Household food insecurity and nutritional status of children aged 6 to 23 months in Kailali District of Nepal

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Abstract

Background. *Food insecurity and malnutrition among children are common in Nepal. However, inadequate data exist on the association between household food insecurity and the nutritional status of children.*

Objective. *To assess the relationship between household food insecurity and malnutrition among children aged 6 to 23 months in Kailali District of Nepal.*

Methods. *We analyzed data from families of 368 children 6 to 23 months of age who completed a cross-sectional survey in January 2009. The data contained information on sociodemographic characteristics, food insecurity, child feeding practices, use of preventive health services, and height, weight, and hemoglobin levels of children and mothers.*

Results. *More than two-thirds (69%) of households were classified as food insecure (had insufficient access to adequate food). The prevalence rates of stunting, underweight, and wasting among children were 41%, 24%, and 9%, respectively. The prevalence of anemia was 58%. There were no significant associations between household food insecurity and stunting, underweight, or anemia. Stunting and underweight were associated with maternal height and household wealth ($p < .05$). Underweight was also associated with maternal education ($p < .05$). Anemia was associated with low maternal hemoglobin concentration ($p < .05$).*

Conclusions. *Food insecurity was common in households with children 6 to 23 months of age in Kailali District of Nepal. The rates of stunting, underweight, wasting, and anemia were also high. However, there was no significant association between household food insecurity and malnutrition among children. Therefore, not just access to food, but an integrated approach that improves the overall socioeconomic well-being of families, maternal education, and knowledge of optimal nutrition practices, together with adequate maternal nutrition, is needed to address malnutrition among young children.*

Key words: Anemia, children, food insecurity, stunting, underweight, wasting

Introduction

Poverty, food insecurity, and malnutrition are prevalent problems in Nepal. Twenty-four percent of the population in Nepal live on less than US$1 per day, and the country ranks 145 among 177 nations on the Human Development Index [1, 2]. Nearly 42 of the 75 districts in the country are considered to be in food deficit, i.e., they lack sufficient food to meet the needs of the population [1]. Nationally, stunting, underweight, and wasting affect 49%, 39%, and 13% of preschoolchildren, respectively, and nearly one in every two preschool-children (48.4%) is anemic [3]. There is substantial regional variation in poverty, food insecurity, and malnutrition in the country, with some of the poorest indicators found in the Far Western region. The estimated prevalence of poverty in the Far Western region is 41%, compared with a national average of 31% [4, 5]. The prevalence of inadequate caloric intake in this region was estimated as 45%, compared with a national average of 40% [6]. Although the prevalence of stunting among preschoolchildren in this region (43%) is slightly lower than the national average, the prevalence rates of underweight (41%), wasting (20%), and anemia (60%) are slightly higher [3].

By a widely accepted definition, a household is considered food insecure if it has limited or uncertain

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physical and economic access to secure sufficient quantities of nutritionally adequate and safe foods in socially acceptable ways to allow household members to sustain active and healthy living [7, 8]. By this definition, household food insecurity has two broad components: insufficient access to a nutritionally adequate and safe food supply at the household level, and inadequate utilization of these foods by household members. The access component is also believed to comprise three core domains: anxiety and uncertainty about household food supply, insufficient quality of food, and insufficient food intake by household members [8–10]. The utilization component is influenced most immediately by nutrition knowledge and beliefs, but also by access to healthcare, water, and sanitation services and practices relating to the management of childhood illness and hygiene [7, 8]. Household food insecurity can negatively affect food consumption, including reduced dietary variety, nutrient intake, and nutritional status of household members. However, research on the relationship between household food insecurity and nutritional status of children has led to mixed results. Whereas some studies have reported a positive association between household food insecurity and childhood growth indicators such as weight gain [11, 12], others have found no relationship [13–16] or a negative association [17–20] with weight and height gain among children.

The majority of studies that have examined the relationship between household food insecurity and nutritional status have focused on adults and older children. Moreover, the majority of such studies were carried out in developed countries, resulting in limited data on the association between food insecurity and malnutrition among preschoolchildren in developing countries. The relationship between household food insecurity and malnutrition among preschoolchildren in Nepal is not yet known. Accordingly, this paper explores the prevalence of household food insecurity and malnutrition among children aged 6 to 23 months, as well as the association between these two factors, in Kailali District of Nepal. The paper concludes by highlighting the implications of our findings for improving the nutritional status of preschoolchildren in Kailali District of Nepal and generally for nutrition program design in similar cultures.

Methods

Study site

Kailali District covers an area of 3,235 km^2 and is located in the lowlands (*terai*) of the Far Western region of Nepal, about 800 km west of Kathmandu. For administrative and developmental purposes, the district is divided into 42 village development committees (VDCs) and two municipalities. Each VDC or municipality consists of several wards (villages). The district has four distinct seasons: spring (March–May), summer (June–August), autumn (September–November), and winter (December–February). The majority of the population in the district practices subsistence farming, primarily the cultivation of rice and vegetables, with limited animal husbandry. However, unpredictable climatic conditions and seasonal flooding limit agricultural productivity in the area. Although the shortage in local production is often supplemented by food imported into the district, the high rate of poverty and the low purchasing power limit access to this food by many households. The major staple food is rice, which is often eaten with dal (a stew prepared with pulse or lentils). A typical diet thus consists mainly of cereals and pulses, with limited animal-source foods or vegetables. There is also a seasonal variation in food availability and consumption, with high intakes immediately after the main harvest period (October–December) and close to extreme deprivation during the planting or lean period (May–July) of the year.

Research design and sampling procedures

To assess the relationship between household food insecurity and malnutrition among children aged 6 to 23 months, we analyzed data from a cross-sectional baseline assessment conducted for an impact evaluation of a community-based program called Action Against Malnutrition through Agriculture (AAMA) in Kailali District. This analysis was secondary to the main purpose of the impact evaluation. The AAMA project is implemented by Helen Keller International (HKI) in partnership with the Nepali Technical Assistance Group (NTAG), the Nepal National Social Welfare Association (NNSWA), and Snehi Mahila Jagaron Kendra (SMJK), with funding from the US Agency for International Development (USAID). The project has an overall goal of improving the nutritional status of children aged 0 to 23 months and their mothers. The project uses an integrated model that combines homestead food production to ensure year-round availability of nutritious foods for families, with a behavior change communication package of proven Essential Nutrition Actions to promote optimal infant and young child feeding (IYCF) practices, ensure adequate micronutrient status (specifically, vitamin A, iodine, and iron) of young children, and optimize maternal nutrition.

The baseline data for the AAMA project were collected in January 2009. The survey involved 484 households with children aged 0 to 23 months selected by a 30 × 15 two-stage cluster-sampling procedure. However, for this study, only data on children aged 6 to 23 months (n = 368) and their families were analyzed. During the sampling process, each ward was considered a cluster, and households and children

were randomly selected from these clusters. A list of all the wards in the 42 VDCs in the district, together with the total population in each, was obtained from the 2001 Nepal national census [21]. Municipalities in the district were excluded from the sample, because the AAMA project targets rural areas. In the first stage of sampling, 30 wards were selected with probability proportionate to the size of the population in each ward. The second stage of sampling involved selecting 15 households from each ward. Households were selected by the spin-a-pen random walk method. If a selected household had more than one child aged 0 to 23 months, only the youngest child was included in the survey. Overall, a total of 450 households were expected for the survey. However, an extra 50 households were surveyed to account for nonresponse. Thus, 500 households were visited by the enumerators, but 16 could not be interviewed because of the absence of household members during the visit by the enumerators.

Data collection and management procedures

The main focus of the study was to use multivariate analysis to assess the association between household food insecurity, defined here as insufficient access to adequate food (independent variable of interest), and malnutrition among children, defined as underweight, stunting, wasting, and anemia (the outcome variables of interest), while controlling for potential confounding variables. Based on the variables available in our dataset, we tried to model our analysis along the UNICEF conceptual framework, which considers household access to food, care for children, and availability of health services and a healthful environment as the three major underlying factors that affect the nutritional status of children [22].

The dataset contained information on the child's age, caste, sex, and illnesses (diarrhea, fever, and acute respiratory infections) suffered in the 2 weeks prior to the survey. IYCF practices, including breastfeeding at the time of the survey, initiation of breastfeeding within 1 hour after delivery, prelacteal feeding, and composition and frequency of feeding complementary foods (obtained through the mother's recall of foods and liquids given to the child in the 24 hours before the survey), were also examined. These were used to compute additional indicators, such as timely introduction of solid, semisolid, or soft foods, age-specific feeding of minimum dietary diversity, minimal meal frequency, and minimum acceptable diet to the child, using the 2008 World Health Organization (WHO) guidelines on IYCF indicators [23].

The dataset also contained information on the use of preventive health services for children, including participation in growth monitoring, immunizations received, and whether the child had received vitamin A capsules and/or deworming tablets in the 6 months prior to the survey. The mother's age and level of education; hygiene practices, such as washing the hands with soap before cooking or feeding the child and after defecation; and the place of disposal of the child's feces were examined. Household-level data collected in the survey included household food insecurity (described below); sex, marital status, and occupation of the head of the household; source of drinking water; presence or absence of electricity; type of toilet facility; monthly income; and ownership of land, home garden, livestock, and household durable assets such as a radio, television, telephone, refrigerator, watch, electric fan, bed, bicycle, motorcycle, car, and animal-drawn cart. The questionnaires were pretested prior to the survey, and all interviews were conducted in Nepali, the local language. Consent was obtained from all heads of households and mothers of children involved in the study. Ethical approval was obtained from the Nepal Health Research Council, Kathmandu.

Anthropometric measurements and reference values

The children and their mothers were weighed with a Seca electronic scale. The recumbent length of the children was measured with a portable length board (Shorr Productions). The height of the mothers was measured with a locally made height board. All anthropometric assessments were performed according to standard WHO procedures [24]. The weights and lengths of the children were used to compute age- and sex-specific z-scores for weight-for-age (WAZ), weight-for-length (WHZ), and length-for-age (HAZ) using WHO Anthro software (version 3, 2009). Underweight, wasting, and stunting among children were defined as WAZ, WHZ, and HAZ less than 2 SD below the 2006 WHO growth standards, respectively [25].

Hemoglobin measurement and definition of anemia

Hemoglobin was measured in a fingerprick blood samples with a portable HemoCue analyzer. Anemia among children and mothers was defined as hemoglobin < 110 g/L and < 120 g/L, respectively, after adjusting for the influence of altitude on hemoglobin using appropriate WHO reference values [26]. The altitude of each household involved in the survey was measured with a hand-held global positioning device (model-eTrex H). The altitude of the households ranged from 112 to 1,390 m above sea level.

Definition of household food insecurity

In this analysis, household food insecurity was assessed using a short version of the Household Food Insecurity Access Scale (HFIAS) developed by the Food and Nutrition Technical Assistance (FANTA) project [10]. The HFIAS tool consists of nine questions that are

believed to capture all three core domains that reflect a household's inadequate access to food.

The data analyzed for this study were based on the answers to five questions that were similar to those of the HFIAS tool and were therefore used as a proxy for the full HFIAS tool. The questions used were as follows:

1. In the past 12 months, were you ever worried that food would run out before you got money to buy more?
2. In the past 12 months, were you not able to feed your children nutritious animal-source foods like eggs and meat because you could not afford it?
3. In the past 12 months, did you or any of your family members ever eat less than usual because you felt there was not enough money to buy food?
4. In the past 12 months, did you or any of your family members ever skip a meal because there was no money to buy food?
5. In the past 12 months, how often did food stored in your home run out and there was no money to buy more?

Each question had four response options—never, rarely, sometimes, or often—which were coded in order of increasing frequency from 0 to 3. A household was classified as food insecure if the family reported experiencing any of the five conditions within the recall period (i.e., if the answer to any of the questions was "rarely," "sometimes," or "often"). All households that did not meet this condition were classified as food secure. The only exception was among households in which the respondent's answer to question 1 was "rarely" but the response to all the other questions was "never." Such households were also considered food secure. The internal consistency of the responses to the five questions was assessed using Chronbach's alpha statistics. All the responses correlated positively, and the alpha was 0.75.

Although we used a short version of the HFIAS tool, the five questions included in our analysis reflected the three core domains of household food insecurity and allowed us to estimate the overall prevalence of this variable in our sample. If anything, we conjecture that the limited number of questions used underestimated the prevalence of household food insecurity among our study households.

Statistical analysis

Descriptive statistics were computed for household food insecurity, sociodemographic characteristics, nutritional status, and child care indicators. Children from food-insecure and food-secure households were compared on these indicators with the chi-square test for proportions, the independent-samples *t*-test for means, and Wilcoxon's test for medians.

Multivariate logistic regression models were used to assess the association between household food insecurity and the outcome variables underweight, stunting, and anemia among children. The following independent variables were included in the models:

At the child level: Child's age, sex, and caste. Breastfeeding initiation within 1 hour after delivery, whether the child was given prelacteals, participation in growth monitoring, and whether the child had completed all three doses of diphtheria-pertussis-tetanus (DPT) immunization (with each of these variables coded 1 when present and 0 when absent) were used as proxy indicators for child care practices [27]. The other variables on IYCF practices and use of preventive health services were not used in the multivariate analysis, for the following reasons: the breastfeeding variable had little variability (98.1% of children were still breastfeeding at the time of the survey); the data from a single 24-hour recall of feeding practices do not reflect the usual practice of individual mothers because of day-to-day variation in IYCF practices; there were many missing cases in the dataset for polio and bacille Calmette-Guérin (BCG) vaccinations, because only 38.6% of the children had health cards; and data on measles vaccination were only available for children 9 months of age or older. Polio vaccine and vitamin A capsules are given by mouth, and some caretakers could have confused recall between these two. Deworming data were only available for children 12 months of age or older. Information on child morbidity and hygiene indicators were left out of the multivariate analysis because of the potential for multicollinearity.

At the mother level: Mother's age, level of education, and height. Maternal hemoglobin was also included in the model, with anemia as the outcome variable.

At the household level: Sex of head of household and tercile of household wealth index (proxy indicator of socioeconomic status). The household wealth index was created by a method similar to that of Engle and Zeitlin [28].

Dummy variables identifying each village were included to account for clustering within villages.

All associations were considered statistically significant if $p < .05$. Full models (including all hypothesized independent variables) and parsimonious models (including only the statistically significant independent variables) are presented. Wasting among children was not used as an outcome in the regression model, because wasting was reported in relatively few children (9%) in our sample.

Results

Prevalence of household food insecurity

More than two-thirds of households in our sample

(69.2%) experienced some degree of food insecurity in the 12 months preceding the survey. The proportions of households that experienced each of the specific conditions that were used to assess food insecurity in this study are given in **table 1**. More than half of the households experienced worry or anxiety about food supply, and a little over 60% of mothers reported they could not feed their children nutritious animal-source foods such as eggs and meat because of lack of money for purchasing these foods. Approximately one in every five households ran out of food stores, and a similar proportion had a household member who ate less than usual at some point in time during the 12 months before the survey.

Household food insecurity and sociodemographic characteristics

Table 2 provides the sociodemographic characteristics of the total sample and stratified by household food insecurity status. The mean age of the children was 14.2 ± 5.1 (SD) months, and slightly more than half were male. Close to half of the children (44.1%) were reportedly ill in the 2 weeks prior to the survey, with the most commonly reported illnesses being acute respiratory infections, diarrhea, and fever.

Only one in every four households had access to a toilet facility, and less than half of the households had electricity. The main source of drinking water was

TABLE 1. Percentage of households that experienced specific food insecurity-related conditions in the 12 months preceding the survey (N = 368)

Frequency	Worry over household food supply	Could not feed children nutritious foods	Household ran out of food	Household member ate less than usual	Household member skipped meal
Never	42.9	38.3	73.4	78.3	89.1
Rarely	0.0	0.0	25.3	5.7	10.6
Sometimes	27.4	34.0	1.4	15.8	0.0
Often	29.6	27.7	0.0	0.3	0.3

TABLE 2. Sociodemographic characteristics of the sample, stratified by household food insecurity status[a]

Characteristic	All children (n = 368)	Food-secure (n = 114)	Food-insecure (n = 254)
Child			
Age (mo)	14.2 ± 5.1	13.7 ± 4.9	14.5 ± 5.2
Sex (% male)	52.5	48.2	54.3
Caste (% upper caste)	50.4	49.1	52.0
Morbidity			
Acute respiratory infection	28.3	28.9	28.0
Diarrhea	18.2	16.7	18.9
Fever	15.2	10.5	17.3
Other illness	2.4	1.8	2.8
Mother			
Age (yr)	25.5 ± 5.3	24.3 ± 4.8	26.0 ± 5.5
Education (% no education)	64.9	54.4	69.7*
Weight (kg)	46.0 ± 6.0	46.6 ± 6.3	45.7 ± 5.8
Height (cm)	148.5 ± 6.3	149.0 ± 6.2	148.2 ± 6.4
Hemoglobin (g/L)	12.3 ± 1.5	12.2 ± 1.4	12.3 ± 1.5
% < 115 g/L (anemia)	35.1	37.7	33.9
Household			
Household size	7.4 (4.0)	7.0 (5.3)	6.0 (3.5)
Sex of household head (% female)	18.3	12.3	20.9
Marital status of household head (% married)	95.7	93.9	96.5
Monthly income (% with no cash income)	48.4	36.3	53.5**

continued

TABLE 2. Sociodemographic characteristics of the sample, stratified by household food insecurity status[a] *(continued)*

Characteristic	All children (n = 368)	Food-secure (n = 114)	Food-insecure (n = 254)
In debt (%)			
Short-term	71.6	53.5	79.1***
Long-term	28.4	46.5	20.9***
Electricity (% yes)	41.0	50.0	37.0*
Toilet (% yes)	27.5	45.6	19.3***
Cooking fuel (% wood)	95.7	87.7	99.2***
Land ownership (%)	93.7	97.3	92.1
Home garden (% yes)	69.0	86.0	61.4***
Household durables (% yes)			
Bed	85.9	95.6	81.5***
Radio	63.3	77.2	57.1***
Clock or watch	68.5	93.9	57.1***
Television	19.8	37.7	11.8***
Electric fan	13.3	21.9	9.4*
Telephone	14.4	28.9	7.9***
Refrigerator	0.5	1.8	0.0
Cupboard	17.7	30.7	11.8***
Animal-drawn cart	24.5	43.9	15.7***
Bicycle or rickshaw	50.5	65.8	43.7***
Motor bike	1.9	5.3	0.4
Car or truck	1.1	3.5	0.0

a. Values are means ± SD, medians (interquartile range), or percentages.
*$p < .05$, **$p < .01$, ***$p < .001$ for the difference between food-insecure and food-secure households.

TABLE 3. Indicators of infant and young child feeding (IYCF) practices and use of preventive health services by mothers stratified by household food insecurity status (percentages)

Indicator	All children (n = 368)	Food-secure (n = 114)	Food-insecure (n = 254)
IYCF practice[a]			
Breastfeeding at time of survey	98.1	97.4	98.4
Early initiation of breastfeeding (n = 285)	64.9	64.0	65.3
Fed prelacteals (n = 363)	13.8	16.1	12.7
Timely introduction of solid, semisolid, or soft foods[b,c]	62.1	73.9	54.3
Fed with minimum dietary diversity (≥ 4 food groups)[b]	18.8	28.9	14.2**
Given age-appropriate frequency of feeding[b]	54.6	64.9	50.0**
Fed minimum acceptable diet[b]	13.0	23.7	8.3***
Use of preventive health services			
Health card (% yes)	38.6	42.1	37.0
Growth monitoring (% ever participated)	51.9	49.1	53.1
DPT (completed 3 doses)	33.5	39.5	30.8
Measles (only for children > 9 mo)	82.3	83.5	81.7
Vitamin A supplementation in past 6 mo (% yes) (n = 321)	86.9	90.9	85.1
Deworming in past 6 mo (% yes)[d]	68.9	67.2	69.6

a. Variables are defined based on the most recent WHO guidelines on infant and young child feeding practices (see World Health Organization [23]).
b. Indicators were based on mother's recall of food fed to the child in the 24 hours prior to the survey.
c. Indicator was computed only for children aged 6 to 8 completed months (n = 58).
d. Indicator was computed only for children aged 6 to 8 completed months (n = 212).
**$p < .01$, ***$p < .001$ for the difference between food-insecure and food-secure households..

from a community or individual tubewell or borehole (48.2%), with only 22.3% of households using tap water and 29.5% using water from other sources such as a well, river, pond, or spring. Almost half of the households (48.4%) earned no cash income, 18.3% earned less than 2,000 rupees (US$25), 9.8% earned between 2,000 and 4,000 rupees (US$25 to US$51), and 23.5% earned more than 4,000 rupees (US$51) in the month prior to the survey.

As expected, food-insecure households had generally lower socioeconomic status than food-secure households. A greater proportion of mothers of children from food-insecure households had no formal education than mothers of children from food-secure households ($p < .05$). Significantly more food-insecure households had no monthly income, electricity, toilet facility, or household durable assets such as a bed, radio, clock or watch, television, electric fan, telephone, cupboard, animal-drawn cart, and bicycle or rickshaw compared with food-secure households ($p < .05$). More food-insecure households than food-secure households did not have home gardens ($p < .05$).

Household food insecurity and child-care practices

Table 3 presents the variables used as proxies for child-care practices for the full sample and stratified by household food insecurity status. Only two-thirds of the mothers initiated breastfeeding within 1 hour after delivery, and one-tenth of the mothers gave prelacteal foods. The most common prelacteal foods were plain water (38%), animal milk (34%), sugar water (6%), and gripe water, a treatment for stomach ailments (2%). One-tenth of mothers gave other liquids, and 10% gave two or more prelacteal foods. There were no differences between food-secure and food-insecure households in the frequencies of these practices.

Complementary feeding practices were also less than optimal. A little over half of children 6 to 8 months of age were given solid, semisolid, or soft foods in the 24 hours before the survey (the 2008 WHO indicator for timely introduction of complementary foods [23]). The frequency of timely introduction of complementary foods did not differ between food-secure and food-insecure households. About one in five children in the sample received diets of the age-appropriate minimum diversity, a little over half were fed at the appropriate frequency for their age, and only 13% were fed the minimum acceptable diet for their age as required by WHO. More children from food-secure households than children from food-insecure households were given a diet of the recommended diversity, were fed at the recommended frequency, and were given the minimum acceptable diet ($p < .05$) (**table 3**).

Household food insecurity and anthropometric measurements of children

The mean HAZ, WAZ, and WHZ were all negative, suggesting a generally poor nutritional status of the children in the study (**table 4**). The mean HAZ and WAZ were lower for children from food-insecure households than for children from food-secure households ($p < .05$). However, the mean WHZ was similar between the two groups. The overall prevalence of stunting, underweight and wasting among children were 41.4%, 24.2% and 9.2% respectively. The prevalence rates of stunting and underweight were slightly higher among children from food-insecure than among children from food-secure households. However, only the difference in prevalence of stunting approached significance ($p = .07$). The prevalence of wasting among

TABLE 4. Stunting, wasting, and overweight among children aged 6 to 23 months from food-secure and food-insecure households[a]

Indicator	All children ($n = 368$)	Food-secure ($n = 114$)	Food-insecure ($n = 254$)
Anthropometry			
Height-for-age z-score	–1.76 ± 1.11	–1.56 ± 1.24	–1.84 ± 1.03*
% < –2 to ≥ –3 (moderate)	31.3	24.6	34.4
% < –3 (severe)	10.1	9.6	10.3
Weight-for-height z-score	–0.65 ± 1.06	–0.56 ± 1.03	–0.69 ± 1.07
% < –2 to ≥ –3 (moderate)	7.3	5.3	8.3
% < –3 (severe)	1.9	1.8	2.0
Weight-for-age z-score	–1.39 ± 1.01	–1.22 ± 1.03	–1.46 ± 1.00*
% < –2 to ≥ –3 (moderate)	19.0	13.2	21.7
% < –3 (severe)	5.2	6.1	4.7
Biochemical indicators ($n = 366$)			
Hemoglobin (g/dl)	10.7 ± 1.5	10.6 ± 1.5	10.7 ± 1.4
% < 110 g/L (anemia)	57.8	57.9	57.7

a. Values are means ± SD or percentages.
*$p < .05$ for the difference between food-insecure and food-secure households, independent-samples *t*-test.

children also did not differ significantly between food-insecure and food-secure households (**table 4**).

In the multivariate analysis, household food insecurity was not associated with stunting or underweight among children (**table 5**). However, being stunted or underweight was significantly associated with the height of the child's mother, as well as with being in the lowest tercile of the household wealth index. As expected, children of taller mothers were less likely to be stunted or underweight than children of shorter mothers ($p < .05$). Children from households in the lower third of the wealth index were at higher risk for being stunted or underweight than children in the upper third. Stunting was also associated with age of the child and early initiation of breastfeeding by mothers, such that older children were less likely to be stunted and initiation of breastfeeding within 1 hour of delivery was associated with stunting ($p < .05$). Children whose mothers had some formal education were less likely to be underweight than children whose mothers had no formal education ($p < .05$).

Household food insecurity and anemia among children

Anemia affected 57.8% of the children, with a similar prevalence among children from food-secure and food-insecure households (**table 4**). In the multivariate analysis, only child's age, child's caste, and mother's hemoglobin concentration were significantly associated with anemia (**table 6**). Anemia was inversely related to the child's age, and children from upper-caste families were more likely to be anemic than children from lower-caste families ($p < .05$). Children whose mothers

TABLE 5. Multiple logistic regression models of the associations between household food insecurity and anthropometric indices of children[a]

	Dependent variables — odds ratio (95% CI)			
	Stunting (HAZ < – 2)		Underweight (WAZ < – 2)	
Independent variable[b]	Full	Parsimonious	Full	Parsimonious
Household food insecurity: 0 = No[c], 1 = Yes	0.99 (0.55–1.79)		0.96 (0.49–1.88)	
Age of child (mo)	1.36 (1.01–1.84)*	1.12 (1.07–1.17)*	1.19 (0.86–1.67)	
Age of child squared	0.99 (0.98–1.00)		1.00 (0.99–1.01)	
Sex of child: 0 = Female[c], 1 = Male	1.31 (0.81–2.11)		0.99 (0.58–1.69)	
Caste of child: 0 = Lower[c], 1 = Upper	1.00 (0.59–1.71)		1.32 (0.73–2.41)	
Age of mother (yr)	1.02 (0.97–1.07)		1.04 (0.99–1.10)	
Education of mother: 0 = No education[c], 1 = Some education	1.07 (0.60–1.88)		0.50 (0.25–0.99)*	0.41 (2.23–0.75)*
Height of mother (cm)	0.92 (0.89–0.96)*	0.93 (0.89–0.97)*	0.94 (0.90–0.98)*	0.93 (0.89–0.97)*
Breastfeeding within 1 h of delivery: 0 = No[c], 1 = Yes	1.76 (1.03–3.02)*	1.88 (1.12–3.16)*	0.95 (0.53–1.70)	
Given prelacteals: 0 = No[c], 1 = Yes	0.71 (0.34–1.49)		1.01 (0.43–2.36)	
Growth monitoring: 0 = No[c], 1 = Yes	1.40 (0.83–2.38)		1.09 (0.60–1.96)	
Complete DPT immunizations: 0 = No[c], 1 = Yes	1.03 (0.60–1.77)		0.87 (0.47–1.63)	
Sex of household head: 0 = Female[c], 1 = Male	0.84 (0.45–1.56)		1.22 (0.59–2.51)	
Wealth index				
0 = Lower tercile	2.21 (1.10–4.44)*	2.16 (1.16–3.99)*	2.50 (1.13–5.69)*	2.28 (1.14–4.54)*
1 = Middle tercile	1.59 (0.83–2.83)	1.52 (0.86–2.70)	2.02 (0.97–4.21)	1.82 (0.94–3.55)
2 = Upper tercile[c]	1	1	1	1
N	359	360	360	368

HAZ, length-for-age z-score; WAZ, weight-for-age z-score

a. All models accounted for clustering using dummy variables that identify each village (or ward) in the study.

b. Variables are either categorical or continuous.

c. Reference category of the categorical variables.

*Different from reference category ($p < .05$).

had higher hemoglobin concentrations were less likely to be anemic than children of mothers with lower hemoglobin concentrations ($p < .05$).

Discussion

Main findings

Household food insecurity and anthropometry of children

This study showed a high prevalence of both household food insecurity and malnutrition among children 6 to 23 months of age in Kailali District of Nepal. To our knowledge, this is the first study to assess household food insecurity in Nepal using a set of questions similar to the questions on the HFIAS tool, and it is also one of the few studies to assess the relationship between household food insecurity and nutritional status of children aged 6 to 23 months in developing countries. Our main finding was that household food insecurity was not associated with stunting and underweight among children aged 6 to 23 months in Kailali District of Nepal. This finding is consistent with the results of some of the studies that tested a similar hypothesis in other countries [13–16]. The high proportion of stunting and underweight and the low proportion of mothers giving the minimum acceptable diet to children in our sample indicate that chronic malnutrition and inadequate IYCF practices (especially those related to optimal breastfeeding, dietary quality, and meal frequency) are important problems for children in our study district. The prevalence of wasting was also in the range classified as poor by WHO, indicative of a problem of acute malnutrition [29].

Considering that Kailali is located in one of the underprivileged and underdeveloped areas of Nepal, the high rates of household food insecurity and childhood malnutrition reported by our study are not surprising. However, the lack of significant association between household food insecurity and malnutrition

TABLE 6. Multiple logistic regression models for the associations between household food insecurity and anemia among children[a]

	Anemia (hemoglobin < 110 g/L)	
Independent variable[b]	Full	Parsimonious
Household food insecurity: 0 = No[c], 1 = Yes	1.12 (0.63–1.99)	
Age of child (mo)	0.90 (0.85–0.94)*	0.91 (0.86–0.95)*
Sex of child: 0 = Female[c], 1= Male	1.19 (0.73–1.95)	
Caste of child: 0 = Lower[c], 1 = Upper	1.89 (1.11–3.22)*	2.08 (1.27–3.41)*
Age of mother (yr)	0.99 (0.94–1.04)	
Education of mother: 0 = No education[c], 1 = Some education	0.70 (0.39–1.23)	
Height of mother (cm)	0.98 (0.94–1.02)	
Hemoglobin level of mother (g/L)	0.71 (0.60–0.85)*	0.73 (0.61–0.86)*
Breastfeeding within 1 h of delivery: 0 = No[c], 1 = Yes	1.42 (0.84–2.40)	
Given prelacteals: 0 = No[c], 1 = Yes	1.08 (0.53–2.23)	
Growth monitoring: 0 = No[c], 1 = Yes	1.05 (0.62–1.78)	
Complete DPT immunizations: 0 = No[c], 1 = Yes	0.58 (0.34–1.00)	
Sex of household head: 0 = Female[c], 1 = Male	1.58 (0.84–3.00)	
Wealth index		
0 = Lower tercile	0.89 (0.44–1.80)	
1 = Middle tercile	0.80 (0.43–1.48)	
2 = Upper tercile[c]	1	
N	359	367

a. All models accounted for clustering using dummy variables that identify each village (or ward) in the study.
b. Variables are either categorical or continuous.
c. Reference category of the categorical variables.
*Different from reference category ($p < .05$).

in our study children was not expected, because of the substantial evidence that a household's access to food is among the key determinants of the nutritional status of children [20]. However, whereas household food security may be a necessary prerequisite for good nutrition outcomes, it is insufficient on its own. In line with our analytical pathways, many studies suggest that the influence of food availability and access on the nutritional status of children can be confounded by other key determinants of child nutrition, such as maternal knowledge of nutrition and healthcare practices, maternal nutritional status, intrahousehold food allocation and utilization, access to health services, and healthful environmental conditions such as good hygiene and sanitation [20, 25, 30–32]. Our results suggest poor complementary feeding practices throughout our study district, with only 10% of children receiving the minimum acceptable diet for their age, as defined by WHO. A household's access to food may partly explain this, because more children in food-secure households than children in food-insecure households were given the minimum acceptable diet (24% vs. 8.3%, $p < .05$). In addition, over 60% of all the mothers surveyed reported an inability to feed their children nutritious foods such as eggs and meat because they could not afford them (**table 3**). Education and knowledge of mothers with respect to optimal nutrition practices appears to be a critical factor, because in our sample fewer mothers with no formal education fed the minimum acceptable diet to their children than mothers with some formal education (8.4% vs. 21.7%, $p < .05$). The difference was even greater when we conducted a subgroup analysis involving only food-secure households (12.9% vs. 36.5%, $p < .05$). This suggests that household food security is important for improved dietary intake of children; however, this alone may not have been enough to influence the nutritional status of the children. The findings of associations between short maternal height and child stunting or underweight, and low maternal education and child underweight, are consistent with the results of many other studies [30, 33]. Therefore, recognition must be given to the important role that maternal education and maternal nutritional status have in any future efforts to improve child nutrition in the district.

Other studies have reported that household-level poverty rather than food insecurity is predictive of malnutrition among children [15]. Although our study did not measure poverty, the significant associations between household wealth index and child stunting and underweight suggest that poverty may be a major determining factor of the nutritional status of children aged 6 to 23 months in Kailali District of Nepal. As this was a secondary analysis of data collected for other purposes, the absence of significant differences in malnutrition among children from food-secure and food-insecure households might also be due to the relatively small sample size used in this study and thus the potential lack of adequate power to detect a significant difference if one exists (type 2 error).

Household food insecurity and anemia

Anemia was common and remains an important public health problem among children aged 6 to 23 months in the study district. The prevalence of anemia in our sample (57.8%) was above the WHO threshold of 40% that indicates a very high public health concern [26]. However, the observed prevalence of anemia in this study was lower than that reported for children of similar age (> 70%) by the recent demographic and health survey [3] and other studies in the *terai* region of Nepal [34]. Anemia among children aged 6 to 23 months was also not associated with household food insecurity in our sample. This is probably due to many of the same reasons outlined above for lack of association between household food insecurity and anthropometric indicators in this population. The inverse association between maternal hemoglobin concentration and anemia has been reported in other studies in Nepal [34] and emphasizes the importance of adequate maternal nutrition for improved nutrition status of children.

Other findings

In the present study, older children were less likely to be anemic than younger children. In contrast, a study in south-central Nepal found a positive association between age and anemia among children 4 to 17 months of age [34]. Increase in age was associated with increased diversity of foods given to the children and reduced infection in our sample (data not shown). Therefore, it is very likely that increased dietary diversity and reduction in infections contributed to the low rate of anemia in older children. In Nepal, there is also a national strategy of providing deworming medication to children aged 12 to 59 months. This program may have contributed to a lower prevalence of intestinal worms and therefore decreased the prevalence of anemia in older children, because 70% of the children over 12 months of age in our study had received deworming treatment in the 6 months prior to the survey (**table 3**). Since iron deficiency is the main cause of anemia among children in most populations, another potential explanation is the decreasing iron requirement per kilogram of body weight with increasing age of children [35].

Children from upper-caste families had a greater risk of being anemic than children from lower-caste families. Again, this is contrary to what was observed in other studies in Nepal [34]. We believe that differences in dietary iron consumption may partly explain the differences in anemia prevalence among children from upper- and lower-caste families in our study district. Upper-caste families in Kailali District are

mainly Brahmin and Cheteri, who are predominantly vegetarian and therefore have limited consumption of animal-source foods, which are rich in heme iron and other micronutrients, whereas lower-caste families in this area (Tharu, Mongolian, and others) are not vegetarian.

The positive association between early initiation of breastfeeding and stunting in our sample was quite surprising and inexplicable. This might be due to recall bias, since mothers had to recall information on initiation of breastfeeding 6 to 24 months after delivery.

The significant inverse associations found in this study between household food insecurity and ownership of most items measuring the socioeconomic status of the households (**table 1**) are consistent with the findings from other studies in different countries [36, 37] and provide some evidence that the questions used as a proxy for the HFIAS tool in this study were effective in assessing household food insecurity in Kailali District. This is further strengthened by the positive association between the household food insecurity variable and the frequency and composition of complementary feeding in our sample (**table 3**), a finding that is consistent with a study among preschoolchildren in Bangladesh [38].

Overall, our results suggest that improving only household food insecurity may be necessary but not sufficient to improve the nutritional status of children 6 to 23 months of age. An integrated strategy that improves the overall socioeconomic well-being of families, maternal education, and knowledge of improved IYCF practices and also ensures optimal maternal nutrition will probably be more effective in improving child nutritional status. Although not adequately assessed by our study, improved hygiene and sanitation practices should also be encouraged by such nutrition strategy.

Several limitations of the study are worth mentioning and need to be considered in future studies. Because we conducted a secondary data analysis, our dataset lacked many of the important variables that could have been used in our models to fully understand the relationship between household food insecurity and malnutrition in children. In addition, our analysis was based on cross-sectional data that were collected during one season of the year, whereas data capturing seasonal trends are needed to fully understand the relationship between childhood nutrition and household food insecurity. The cross-sectional nature of the data also limits our ability to draw any causal conclusions. Recall bias was also possible and may explain the high prevalence of household food insecurity. Despite these limitations, our results provide important contributions to the limited data available on the association between household food insecurity and the nutritional status of children aged 6 to 23 months in developing countries.

Conclusions

Household food insecurity and the prevalence rates of stunting, underweight, wasting, and anemia among children 6 to 23 months in our study district were high. However, there was no significant association between household food insecurity and measures of undernutrition among children in this age group. On the other hand, lower household socioeconomic status was associated with both household food insecurity and childhood stunting, underweight, and anemia. Maternal education, height, and hemoglobin concentration were inversely related to young child nutritional status indicators such as stunting, underweight, and anemia. Thus, improving only household food security may be necessary but not sufficient to improve the nutritional status of young children. An integrated strategy that improves the overall socioeconomic well-being of families, maternal education, and knowledge of improved IYCF practices and ensures optimal maternal nutrition will probably be more effective in improving the nutritional status of children aged 6 to 23 months.

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