard deviations. We repeat the above regressions using WAZ scores as the dependent variable and do not find a relationship between WAZ scores and milk consumption in any specification (see Table A.3 for these results). This suggests that milk has a stronger relationship with linear growth than with weight gain, which is consistent with previously discussed scientific findings related to insulin-like growth factor stimulation.

Table 5.1 Determinants of HAZ score

Determinant	(1)	(2)	(3)	(4)
Total daily milk consumption (100 grams)	0.0118***	0.0135***	0.0136***	0.0129**
	(0.005)	(0.005)	(0.005)	(0.005)
Total daily calories (kilocalories)		–0.0000	–0.0000	–0.0000
		(0.000)	(0.000)	(0.000)
Monthly dietary diversity index			0.0293	
			(0.021)	
Percentage of daily kilocalories that come from cereals/roots/tubers				–0.0011
				(0.004)
Male	0.0088	0.0059	0.0053	0.0060
	(0.047)	(0.047)	(0.047)	(0.047)
Breast-fed	0.1221*	0.1232*	0.1215*	0.1230*
	(0.063)	(0.063)	(0.063)	(0.063)
Sanitary water source	–0.2463***	–0.2441***	–0.2479***	–0.2445***
	(0.084)	(0.084)	(0.083)	(0.084)
Child age at time of measurement (months)	–0.0321***	–0.0321***	–0.0321***	–0.0321***
	(0.002)	(0.002)	(0.002)	(0.002)
Female head	0.0622	0.0618	0.0655	0.0615
	(0.072)	(0.072)	(0.072)	(0.072)
Max educational attainment (years)	0.0140	0.0139	0.0134	0.0139
	(0.009)	(0.009)	(0.009)	(0.009)
Education of female head or spouse of head (years)	0.1015	0.1049	0.1068	0.1042
	(0.094)	(0.095)	(0.094)	(0.095)
Education of male head or spouse of head (years)	0.1020***	0.1065***	0.0973***	0.1059***
	(0.037)	(0.038)	(0.036)	(0.037)
Age of mother at child's birth (years)	0.0756**	0.0777**	0.0770**	0.0779**
	(0.035)	(0.035)	(0.035)	(0.035)

[10] To our knowledge, no other studies have looked specifically at quantity of milk consumed, but related studies find that cow ownership is associated with HAZ scores that are between 0.24 and 0.54 standard deviations higher than nonowners' scores (Hoddinott, Headey, and Dereje 2015; Rawlins et al. 2014). If the average Murrah cross buffalo in Nepal produces 3,730 grams of milk per day (Nanda and Nakao 2003) and that is consumed entirely by the household and not sold or left for baby animals, the standard deviation change in HAZ score becomes 0.45.

Table 5.1 Continued

Determinant	(1)	(2)	(3)	(4)
Age of mother at child's birth squared (years)	–0.0011*	–0.0011*	–0.0011*	–0.0012*
	(0.001)	(0.001)	(0.001)	(0.001)
Rural (1 = rural)	–0.0852	–0.0823	–0.0816	–0.0818
	(0.084)	(0.085)	(0.085)	(0.085)
(ln) Yearly consumption expenditure (2005 Rs.)	0.0985**	0.1082**	0.1004**	0.1061**
	(0.045)	(0.045)	(0.045)	(0.047)
Housing amenities and durables asset index	0.2832***	0.2705***	0.2637***	0.2673***
	(0.054)	(0.055)	(0.055)	(0.055)
(ln) Value of owned landholdings	–0.0106*	–0.0099	–0.0096	–0.0099
	(0.006)	(0.006)	(0.006)	(0.006)
Birth order = 2nd	–0.1741**	–0.1763**	–0.1759**	–0.1760**
	(0.070)	(0.070)	(0.070)	(0.070)
Birth order = 3rd	–0.1141	–0.1165	–0.1178	–0.1161
	(0.099)	(0.099)	(0.099)	(0.099)
Birth order = 4th	–0.1522	–0.1536	–0.1551	–0.1525
	(0.123)	(0.123)	(0.123)	(0.124)
Birth order = 5th or greater	–0.4177***	–0.4206***	–0.4154***	–0.4192***
	(0.140)	(0.140)	(0.140)	(0.141)
Percentage of household 5 years old and younger	–0.0005	–0.0009	–0.0008	–0.0010
	(0.004)	(0.004)	(0.004)	(0.004)
Percentage of household between 6 and 15 years old	–0.0018	–0.0019	–0.0018	–0.0020
	(0.004)	(0.004)	(0.004)	(0.004)
Percentage of household between 16 and 65 years old	0.0003	0.0004	0.0004	0.0004
	(0.003)	(0.003)	(0.003)	(0.003)
Household size	–0.0139	0.0013	0.0023	0.0014
	(0.013)	(0.018)	(0.018)	(0.018)
Constant	–1.4646**	–1.5039**	–1.7637**	–1.4098*
	(0.668)	(0.667)	(0.697)	(0.767)
Observations	2,800	2,800	2,800	2,800
R^2	.261	.261	.262	.261

Source: Nepal Living Standards Survey data (World Bank 2011).
Note: Robust standard errors are in parentheses. Birth month, District and Region × Belt × Year fixed effects are included. Standard errors are clustered at the community level. The 1996 data manual warns against using anthropometric data from that year, so only 2011 data are used. *$p < .1$. **$p < .05$. ***$p < .01$.

Livestock Ownership and Milk Consumption Results

The relationship between livestock ownership and milk consumption depicted in equations 2 and 3 is reported in Table 5.2.[11,12] Because 18 percent of observations of total milk consumption are zero, we display linear fixed effects estimates in columns (1) and (3) in addition to the CRE Tobit estimation results in columns (2) and (4). To account for the possibility that community-level milk sharing is a driver of milk consumption, we add community average buffalo and cattle holdings (columns [3] and [4]), which are not statistically significant, suggesting that community-level milk production is not strongly tied to an individual household's milk consumption. We find strong support for hypothesis 2, that there is

[11] In this and all subsequent analyses we disaggregate livestock into cattle and buffalo, the main milk-producing species. Alternative specifications using aggregate milk-producing livestock weighted by milk production potential yield very similar results and are included in Table A.4. We choose buffalo and cattle for ease of interpretation.

[12] For brevity, we do not report household-level controls in this and all subsequent analyses. Unless otherwise specified, these variables include household educational attainment, gender of head, age of head, household age composition (ln), total consumption expenditure, durable asset index, value of landholdings, urban/rural, and agroecological time trend controls. CRE Tobit estimates also include within-household means of all variables.

a link between livestock ownership and milk consumption that is not attributable to an income effect. Each additional buffalo is associated with an increase in household milk consumption of 81 to 107 grams per day, while each additional cow contributes 23 to 29 grams per day. This is consistent with these species' role as the primary milk producers in Nepal and anecdotal evidence of a preference for buffalo milk. Overall, these results are consistent with previous findings (Hoddinott, Headey, and Dereje 2015; Hirvonen and Hoddinott 2014) and point to a production-consumption linkage at the household level.

Table 5.2 Partial effects of livestock ownership on total daily household milk consumption, fixed effects, and CRE Tobit results

Variable	(1) Fixed effects	(2) CRE Tobit	(3) Fixed effects	(4) CRE Tobit
E(y | x=x$_{it}$)				
Buffalo	0.977***	0.806***	1.075***	0.842***
	(0.257)	(0.169)	(0.254)	(0.171)
Cattle	0.191	0.270**	0.231**	0.287**
	(0.124)	(0.102)	(0.103)	(0.104)
Community-average buffalo including own			–0.856	–0.307
			(0.683)	(0.218)
Community-average cattle including own			–0.239	–0.093
			(0.462)	(0.136)
Market > 2 hours away	1.840*	1.438**	1.862*	1.458**
	(1.022)	(0.532)	(1.024)	(0.532)
Observations	1,775	1,775	1,775	1,775
R^2	.1343014		.1355798	
Groups	959	959	959	959
Uncensored		1,470		1,470
Censored		305		305

Source: Nepal Living Standards Survey household panel data, (World Bank 1996, 2003).
Note: CRE = correlated random effects. Here we report the partial effects on the observed y with respect to x. All partial effects and coefficient estimates are available on request. Control variables include whether milk is available in local markets, milk price conditional on availability, household educational attainment, gender of household head, age of household head, household age composition, (ln) total consumption, durable asset index, value of landholdings and urban, within-household means of all variables, and agroecological time trend controls. *p < .1. **p < .05. ***p < .01.

A final observation from Table 5.2 is that distance from market is positively and significantly related to milk consumption in all models. Being more than two hours from a market is associated with a 142- to 186-gram increase in milk consumption, highlighting the importance of milk in the most remote areas.

Conflict, Total Milk Consumption, and Heterogeneous Effects

To test hypothesis 3, we incorporate conflict variables into the previous model as per equation 3 and display the results in Table 5.3. Given the previously discussed measurement challenges surrounding conflict, we report linear fixed effects and CRE Tobit estimates for both total deaths (INSEC) and total disappearances (ICRC).[13] The first four columns of Table 5.3 show no statistically significant relationship between either measure of conflict and milk production, though Tobit models yield point estimates that are negative, as one might expect. The strongest correlate of milk consumption appears to be livestock holdings. The final four columns in Table 5.3 represent results from equations 4 and 5, interacting conflict with livestock ownership. Heterogeneous effects emerge. In columns (5) and (6), we see statistically

[13] Our results are robust to normalizing the deaths and disappearances data by population. See Table A.5 for estimation results.

significant interactions between disappearances and livestock. Households that own neither cattle nor buffalo see a 36-gram decline in total daily milk consumption for every 1 percent increase in disappearances in their district. The effect of deaths (columns [7] and [8]) is statistically significantly different across both cattle and buffalo holdings, which we plot in Figure 5.1, panels A and B, respectively. Households with less than 2.8 cattle (73 percent of households) or 1.6 buffalo (71 percent of households) see a significant reduction in milk consumption ranging from 39 to 49 grams of milk per day. Households with fewer animals clearly fail to smooth their milk consumption during conflict. Overall, we find support for hypothesis 3, that conflict differentially affects households' milk consumption depending on their livestock holdings. We now briefly explore productivity and price channels that might explain these heterogeneous effects.

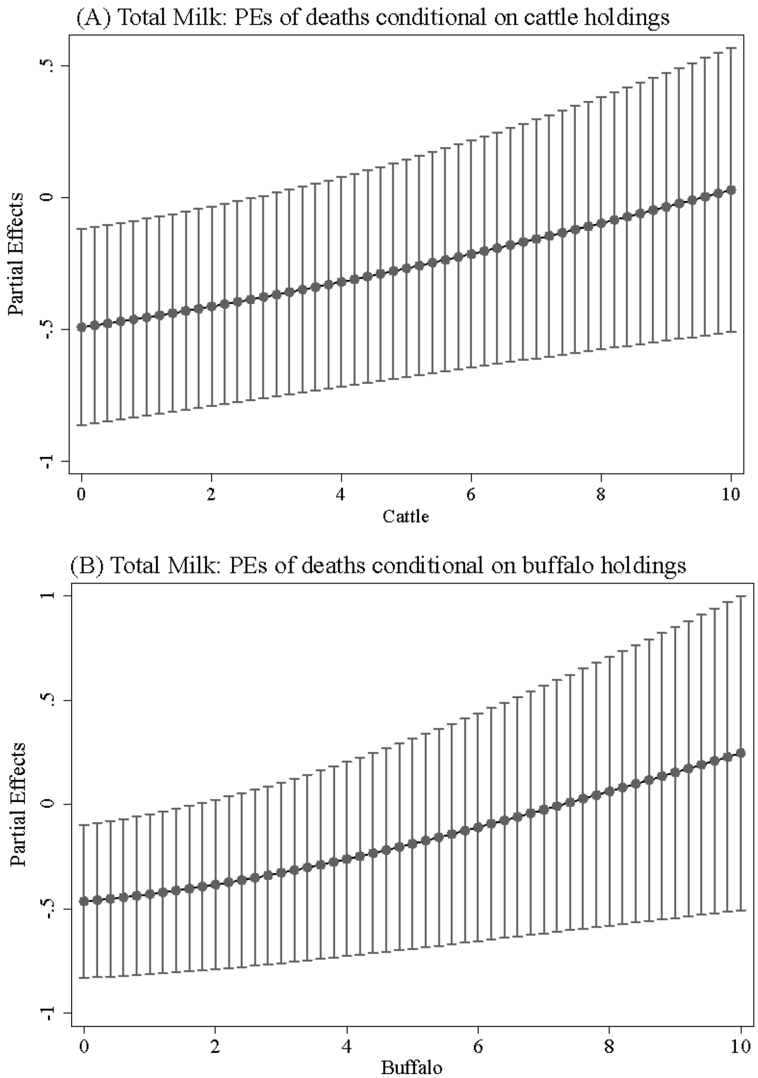
Table 5.3 Relationship between conflict and total milk consumption with heterogeneous conflict effects along livestock ownership fixed effects and CRE Tobit

Variable	(1) Fixed effects	(2) CRE Tobit	(3) Fixed effects	(4) CRE Tobit	(5) Fixed effects	(6) CRE Tobit	(7) Fixed effects	(8) CRE Tobit
Buffalo	0.978***	0.806***	0.973***	0.812***	0.710**	1.014***	0.566*	0.866***
	(0.256)	(0.169)	(0.255)	(0.169)	(0.280)	(0.248)	(0.293)	(0.258)
Cattle	0.188	0.273**	0.194	0.264**	0.161	0.349**	0.129	0.295**
	(0.124)	(0.102)	(0.120)	(0.102)	(0.131)	(0.146)	(0.133)	(0.150)
(ln) Total disappearances	0.136	–0.165			–0.026	–0.356**		
	(0.154)	(0.122)			(0.164)	(0.180)		
(ln) Conflict deaths			0.147	–0.299			–0.624	–0.831**
			(0.382)	(0.227)			(0.433)	(0.339)
Buffalo × (ln) Disappearances					0.199*	0.077		
					(0.106)	(0.062)		
Cattle × (ln) Disappearances					0.128*	0.083		
					(0.069)	(0.051)		
Buffalo × (ln) Deaths							0.160**	0.095**
							(0.070)	(0.043)
Cattle × (ln) Deaths							0.104**	0.077**
							(0.041)	(0.032)
Observations	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775
Groups	.1343045		.1339721		.1535552		.1632167	
Uncensored	959	959	959	959	959	959	959	959
Censored		1,470		1,470		1,470		1,470

Source: Nepal Living Standards Survey household panel data (World Bank 1996, 2003).

Note: CRE = correlated random effects. Here we report the partial effects on the observed y in columns (1) and (2). Columns (5) through (8) contain coefficient estimates. Corresponding Tobit partial effects are plotted in Figure5.1. All partial effects are available on request. Control variables include whether milk is available in local markets, milk price conditional on availability, household educational attainment, gender of household head, age of household head, household age composition, (ln) total consumption, durable asset index, value of landholdings and urban, within-household means of all variables, and agroecological time trend controls. *p < .1. **p < .05. ***p < .01.

Figure 5.1 Partial effects of conflict on milk consumption by livestock holdings from correlated random effects Tobit estimates (Tables 5.3 and 5.4)



Source: World Bank (1996, 2003).

To explore the role that conflict-related reductions in livestock productivity may play, Table 5.4 displays estimates of the relationship between conflict and two measures of milk production, conditional on livestock ownership, as depicted in equations 6 and 7. We find that a 1 percent increase in disappearances and deaths reduces total milk production by 49 grams and 51 grams per day, respectively. Deaths reduce per-animal productivity by 33 grams per day for households that own livestock. The underlying reasons for conflict-related productivity declines suggested by these results are beyond the scope of this paper but could range from poorer animal health, reduced access to grazing land, or farmers' choice to remove some animals from milk production. It is not surprising that productivity declines have a larger impact on households with fewer livestock, because these households' total milk-production capacity is lower. When productivity declines, total household production is more likely to fall below consumption for households with fewer animals, many of which already supplement their consumption with purchased milk.

Table 5.4 Effect of conflict on daily milk production (CRE Tobit) and per-animal milk production (fixed effects)

	(1)	(2)	(3)	(4)
	Daily milk production (100 grams)		Milk production per cattle equivalent (100 grams)	
Variable	CRE Tobit	CRE Tobit	Fixed effects	Fixed effects
(ln) Total disappearances	–0.490***		0.142	
	(0.170)		(0.108)	
(ln) Conflict deaths		–0.510*		–0.327**
		(0.296)		(0.162)
Observations	1,887	1,887	1,429	1,429
Groups	959	959	775	775
Uncensored	816	816		
Censored	1,071	1,071		

Source: Nepal Living Standards Survey household panel data (World Bank 1996, 2003).

Note: CRE = correlated random effects. Columns (1) and (2) contain partial effects on the observed y. Columns (3) and (4) contain coefficient estimates. All regressions are conditional on livestock holdings. Additional control variables include household educational attainment, gender of household head, age of household head, household age composition, (ln) total consumption, durable asset index, value of landholdings and urban, within-household means of all variables, and agroecological time trend controls. *$p < .1$. **$p < .05$. ***$p < .01$.

This leads us to consider whether milk prices are affected by conflict because price increases are likely to affect the milk consumption of households with lower milk-production capacity that must rely on the market to smooth consumption. Table 5.5, corresponding to equation 8, examines the relationship between milk prices (consumer price) and conflict, and we see that disappearances are significantly associated with price increases in column (1), while the coefficients on deaths are positive but not significant. If, during conflict, prices increase and productivity declines, it is no surprise that households with more animals and therefore higher milk-production capacity are able to buffer their consumption of this nutritious food more effectively than households with few animals.[14]

Table 5.5 Effects of conflict on milk prices

Variable	(1)	(2)	(3)	(4)
(ln) Total disappearances	0.096***		0.004	
	(0.022)		(0.047)	
(ln) Conflict deaths		0.057		0.074
		(0.048)		(0.081)
Observations	344	344	539	539
R^2	.2271021	.1843194	.2617319	.2612462

Source: Nepal Living Standards Survey community data (World Bank 1996, 2003).

Note: Standard errors are clustered at the district level. Additional controls include time period and district dummies. All prices are expressed in 2005 Rs. ***p < .01.

[14] We would expect that liquidity also matters more to households that rely on purchased milk to supplement their own production. We tested the relationship between cash income and conflict and found no significant result. We suspect the high degree of measurement error in cash income significantly attenuates any relationship that may exist.

Discussion

While this paper uses panel data to control for unobserved household characteristics to explore the relationship between conflict and milk consumption, we still may not have completely avoided potential endogeneity bias. If, for example, an external shock exacerbates conflict while simultaneously affecting milk production, then our estimates would be biased.

Another potential source of bias relates to attrition patterns, particularly with respect to conflict. We estimate the relationship between household observables on attrition using logistic regression and report the average partial effects in Table 5.6. Neither conflict, nor milk production, nor livestock ownership appear to predict overall attrition in columns (1) and (2). Overall, attrition was more likely for more educated households and households with a larger proportion of working-age members, which is consistent with patterns of out-migration, which may be related to conflict. In addition, urban households and those with lower consumption expenditure were more likely to drop out of the sample.[15]

Table 5.6 Logistic regression results of attrition on household characteristics, average partial effects reported

Variable	(1)	(2)
(ln) Deaths	–0.018	
	(0.012)	
(ln) Disappearances		–0.009
		(0.006)
Daily value of all milk produced (2005 Rs.)	–0.001	–0.001
	(0.001)	(0.001)
Buffalo	0.010	0.008
	(0.007)	(0.007)
Cattle	0.001	–0.000
	(0.004)	(0.004)
Head age	–0.001	–0.001
	(0.001)	(0.001)
Rural (1 = rural)	–0.172***	–0.183***
	(0.029)	(0.030)
(ln) Value of owned landholdings	0.002	0.002
	(0.002)	(0.002)
Maximum household educational attainment	0.010***	0.011***
	(0.002)	(0.002)
Female head	–0.021	–0.022
	(0.025)	(0.025)
Percentage of household between 16 and 65 years old	0.001*	0.001*
	(0.001)	(0.001)
Percentage of household between 6 and 15 years old	0.001	0.001
	(0.001)	(0.001)
Percentage of household 5 years old and younger	0.002	0.002
	(0.001)	(0.001)
Household size	0.009*	0.009*
	(0.004)	(0.004)
(ln) Yearly consumption expenditure (2005 Rs.)	–0.187***	–0.187***
	(0.014)	(0.014)
Observations	1,232	1,232

Source: Nepal Living Standards Survey household data (World Bank 1996, 2003).
Note: *p < .1. ***p < .01.

[15] When we consider only the 56 households that were excluded explicitly due to conflict, we see no significant relationship between deaths or disappearances and attrition, nor do we see any other significant patterns, suggesting that communities that were dropped due to conflict were not dissimilar to those retained in the sample. Attrition that took place without documentation matches the patterns of overall attrition.

6. CONCLUSIONS

This paper contributes to the growing body of literature exploring pathways between agriculture and nutrition in the poorest parts of the world, demonstrating a strong link between livestock ownership, milk consumption, and child anthropometric outcomes in Nepal. We make a unique contribution to the literature by highlighting the mediating effect of conflict in the relationship between production and consumption of a highly nutritious agricultural product of significant local relevance to child nutritional outcomes. We find that household-level milk consumption has a robust positive relationship with child linear growth (HAZ scores), accounting for dietary and health factors along with a host of relevant controls, confirming that household-level milk consumption is relevant to child nutrition in Nepal (hypothesis 1).

Using multiple indicators of conflict intensity and household panel data to estimate household-fixed-effects models, we find strong evidence of a production-consumption linkage between livestock and milk in Nepal, showing that households consume the milk they produce (hypothesis 2). We find that this production-consumption relationship was affected by conflict and that negative milk consumption effects are felt more strongly by households with fewer cattle and buffalo. We conclude that this relationship may be explained by conflict-related decreases in productivity, which would be felt more strongly by households with lower milk-production potential. Under any circumstances, livestock-poor households are more likely to turn to the market to smooth milk consumption. During conflict, transaction costs increase, as do real milk prices, limiting this avenue for consumption smoothing.

Agriculture-oriented policies have long been thought to have the potential to improve nutrition, but establishing causal mechanisms poses a considerable challenge. In Nepal, promoting milking herds may have a stronger impact on child nutrition through the direct production-consumption linkage than would promoting livestock only as a tool to increase income, particularly when households are facing stress such as conflict. Improving nutrition through increased income relies on household willingness to purchase nutritious foods and the availability of markets in which to purchase them, the latter of which is tenuous in Nepal due to limited infrastructure. The perishability of milk further limits possibilities for marketing in infrastructure-poor settings. Until infrastructure develops sufficiently to integrate milk markets, livestock-oriented policies could target households with lower milk-production capacity so that they can adequately smooth their consumption when facing conflict or other hardship that might disrupt the purchase of supplemental milk in the market. Additional research disaggregating livestock by sex and milk-production capacity may shed light on appropriate animals for such purposes, which, given Nepal's extreme agroecological diversity, are likely to vary regionally. It also may be useful to further understand the specific features of Nepal's conflict that affected markets, such as infrastructure damage, decreased mobility, and price uncertainty. Ideally, the exact circumstances under which the milk consumption patterns described in this paper occurred will not be repeated in Nepal. However, livestock-oriented policies to improve child nutrition should be designed to resist the mitigating impacts of any events that share relevant features with conflict, such as climate change or natural disasters, ultimately leading to healthier, more resilient children and communities.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1 Effects of conflict on total milk consumption with heterogeneous effects along livestock ownership (fixed effects and CRE Tobit) using INSEC disappearances

Variable	(1) Fixed effects	(2) CRE Tobit	(3) Fixed effects	(4) CRE Tobit	(5) Fixed effects	(6) CRE Tobit	(7) Fixed effects	(8) CRE Tobit
Buffalo	0.978***	0.807***	0.973***	0.812***	0.673**	1.004***	0.566*	0.866***
	(0.257)	(0.170)	(0.255)	(0.169)	(0.280)	(0.251)	(0.293)	(0.258)
Cattle	0.191	0.265**	0.194	0.264**	0.163	0.294**	0.129	0.295**
	(0.123)	(0.102)	(0.120)	(0.102)	(0.132)	(0.146)	(0.133)	(0.150)
(ln) Total disappearances (INSEC)	0.105	–0.247			–0.382	–0.691***		
	(0.246)	(0.155)			(0.258)	(0.242)		
(ln) Conflict deaths			0.147	–0.299			–0.624	–0.831**
			(0.382)	(0.227)			(0.433)	(0.339)
Buffalo × (ln) Disappearances (INSEC)					0.225*	0.073		
					(0.115)	(0.065)		
Cattle × (ln) Disappearances (INSEC)					0.158**	0.160***		
					(0.076)	(0.055)		
Buffalo × (ln) Deaths							0.160**	0.095**
							(0.070)	(0.043)
Cattle × (ln) Deaths							0.104**	0.077**
							(0.041)	(0.032)
Observations	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775
Groups	.1339853		.1339721		.157511		.1632167	
Uncensored	959	959	959	959	959	959	959	959
Censored		1,470		1,470		1,470		1,470

Source: Informal Sector Service Centre (World Bank 1996, 2003).

Note: INSEC = Informal Sector Service Centre; CRE = correlated random effects. Columns (5) through (8) contain coefficient estimates. Control variables include household educational attainment, gender of household head, age of household head, household age composition, (ln) total consumption, durable asset index, value of landholdings and urban, within-household means of all variables, and agroecological time trend controls. *$p < .1$. **$p < .05$. ***$p < .01$.

Table A.2 Variable descriptions

Variable	Description
Anthropometric variable	
Birth order	Binary variables for first, second, third, fourth, and fifth or greater. Omitted category in analysis is firstborn.
Breast-fed	1 = breast-fed
Sanitary water source	1 = household water source is piped or a covered well
Diarrhea/dysentery	1 = child had diarrhea or dysentery in past 30 days
Dietary Diversity Index	Dietary diversity index on scale of 1–13, following Kennedy et al. (2011)
Dietary quality	Percentage of daily kilocalories from cereals, roots, and tubers (Headey and Ecker 2013)
Breast-fed	1 = ever breast-fed
Total daily calories	Total kilocalories consumed by household. Calculated using "typical month" consumption recall.
Child age	Child age at time of measurement in months.
Age of mother	Age of mother at child's birth in years
Conflict variable	
Deaths	(ln) Total district-level conflict-related deaths as compiled by the Informal Sector Service Centre.
Disappearances	(ln) Total district-level conflict-related disappearances as compiled by the International Committee of the Red Cross (2008)
Disappearances (robustness)	(ln) Total district-level conflict-related disappearances as compiled by the Informal Sector Service Center.
Agriculture, milk, and marketing variable	
Market > 2 hours away	1 = market is more than two hours away.
Availability of milk in local market	1 = item is available always or seasonally in local market
Local milk prices	Price per 100 grams of milk in 2006 Rs, conditional on availability of milk in community. Obtained from community survey.
Buffalo	Number of buffalo owned by the household
Cattle	Number of cattle owned by the household
Cattle equivalents	Buffalo and cattle normalized by milk-production potential as calculated using Food and Agriculture Organization of the United Nations livestock and milk-production data from Nepal.
Daily milk production	Sum of own-produced milk reported as consumed and quantity of milk sold in 100-gram units
Daily milk consumption	Own-produced milk reported as consumed in 100-gram units
Daily milk sold	Total milk sold by household in 100-gram units
Income variable	
Daily per capita total consumption expenditure	(ln) Total daily food and nonfood consumption expenditure in 2005 Rs.
Daily cash income	Total cash income received from all sources in 2005 Rs.
Daily wage income from agriculture	Cash and in-kind income from agricultural occupations in 2005 Rs.
Gross daily cash income from agriculture	Sum of agricultural wage labor income and income from sales of crops and livestock. Includes value of in-kind payments received. All in 2005 Rs.

Table A.2 Continued

Variable	Description
Other household characteristics	
Rural	1 = community categorized as rural by Nepal Living Standards Survey. Criteria unknown.
Value of landholdings	(ln) Total value of owned landholdings in 2005 Rs.
Housing amenities and asset index	Asset index comprising 12 durable goods (bicycle, camera, car, refrigerator, heater, motorcycle, telephone, radio, sewing machine, television, washing machine) and 5 housing amenities (improved cooking fuel, piped water in home, underground wastewater disposal, flush toilet, no toilet of any kind).
Household age composition	Three variables representing percentage of household members younger than 5, between 6 and 15, and 16 to 65 years old.
Household size	Total number of household members of any age.
Education	Maximum household educational attainment (years)
Female head education	Education of female head or spouse of head (years)
Male head education	Education of male head or spouse of head (years)

Source: Authors.

Table A.3 Determinants of WAZ score

Variable	(1) WAZ	(2) WAZ	(3) WAZ	(4) WAZ
Total daily milk consumption (100 grams)	0.0053	0.0038	0.0038	0.0035
	(0.0038)	(0.0039)	(0.0039)	(0.0043)
Total daily calories (kilocalories)		0.0000	0.0000	0.0000
		(0.0000)	(0.0000)	(0.0000)
Monthly dietary diversity index			–0.0046	
			(0.0170)	
Percentage of daily kilocalories that comes from cereals/roots/tubers				–0.0005
				(0.0030)
Male	0.0089	0.0111	0.0112	0.0112
	(0.0407)	(0.0407)	(0.0407)	(0.0407)
Breast-fed	0.0511	0.0499	0.0502	0.0498
	(0.0508)	(0.0508)	(0.0508)	(0.0508)
Diarrhea/dysentery in past 30 days	–0.2145***	–0.2174***	–0.2171***	–0.2173***
	(0.0822)	(0.0821)	(0.0821)	(0.0822)
Sanitary water source	–0.2489***	–0.2512***	–0.2506***	–0.2514***
	(0.0748)	(0.0746)	(0.0745)	(0.0746)
Child age at time of measurement (months)	–0.0164***	–0.0165***	–0.0165***	–0.0165***
	(0.0013)	(0.0013)	(0.0013)	(0.0013)
Female head	0.1460**	0.1458**	0.1454**	0.1456**
	(0.0583)	(0.0579)	(0.0579)	(0.0579)
Maximum educational attainment (years)	–0.0012	–0.0011	–0.0010	–0.0011
	(0.0070)	(0.0070)	(0.0069)	(0.0070)
Education of female head or spouse of head (years)	–0.0086	–0.0117	–0.0119	–0.0121
	(0.0460)	(0.0448)	(0.0450)	(0.0451)
Education of male head or spouse of head (years)	0.0733**	0.0692**	0.0707**	0.0690**
	(0.0303)	(0.0310)	(0.0306)	(0.0310)
Age of mother at child's birth (years)	0.0398	0.0377	0.0378	0.0378
	(0.0296)	(0.0296)	(0.0296)	(0.0296)

Table A.3 Continued

Variable	(1) WAZ	(2) WAZ	(3) WAZ	(4) WAZ
Age of mother at child's birth squared (years)	–0.0004	–0.0004	–0.0004	–0.0004
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Rural (1 = rural)	–0.0243	–0.0267	–0.0268	–0.0266
	(0.0652)	(0.0651)	(0.0651)	(0.0651)
(ln) Yearly consumption expenditure (2005 Rs.)	0.0890**	0.0795**	0.0807**	0.0788*
	(0.0391)	(0.0396)	(0.0398)	(0.0402)
Housing amenities and durables asset index	0.2004***	0.2124***	0.2135***	0.2110***
	(0.0452)	(0.0457)	(0.0462)	(0.0473)
(ln) Value of owned landholdings	–0.0050	–0.0056	–0.0057	–0.0056
	(0.0048)	(0.0048)	(0.0048)	(0.0048)
Birth order = 2.0000	–0.1169*	–0.1145*	–0.1146*	–0.1144*
	(0.0610)	(0.0611)	(0.0611)	(0.0613)
Birth order = 3.0000	–0.1173	–0.1142	–0.1141	–0.1140
	(0.0836)	(0.0835)	(0.0835)	(0.0835)
Birth order = 4.0000	–0.1737	–0.1712	–0.1710	–0.1707
	(0.1076)	(0.1072)	(0.1072)	(0.1074)
Birth order = 5.0000	–0.3475***	–0.3431***	–0.3439***	–0.3425***
	(0.1247)	(0.1242)	(0.1241)	(0.1245)
Percentage of household 5 years old and younger	–0.0021	–0.0018	–0.0018	–0.0019
	(0.0033)	(0.0033)	(0.0033)	(0.0034)
Percentage of household between 6 and 15 years old	–0.0045	–0.0044	–0.0044	–0.0045
	(0.0031)	(0.0031)	(0.0031)	(0.0031)
Percentage of household between 16 and 65 years old	–0.0004	–0.0005	–0.0005	–0.0005
	(0.0027)	(0.0027)	(0.0027)	(0.0027)
Household size	–0.0138	–0.0267**	–0.0270**	–0.0266**
	(0.0096)	(0.0122)	(0.0123)	(0.0122)
Constant	–1.8622***	–1.7564**	–1.7233**	–1.7118**
	(0.7104)	(0.7102)	(0.7293)	(0.7623)
Observations	2,858	2,858	2,858	2,858
R^2	.2316	.2324	.2324	.2324

Source: Nepal Living Standards Survey data (World Bank 2011).

Note: WAZ = weight-for-age z. Robust standard errors are in parentheses. Birth month, District and Region × Belt × Year fixed effects are included. Standard errors are clustered at the community level. **p* < .1. ***p* < .05. ****p* < .01.

Table A.4 Effects of conflict on total milk consumption with heterogeneous effects along livestock ownership (linear fixed effects and CRE Tobit) using cattle equivalents

Variable	(1) Fixed effect	(2) CRE Tobit	(3) Fixed effect	(4) CRE Tobit	(5) Fixed effect	(6) CRE Tobit	(7) Fixed effect	(8) CRE Tobit
Total livestock (cattle equivalents)	0.372***	0.327***	0.371***	0.329***	0.270***	0.410***	0.210**	0.349***
	(0.085)	(0.061)	(0.085)	(0.061)	(0.091)	(0.089)	(0.093)	(0.093)
(ln) Total disappearances	0.139	–0.148			–0.017	–0.316*		
	(0.150)	(0.122)			(0.163)	(0.179)		
(ln) Conflict deaths			0.170	–0.301			–0.595	–0.794**
			(0.410)	(0.227)			(0.420)	(0.338)
Livestock × (ln) Disappearances					0.094***	0.042*		
					(0.035)	(0.021)		
Livestock × (ln) Deaths							0.076***	0.046***
							(0.023)	(0.015)
Observations	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775
R^2	.1352724		.1349668		.1546809		.1642431	
Groups	959		959		959		959	
Uncensored		1,470		1,470		1,470		1,470
Censored		305		305		305		305

Source: World Bank (1996, 2003).

Note: CRE = correlated random effects. Columns (5) through (8) contain coefficient estimates. Corresponding Tobit partial effects are plotted in Figure5.1. Control variables include household educational attainment, gender of household head, age of household head, household age composition, (ln) total consumption, durable asset index, value of landholdings and urban, within-household means of all variables, and agroecological time trend controls. *$p < .1$. **$p < .05$. ***$p < .01$.

Table A.5 Effects of conflict on total milk consumption with heterogeneous effects along livestock ownership (linear fixed effects and CRE Tobit) using population-weighted conflict indicators

Variable	(1) Fixed effect	(2) CRE Tobit	(3) Fixed effect	(4) CRE Tobit	(5) Fixed effect	(6) CRE Tobit	(7) Fixed effect	(8) CRE Tobit
Buffalo	0.978***	0.810***	0.965***	0.820***	0.800***	1.081***	0.699**	1.090***
	(0.257)	(0.170)	(0.257)	(0.170)	(0.272)	(0.244)	(0.285)	(0.251)
Cattle	0.190	0.272**	0.203*	0.258*	0.211*	0.399***	0.205	0.357**
	(0.124)	(0.102)	(0.116)	(0.102)	(0.124)	(0.144)	(0.124)	(0.147)
(ln) Total disappearances	1.198	–6.786*			–6.248	–10.024*		
	(2.133)	(2.807)			(3.993)	(5.256)		
(ln) Conflict deaths			1.334	–1.595*			–2.694	–3.068*
			(1.378)	(0.775)			(1.959)	(1.650)
Buffalo × (ln) Disappearances					4.791**	1.676		
					(1.973)	(1.651)		
Cattle × (ln) Disappearances					1.711	–0.800		
					(1.972)	(1.761)		
Buffalo × (ln) Deaths							1.249*	0.247
							(0.678)	(0.379)
Cattle × (ln) Deaths							0.564	0.138
							(0.465)	(0.297)
Observations	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775
R^2	.1338937		.1351527		.1422062		.1474738	
Groups	959	959	959	959	959	959	959	959
Uncensored		1,470		1,470		1,470		1,470
Censored		305		305		305		305

Source: World Bank (1996, 2003).

Note: CRE = correlated random effects. Columns (5) through (8) contain coefficient estimates. Corresponding Tobit partial effects are plotted in Figure5.1. Control variables include household educational attainment, gender of household head, age of household head, household age composition, (ln) total consumption, durable asset index, value of landholdings and urban, within-household means of all variables, and agroecological time trend controls. *$p < .1$. **$p < .05$. ***$p < .01$.

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