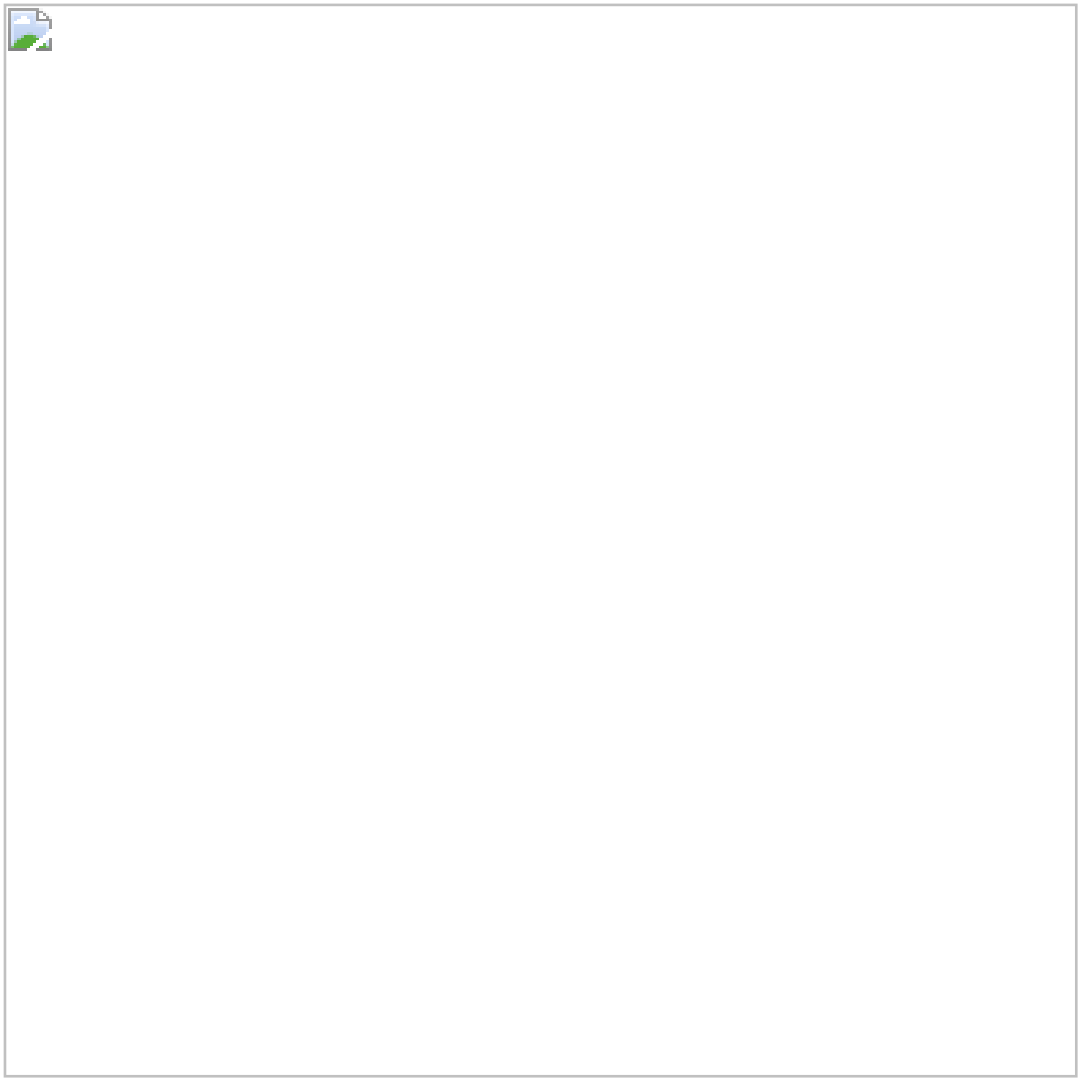

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After the Road Came: Insights Into the Nexus of Food Security and Malnutrition in Northwestern Nepal

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The United Nations Decade of Action on Nutrition 2016–2025 and the 2030 Agenda for Sustainable Development call on all countries and stakeholders to work together to prevent all forms of malnutrition by 2030. In Nepal, these considerations are at the forefront of the country's Sustainable Development Goals. To aid in this effort, this article presents a case study from the mountainous Humla District, Nepal, that was designed to better understand how the arrival of the first road in this area is affecting food security and nutritional status, and how these 2 variables are interrelated. Data from participant observation, interviews, the Household Food Insecurity Access Scale questionnaire, and a region-specific food frequency questionnaire suggest that while the road provides more reliable access to market-sourced food than before, villagers' intake of many micronutrients remains below recommended levels, as most of the market-purchased foods are nutrient poor. Data also suggest that this population is experiencing the double burden of malnutrition: simultaneous cases of underweight and overweight. High food security levels among those in the malnourished/overweight group could easily mask this emerging public health concern. This study provides an analytical framework to better understand the nexus of food security and nutrition, and offers evidence-based recommendations for decreasing food insecurity and malnutrition in mountainous regions, which will help achieve the goal of preventing all forms of malnutrition by 2030.

Keywords: *Poverty; vulnerability; food security; land cover; ethnography; interdisciplinary approaches; transdisciplinary approaches; South Asia; Himalaya.*

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Introduction

Despite public health efforts, the number of underweight and undernourished people in the world increased in 2017 to an estimated 821 million, up from 777 million in 2015 (FAO et al 2018). Another estimated 600 million adults and 41 million children under 5 are overweight/obese, of which a significant number are expected to also be undernourished (UNICEF et al 2017), demonstrating that malnutrition comes in a variety of forms. Decreasing the rate of these indicators has proven more difficult in fragile regions such as conflict zones (Messer and Cohen 2007; FAO et al 2017), those prone to natural hazards (De Haen and Hemrich 2007; Israel and Briones 2012), food deserts (Walker et al 2010), and mountain regions (Jenny and Egal 2002; Rasul and Hussain 2015). In mountain regions, rates of malnutrition are frequently higher than in lowland areas, due to a combination of shorter growing seasons that are affected by increasingly variable weather patterns, limited infrastructure that makes it difficult to grow enough food for subsistence, topographical constraints that heighten transportation costs of goods and food, and rapid socioeconomic and environmental changes (Dutta and Pant 2003; Rasul and Hussain 2015).

The challenge of malnutrition in mountain areas is often compounded by the fact that when rural roads are built, previously isolated communities are afforded easier access to markets, which typically have an abundance of nutrient-poor processed foods. Consuming a diet lacking in micronutrients (vitamins and minerals) yet high in macronutrients (lipids, proteins, and carbohydrates) results in the simultaneous prevalence of undernutrition, overweight, and diet-related noncommunicable diseases in the same population (Yates-Doerr 2015). This nutritional phenomenon, often called malnutrition's double burden, has been researched in numerous mountain regions, including Guatemala (Yates-Doerr 2015), Argentina (Romaguera et al 2008), and Pakistan

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(Shah et al 2004). This downside often occurs simultaneously with a loss of agricultural diversity, selective overextraction, and a shift to high-return crop production in response to market forces (Jodha 2000). Together, these factors have created a situation in which the FAO has declared that nearly half the people in the world's mountainous developing nations are food insecure (Romeo et al 2015).

A complex relationship exists between a number of infrastructural, agricultural, and social-change variables affecting food security. According to *The State of Food Security and Nutrition in the World,* reaching the 2030 Sustainable Development Goals requires a proper understanding of the "complex relationship between food security and nutrition, the food systems in which they are embedded and the social, political, and economic forces shaping them" (FAO et al 2017: 22). To advance understanding, the Food Security Information Network recommends that practitioners measure the degree to which individuals have "*availability*, *access*, *utilization* and *stability* of sufficient, safe and nutritious food to meet their dietary needs, at any given place and time" (FSIN 2016). However, Ashby et al found that "current tools available for measuring food insecurity are subjective, limited in scope, with a majority assessing only one dimension of food insecurity (access)" (2016: 2887).

We present a case study of ways that recent road development in Nepal's mountainous northwest has influenced each of these 4 food security dimensions (see FAO 2008 for more details on these dimensions). By identifying the interrelationships between these dimensions, we provide an analytical framework that highlights connections among food security, nutritional outcomes, and their socio-environmental determinants. This will be useful for providing evidence-based recommendations for stakeholders working to achieve Nepal's Sustainable Development Goals, who have recently declared numerous goals aimed at both reducing the prevalence of malnourishment and improving food security throughout the country (GON 2017).

Infrastructure change and food security in upper Humla District, Nepal

Upper Humla District, Nepal, is a mountain area where recent infrastructural changes have impacted food security for local villagers in numerous ways. The area was once an epicenter of trade, and the ethnic Tibetans living there have been able to minimize food insecurity risks for centuries by using that trade to supplement their local crops with lowland foods (Fürer-Haimendorf 1975). In 1999, this situation experienced a major change as the World Food Programme began a Food for Work initiative (see Gautam and Andersen 2017), which included a road-building project to connect Humla to both China and the rest of Nepal; local villagers were offered white rice as an incentive to work on this road.

The initial hope was that the road would provide increased access to markets and therefore help minimize risk of food insecurity, but villagers have described many unplanned effects, some negative. According to our interviews, many villagers abandoned some of their agricultural plots in order to spend more time working on the road, which was regarded as more profitable and more enjoyable. Although villagers were able to obtain more rice than before, the long-term effect was a decrease in dietary diversity as people ate more rice and less of nutrient-rich traditional crops such as amaranth, barley, and bitter buckwheat.

Eventually, the World Food Programme ended its involvement with the road project. Since then, progress has been slow: since construction began 19 years ago, only 45 km has been completed, much of which is a dirt track only wide enough for one vehicle. As of 2015, the road begins in Taklakot, a market town across the border in China; crosses a 5000-m pass into Nepal; and continues southeast until it terminates in the village of Thumkhot (Figure 1). Families from the surrounding villages had purchased 5 trucks to provide easy transport of foods, household items, and people to and from Chinese markets during favorable weather. Although more commodities are now available in upper Humla as a consequence, the majority of the foods being brought in are processed foods such as white flour, ramen noodles, and other foods high in sugar and additives such as candy, fruit juice, and soda (see Grocke and McKay 2016 for more details).

Although it can be argued that the new road has succeeded at increasing the availability of food, our research investigated how this new avenue of food acquisition is influencing villagers' food security levels, and whether it has brought the double burden of malnutrition to the population.

Methods

We conducted 10 months of ethnographic fieldwork between August 2014 and June 2015 in 2 Tibetan-speaking Buddhist villages in upper Humla District, Nepal (Table 1, Figures 1, 2A, B). They were chosen because of their similarity, aside from the fact that one lies directly beside the new road (Gyepo) while the other is far from it (Kale). Members of these communities have historically been better off than their Nepali-speaking Hindu neighbors to the south in terms of socioeconomic status and overall food security, in part because of their expansive trade networks and traditional polyandrous family structures (Haddix 1998, 2001; McKay 2002; Haddix McKay 2003; Gautam and Andersen 2016). By analyzing the changing food production systems and dietary practices in these 2 villages, this study provides insight into how the first road in the district is impacting their dietary and food security trends.

FIGURE 1 Map of upper Humla district and the location of the first road. (Sources: base map Google Earth 2018; district boundaries HDX 2018)

We used a mixed-methods approach to assess the 4 dimensions of food security (availability, access, utilization, and stability). Participant observation and unstructured interviews served as a method to better understand both food *availability* and *stability*. The first author participated daily in activities such as planting and processing crops and preparing meals, and frequently accompanied local people to food-related barter and market transactions. This participation provided the first author with insight into the various sources of food acquisition; it also allowed for ample time for discussions concerning the advantages and barriers of utilizing different food sources, and the level of sustainability each source provided throughout the year.

TABLE 1 Comparison of the 2 study villages.

	Gyepo	Kale
Administrative unit	Muchu Village Development Committee	
Elevation (m)	3850	3800
Coordinates	30°06′42.4″N 81°25′22.7″E	29°58′40.11″N 81°36′01.93″E
Distance from road	None	2-day walk over 2 mountain passes
Topography	Relatively flat	Extremely steep
Crops	Wheat, bitter buckwheat, mustard, radish, potato	
Ethnic composition	Tibetan (Lama caste)	
Religion	Buddhist	
Number of households	36	31

To understand household-level food security in terms of *access*, we implemented the US Agency for International Development's Household Food Insecurity Access Scale (HFIAS) questionnaire with all households (N = 67) in both villages, once in the fall (October) and once in the spring (April). The HFIAS is an experience-based metric of the severity of food insecurity, which relies on direct yes/no and frequency responses to 9 questions regarding food access (Maes et al 2009; Knueppel et al 2010; Becquey et al 2012). Based on participants' responses, their households were scored from 0 to 27, with 0 representing very food-secure households and 27 representing very food-insecure households. Households were placed into 4 categories (food secure, mildly food insecure, moderately food insecure, and severely food insecure—see Coates et al 2007), and further into 2 categories: food secure (secure or mildly insecure) and food insecure (moderately or severely insecure).

To assess *utilization*, we developed a regionally specific food frequency questionnaire based on our firsthand

FIGURE 2 (A) The steep topography of Kale village; (B) the flat topography of Gyepo village. (photos by Michelle Grocke [A] and Stephanie Grocke [B])

knowledge of Humli food consumption patterns and previous ethnographic accounts of the region (Bishop 1990; Citrin 2012). Our questionnaire included all of the foods that an individual in Gyepo or Kale has the opportunity to eat (see Grocke 2016 for more details). We administered this questionnaire to all households twice, with the person responsible for cooking the majority of the meals. We asked respondents whether they had consumed each of the foods/drinks on the list during the last 3 months, and if so, how often. To gauge consumption quantity, we showed respondents a set of pictures with which they could indicate how much of each food/drink was consumed.

The energy and nutrient content of foods were calculated using the ESHA Food Processor Plus Software (Version 10), which has been used in numerous cultural contexts (Liu et al 2013; Nti et al 2016). For local foods (eg yak butter) for which the nutritional content was not available in the database, we outsourced the nutritional content analysis to a lab in Kathmandu and manually

entered the data into the ESHA software. Considering, however, that the majority of villagers responsible for cooking were women, our sample does limit the generalizability of our questionnaire results, since we had more women respondents than men.

We also relied on anthropometric data (seasonal height and weight measurements) to assess utilization. For children 6–60 months, weight was taken using a hanging scale, while adults were weighed using a floor scale. Length was measured for children less than 2 years of age, while height was measured for children and adults more than 2 years of age using a stadiometer. From these measurements, body mass index (BMI) and underweight/overweight status was ascertained using the Centers for Disease Control BMI calculator and growth charts (CDC 2018a).

This research received institutional review board approval from the University of Montana in Missoula, MT, USA, on 1 May 2014 (IRB #217-13), in addition to approval from the Nepal Health Research Council.

Results

The variables most frequently cited by respondents in our study as important food security determinants were the number of harvests per year and the predictability of the weather. Having multiple harvests allows villagers to rely on the second harvest if the first one produces subpar yields. Gyepo and Kale are the only villages in upper Humla that have only 1 harvest per year, making them entirely reliant on the fall harvest. This was a significant cause of concern in these communities.

In recent years, Humlis have also had to face highly unpredictable and extreme weather events. Although the term "climate change" is not used in the local discourse, villagers frequently remarked on the impacts of a changing climate. One 67-year-old man said, "Lately it has been crazy—months of no rain, sometimes too much snow, sometimes it even snows during the monsoon!" In interviews, villagers mentioned prolonged snowfall in the spring and droughts in the fall as the most troubling, as these shorten the already-short growing season. Prolonged snowfall, as in 2015, prevents villagers from plowing and planting at the optimal time (mid-March), and fall droughts, like the ones in 2006, 2009, and 2015, devastate yields. This instability has heightened villagers' vulnerability to food insecurity by causing the volume and quality of crop yields to fluctuate dramatically from year to year, compounding a situation in which food insecurity was already prevalent. In combination, these new realities heighten the attractiveness of market-purchased foods.

Availability: past and present sources of food

We found that agricultural yields last an average of only 5 months in both villages. To minimize food insecurity risk, villagers strategically supplement their own harvests with foods obtained from the wild, their greenhouses, and/or other villagers, as well as market foods from China.

Villagers explained that historically, foraging was the only recourse for many households after the harvest was consumed. Recently, foraging has been less common. According to one elderly woman, foraged foods "have become more of an additive to food [...] a nice, familiar ingredient, but not something necessary [...] unless they have medicinal properties, those are useful to have in the house."

Rudimentary greenhouses were introduced relatively recently in Gyepo and Kale by local and international NGOs, and many households have used them successfully to grow leafy greens, onions, herbs, carrots, and other vegetables. Since every person has many social and familial ties to other households, even those without a greenhouse can share the produce grown in the greenhouses of their family and friends. Villagers also barter with lowland villagers (primarily for chilies and millet) and make purchases at the market located at the terminus of the road (primarily for white rice, white flour, cooking oil, and packaged foods).

Access: differences by village and season

In response to the first HFIAS question—"[In the last 30 days], did you worry that your household would not have enough food?"—numerous replies mirrored this one by a 42-year-old Kale man: "Our fields produce only for 1 month! But because of Taklakot [the Chinese market town that is the source of imported food] we don't have any worry." However, the villages' mean HFIAS scores indicate that food insecurity is higher in Gyepo (5) than in Kale (2). Based on other recent studies using the same metric, food insecurity is more prevalent in upper Humla than in, for example, Dhanusha, Nepal (0.69; Kular et al 2013), and Rajasthan, India (0.83 and 0.90; Srivastava et al 2014), but lower than in other areas such as North Korea (10.05; Lee and Nam 2014), Limpopo, South Africa (10.05; De Cock et al 2013), and Mumbai, India (10.29; Chatterjee et al 2012).

Ethnographic data revealed 2 primary reasons why food insecurity is higher in Gyepo than in Kale: unreliability of nonagricultural wages and harvest-related anxiety. Since the arrival of the road, 42% of households in Gyepo have abandoned a portion of their land in order to devote more time to road-related opportunities such as starting a business and/or purchasing more food from the Chinese market. Although this choice has proven beneficial for some, it has also made them more reliant on adequate market access conditions (favorable weather and passable roads) and on having enough cash to buy food. This has led villagers in Gyepo to become much more reliant on nonagricultural income—from businesses such as restaurants and tea shops, alternate livelihoods such as herb collection and timber harvesting, and (to a lesser

extent) remittances—to purchase food. But access to cash is still less predictable in this village than agriculture, and reliance on cash therefore contributes to Gyepo villagers' higher overall food insecurity.

In contrast, ethnographic narratives indicate that in Kale, households view the easier Chinese market access afforded to them by the road as an added benefit or convenience rather than a food source they have come to rely on. Not a single household in Kale abandoned any of its land in favor of road-related livelihood opportunities, nor have villagers' values shifted as drastically as they have in Gyepo. Households in Kale still place heavy value on agricultural activities, and aside from some village men engaging in an herb or timber business, nearly all of the household resources are dedicated to agriculture and herding.

Many more households were food insecure in Gyepo in the fall (87%) than in the spring (42%), with most individuals citing harvest-related anxiety as a primary producer of their food insecurity experience. The fall is generally a more anxiety-producing time than the spring—not only do all harvesting tasks need to be accomplished, but this is the time, falling between the monsoon rains and winter snow, when travel to the market in China is most feasible. Villagers in Gyepo reported feeling even more anxious once the road was in place because of the increased pressure to capitalize on it when they can. A 28-year-old man from Gyepo said, "In month 8 [of the Tibetan calendar—around October], I am most anxious because I have to stock up on all of the food for the winter. Every day I am thinking about this. Even in my dreams I am wondering whether I will accomplish all these tasks."

Kale villagers indicated that, since they live much farther from the road, trips to the Chinese market take much more advance planning, and households often team up and send 1 member from each household to travel to the market together. Since villagers know when and for how long family members will be traveling, these trips take place in a much calmer environment. Kale villagers also do not rely on the Chinese market for their food security. As one young man said, "Due to the remoteness of our village and difficult route to the market, it would not be wise to rely on it for food security."

Another important feature of the *access* dimension of food security is that during the fall, not all harvested items are ready for consumption. The process of converting crops to a consumable form has numerous steps: (1) harvesting the crops, (2) manually hauling them to the rooftops, (3) drying them, (4) processing and cleaning them, and (5) grinding the grain into flour. It is nearly winter before most households have access to their harvest in consumable form.

Utilization: dietary patterns and nutritional outcomes

Our food frequency questionnaire results suggest that villagers' average daily consumption ranges from 2931 to 4013 kcal per day, depending on the season and location (Table 2). Although this figure may seem high, it must be viewed in conjunction with average daily caloric expenditure. The caloric sufficiency correlates well with our HFIAS responses, in which numerous villagers attributed their food security to the increased market access afforded to them by the road.

However, in terms of diet quality, 2 significant patterns emerge. First, questionnaire responses indicate that the percentages of carbohydrates, protein, and fat in total calories are not ideal, with carbohydrates comprising too much of the diet in the springtime, while protein intake is slightly low, especially during the harvest season, when villagers are very active. Second, the average daily intake of many micronutrients remains below recommended levels (Table 3). Our interview data suggest the existence of many sociocultural and environmental determinants for these dietary patterns.

Villagers' adequate consumption of vitamin K, which is essential for regulating blood clotting and assisting in calcium transport throughout the body (NIH 2017), can be largely attributed to daily consumption of chili peppers (1 teaspoon of which contains 4% of the daily requirement) and greenhouse vegetables. Villagers also seem to be consuming enough iron, which assists in providing oxygen to organ systems (NIH 2017). However, since nonheme iron is difficult to absorb without simultaneous vitamin C consumption (Lynch and Cook 1980), villagers may be absorbing less than our data suggest, which could be contributing to heightened rates of anemia—which, though unmeasured in this population, have been observed in other Himalayan populations (Bhardwaj et al 2013).

Since fruit does not grow easily above 3800 m, vitamin C is difficult to acquire. Consistently low vitamin C levels can compromise many bodily functions, such as ridding itself of cholesterol, fighting off infections, and protecting against chronic and allergic diseases (Weber et al 1996; Arnson et al 2013). Recommended vitamin A levels are also difficult to consume, in part because vitamin A-rich foods, such as carrots and sweet potatoes, are not readily available. Villagers frequently complained of having severe dry eyes (a sign of vitamin A deficiency) and itchy skin, which can be a sign of hyperkeratosis (dry, scaly skin caused by a vitamin A deficiency) (Whitney and Rolfes 2015).

In terms of calcium, villagers in Kale cited their steep topography as a reason for low dairy consumption, especially among women and children. To find flat pastureland, men typically take animals to graze away from the village for an extended time (often days if not weeks). During this time, they have more consistent access to dairy products. In contrast, the topography in Gyepo is very flat, which makes it easier for all household members to consume dairy on a daily basis, since animals can freely graze throughout the village. Finally, average daily zinc consumption in both Gyepo and Kale is far lower than the recommended levels, in part because meat consumption is

TABLE 2 Average daily per capita macronutrient intake in Gyepo and Kale, by season.[a)]

Macronutrients (recommended intake)	Kale		Gyepo		Comments
	Fall	Spring	Fall	Spring	
Total (kcal) (depends on calories expended)	3713	3240	4013	2931	More calories are consumed in fall, when more work is done. Data from our study suggest that a 115-pound woman can expend roughly 3900 calories per day during a 13-hour workday.[b)]
Carbohydrates (45–60% of total diet)[c)]	64%	70%	55%	70%	Tibetan dishes are largely centered on carbohydrates; it is difficult to maintain a high level of dietary diversity in winter and spring.
Protein (10–35% of total diet)[d)] Individuals who engage in high amounts of moderate–vigorous intensity aerobic activity require more[e)]	14%	14%	19%	13%	Since villagers are Buddhist, meat is consumed only if an animal dies of natural causes. Poultry rearing is considered taboo since wolves have been known to kill the chickens, which is considered a bad omen.

[a)] Daily consumption values are estimates based on responses to our food frequency questionnaire.
[b)] Source: Grocke 2016.
[c)] Source: HHS and USDA 2015.
[d)] Source: HHS and USDA 2015.
[e)] Lemon 2000.

low. Zinc deficiency increases susceptibility to a variety of pathogens (Shankar and Prasad 1998) and is reportedly responsible for over 800,000 childhood deaths worldwide every year (WHO 2018).

Our dietary analysis suggests that villagers in Gyepo are consuming on average slightly lower levels of micronutrients than villagers in Kale (Table 3). This is compounded by the fact that Gyepo residents, on average,

TABLE 3 Average daily per capita micronutrient intake in Gyepo and Kale, by season. Data in bold represent less than recommended intake levels.[a)]

Micronutrients (recommended intake)[b)]	Kale		Gyepo		Comments
	Fall	Spring	Fall	Spring	
Vitamin K (mcg/d) (males, 138; females, 122)	311	360	204	291	Kale has more greenhouses, which yield more vegetables; both villages consume high amounts of chili peppers.
Vitamin A (mcg/d) (males, 900; females ≥14 years, 700)	**471**	**515**	984	**275**	Dried apricots, a good source of Vitamin A, are more common in Gyepo.
Vitamin C (mg/d) (males, 90; females, 75)	**83**	**71**	**56**	**52**	Fruit is rarely consumed; no households in Gyepo consume fruit on a daily basis.
Iron (mg/d) (males ≥13 y, 8; females ≥13 y, 18; females in menopause, 8)	23	21	19	17	Our survey results, disaggregated by gender, indicate that women in Gyepo do not consume adequate amounts of iron.
Zinc (mg/d) (males ≥19 y, 11; females ≥19 y, 8; higher for pregnant/lactating females)	**7**	**4**	**4**	**3**	Foods high in zinc are difficult to acquire in both villages.
Calcium (mg/d) (males and females 19–50 y, 1000)	**539**	**739**	**921**	**787**	Calcium consumption is directly related to village topography; since Gyepo is flat, all children and adults have easier access to dairy products on a daily basis since animals can stay near village to graze.

[a)] Daily consumption values are estimates based on responses to our food frequency questionnaire. Consumption values in bold indicate that the average amount consumed is less than the recommended intake.
[b)] Source for recommended intake data: Otten et al 2006.

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FIGURE 3 Percentage of underweight and overweight adults in Gyepo and Kale, by season.

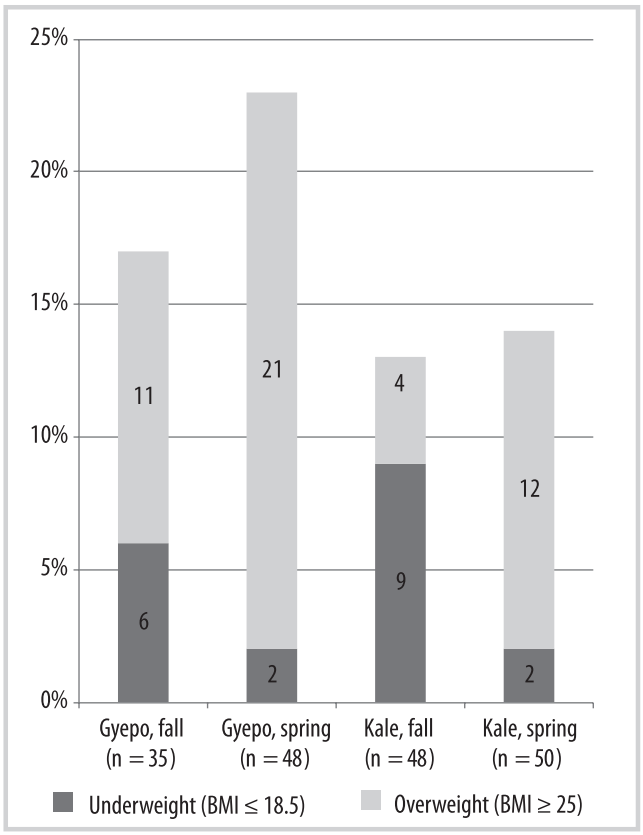
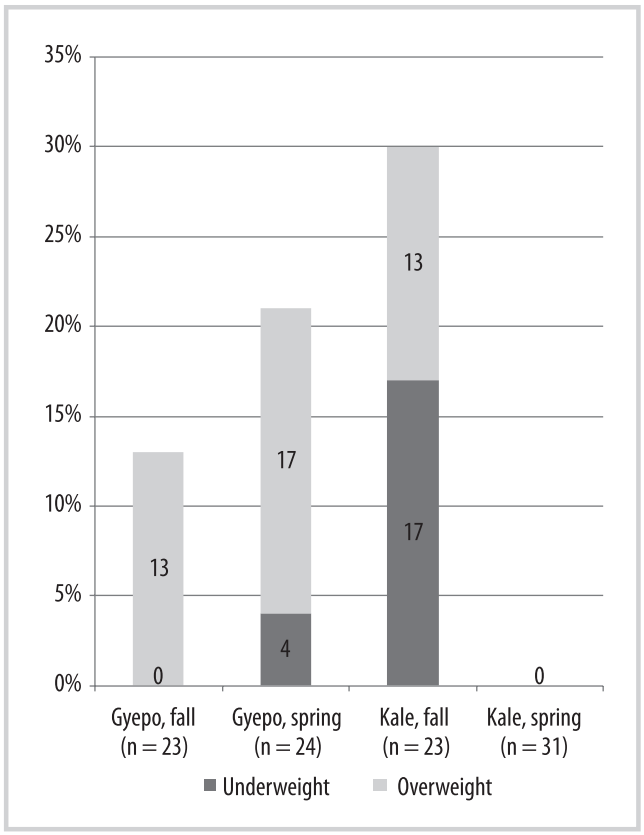


FIGURE 4 Percentage of underweight and overweight children in Gyepo and Kale, by season.



consume more sugar and high-proof alcohol than Kale residents. Our anthropometric data reflect these results, as a higher percentage of adults were shown to be either underweight or overweight in Gyepo than in Kale (Figure 3). Interview data suggest that Gyepo's higher reliance on nonagricultural livelihoods and more sedentary lifestyle are contributing to this phenomenon.

When we cross-tabulated our anthropometric data with our food security data, we found that 75% of overweight individuals from Gyepo came from food-secure households. Interview data suggest that these individuals have the resources to consume what they deem luxury foods (such as alcohol and sweets) nearly daily, which can easily lead to them becoming overweight yet remaining undernourished. On the other hand, all underweight adults in Gyepo belonged to food-insecure households. This suggests that, while food insecurity may be a strong indicator of adult malnutrition in the form of underweight, it may fail to identify those adults who are malnourished and overweight.

We identified 2 primary trends regarding child malnutrition: the highest percentage of underweight occurred in Kale in the fall, and Gyepo had a higher percentage of overweight children (Figure 4). Interview data show that while easy-to-prepare foods from the Chinese market—such as ramen noodles, chocolate, sweets, and soda—are keeping the prevalence of underweight children low in Gyepo, these processed foods are causing a higher percentage of children to become overweight. Compared to the adults, a higher percentage of malnourished children came from food-insecure households. All underweight children in Kale and all overweight children in Gyepo came from food-insecure households. For children, food insecurity was a strong indicator of both underweight and overweight forms of malnutrition.

Stability: dependent on primary food source and livelihood

The stability of food access in upper Humla depends on a variety of factors. First, access to food from the Chinese market is unreliable, as the market is season- and weather-dependent, and prices fluctuate with the currency exchange rate. Second, it is becoming more difficult for villagers to rely on their agricultural yields, in part due to the decrease in the predictability of weather patterns and in part due to loss of agricultural labor. Villagers who continued to invest in their crops despite the new options created by the road had the lowest average levels of food insecurity, as they could rely on their yields and treated food from the market as an added benefit rather than a necessity.

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Conclusions and recommendations

To contribute to the discussion about ways to tackle food security challenges in Nepal, we analyzed subsistence and dietary patterns in terms of availability, access, utilization, and stability in 2 Buddhist communities in upper Humla. In terms of *availability*, the road provides villagers with another source of food, which has directly helped to decrease villagers' food-related anxiety and increase the quantity of food available to them. In terms of *access*, however, our results suggest that food insecurity levels were actually higher near the road, most notably because many villagers in Gyepo have overinvested in nonagricultural livelihoods, which is proving to be stressful and, at times, unreliable.

In terms of *utilization*, while villagers consumed a high number of calories, both the carbohydrate/protein/fat ratios and the high rates of alcohol and added sugar consumption are worrisome, particularly near the road, where there is easier access to processed foods. The higher percentage of overweight adults in comparison to those who are underweight may be attributed to these dietary changes. However, since many overweight adults came from food-secure households, our data suggest that food insecurity is more likely to result in adult malnutrition in the form of underweight, and, as a stand-alone metric, may fail to identify adult malnutrition in the form of overweight. This is not the case for children; 80% of malnourished children (both overweight and underweight) came from food-insecure households, illustrating the potential relationship between these variables.

Although market access is often seen as one of the most important factors affecting rural food security (BMZ 2010), we argue that the negative outcomes of increased market access may be masked by the apparent advantages. In this case, increased market access is bringing about a new challenge, one that might further increase the number of people who are malnourished due to overconsumption of nutrient-poor foods. Members of food-secure, well-to-do households near the road had the highest risk of being overweight and adding to the global food insecurity and nutrition burden. Additionally, packaged market foods have become a quick way for mothers to temporarily satiate their children; although this has kept underweight at bay near the road, it has already caused an upsurge of overweight among children. Our data suggest that the double burden of malnutrition is present among both adults and children in these 2 communities.

We recommend that vitamin C and zinc supplements be prioritized by local NGOs. Vitamin C will repair and regenerate tissues, protect against heart disease, increase overall immunity (NIH 2017), and aid in the absorption of nonheme iron (CDC 2018b). Zinc will not only help insure against ever-present threats of gastrointestinal and respiratory illness, but will decrease susceptibility to disease and help individuals heal more quickly after an injury (Ruel et al 1997). This would be particularly helpful in a rural mountain environment where access to health care is limited. We also encourage a health promotion campaign to educate adults in these and similar villages on the health risks (eg noncommunicable diseases) of consuming high levels of alcohol, added sugar, and processed foods; which available, culturally appropriate foods contain high levels of protein and micronutrients (eg eggs purchased from the market in China); and strategies for capitalizing on the opportunities provided by the road while maintaining traditional agricultural practices.

We urge other scholars and health practitioners to implement a similar analytical framework that highlights connections among food security, nutritional outcomes, and their socio-environmental determinants. While outcomes of the more quantitative methods can be used to compare food security and nutritional outcomes across regions and cultures, the qualitative methods will illuminate local food security nuances and sociocultural and environmental determinants that might otherwise be overlooked. Since individuals living in mountain environments are especially likely to experience high levels of food insecurity, an increase in attention to these issues in Upper Humla, Nepal, will help us collectively achieve the goal of ending hunger and preventing all forms of malnutrition by 2030.

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