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ORIGINAL PAPER

Population-Based Study of Food Insecurity and HIV Transmission Risk Behaviors and Symptoms of Sexually Transmitted Infections Among Linked Couples in Nepal

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Abstract Food insecurity has recently emerged as an important risk factor for HIV acquisition among women worldwide. No previous studies have used linked data that would permit investigation of the extent to which food insecurity may have differential associations with HIV transmission risk behaviors or symptoms of sexually transmitted infections (STIs) among men and women in the same households. We used nationally representative data on linked couples from the Nepal 2011 Demographic and Health Survey. The primary explanatory variable of interest was food insecurity, measured with a modified version of the Household Food Insecurity Access Scale. In multivariable logistic regression models, women in food insecure households were less likely to report recent condom use and more likely to report symptoms consistent with STIs. These patterns were absent among men. Interventions targeting food insecurity may have beneficial implications for both HIV prevention and gender equity in Nepal.

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Introduction

Food insecurity has recently been identified as an important risk factor for HIV acquisition among women worldwide [1–8]. Conceptually, these elevated risks have been interpreted as resulting from a process through which women's coping responses to food insecurity place them at greater risk for being sexually exploited by men [8, 9]. Food insecurity may exert disempowering effects, especially in the context of economically motivated relationships, that vary along a continuum of severity, from undermining women's ability to negotiate for condom use with partners upon whom they may be economically dependent [10] to unduly influencing decisions to engage in transactional sex and/or enter commercial sex work [11–14].

While food insecurity is related to poverty, in many different contexts these have been shown to be distinct constructs with different causes and consequences [8]. Persons living in poverty, for example, may be food secure if they are able to grow food for household consumption. Conversely, women in relatively wealthy households may remain food insecure if they are systematically disfavored in the allocation of food within the household. Such intra-household inequalities have been described in numerous contexts [15–18], including Nepal [19, 20]. Thus, even in analyses that adjust for economic status or other measures of household wealth that may also be correlated with HIV risk [21–24] a strong association between food insecurity and HIV risk has been observed.

Among the few studies in this literature that have evaluated food insecurity and HIV risk among both men and women, two studies from sub-Saharan Africa showed

that single-item measures of food insufficiency were associated with HIV transmission risk behaviors among women but not men [1, 4]. However, Kalichman et al. [6] showed that food insufficiency was associated with transactional sex among both men and women (and with unprotected sexual intercourse among women but not men) in South Africa. Similarly, a more recent study of HIV-infected, homeless and marginally housed men and women in the U.S. found that food insecurity was associated with inconsistent condom use and multiple concurrent partnerships among both men and women [25]. It is unclear whether these recent findings are consistent with the dominant paradigm of disempowerment and exploitation. Sexual exploitation of *men* by women is understood as a very different process [26, 27], and in most contexts, men are not economically marginalized vis-à-vis women.

Nepal provides a unique and compelling context in which to investigate the relationship between food insecurity and HIV risk factors. While the overall prevalence of HIV in the reproductive-age population in Nepal is estimated to be less than one percent [28], over the past decade, the HIV epidemic has been concentrated in high-risk groups such as commercial sex workers, migrants, men who have sex with men, and persons who inject drugs [29, 30]. Recently it has been suggested that the epidemic is beginning to expand out of high-risk groups [28, 31, 32]. Specifically, migrants may act as a "bridge" [33, 34] between commercial sex workers in neighboring regions and their spouses or primary partners at home. Nepal is also one of the poorest countries in the world, and food insecurity is highly prevalent [35]. Data from the most recent national household survey showed that more than one-half of households in Nepal were food insecure and that food insecurity was particularly prevalent in rural areas and in the hill districts of the midwestern region [36]. In this setting, we used nationally representative data on married or cohabiting couples to study the intertwined relationships between food insecurity and HIV transmission risk behaviors and symptoms of sexually transmitted infections (STIs).

Methods

Data Source

The data for this study were drawn from the 2011 Nepal DHS, a national study implemented by New ERA, a local research firm, under the auspices of the Population Division, Ministry of Health and Population of the Government of Nepal and with technical assistance from ICF International. The 2011 Nepal DHS employed a stratified, two-stage cluster design and was designed to yield nationally representative estimates for women of reproductive age (i.e., 15–49 years). A separate module was administered to men in every second household. The overall response rate among women was 97.6 %, and the response rate among men was 94.7 %. For the specific analysis presented in this manuscript, we used data on 2,322 linked couples.

Measures

The primary outcomes of interest were HIV transmission risk behaviors and symptoms of STIs: (a) recent condom use, defined as using a condom with the most recent sexual partner; (b) consistent condom use, defined as using a condom at each occasion of sexual intercourse with the most recent sexual partner during the previous 12 months; and (c) self-report of an abnormal genital discharge or genital sore/ulcer within the previous 12 months.

The primary explanatory variable of interest was household food insecurity. This was measured with a modified version of the Household Food Insecurity Access Scale (HFIAS), which was administered to the head of the household, with a reference period of assessment extended to 12 months to allow for seasonal variations. The HFIAS is an experience-based measure of food insecurity that measures multiple domains of the food insecurity experience, including anxiety and uncertainty about food supply, insufficient quality, and insufficient food intake and its physical consequences [37]. It has been shown to represent apparently universal domains of the household food insecurity access experience and to distinguish between food secure and food insecure households across different cultural contexts [37]. The recommended HFIAS algorithm assigns households to one of four categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure. The original nine-item HFIAS was modified by the DHS team by dropping two items ("Did you or any household member eat food that you preferred not to eat because of a lack of resources to obtain other types of food?" and "Did you or any household member go a whole day without eating anything because there was not enough food?") that were similar to two of the other seven questions retained in the scale (Table 5 in Appendix). A shortened version of the HFIAS has shown to have good reliability and construct validity in Nepal [38].

The 3-item Household Hunger Scale, which consists of the 3 HFIAS items specifically related to extreme manifestations of hunger, has been shown to have the highest potential for cross-cultural reliability and validity [39]. We could not construct this measure given the data, but as a sensitivity analysis we created an *ad hoc* hunger scale by adding the two available items about hunger ("How often was there no food to eat of any kind in your household because of lack of resources to get food?" and "How often

did you or any household member go to sleep at night hungry because there was not enough food?"). We then substituted this variable for the HFIAS in the regression models.

The following individual-level variables, previously investigated in this literature, were considered as potential confounders: age [1, 6], ethnic/caste group membership (Brahmin/Chhetri, Newar, Dalit, Janajati, or other) [4–6], household headship [7], and educational attainment (none, primary, secondary, or greater than secondary) [1, 4]. We also adjusted for two measures of economic status: professional occupation (whether the participant worked outside the home and in an occupation that was categorized as professional, technical, managerial, clerical or sales), which was measured at the individual level; and quintiles of household asset wealth [4, 5], which was measured at the household level.

Statistical Analysis

To estimate concordance between partners in their reporting about condom use, we estimated the kappa statistic and its 95 % confidence interval. To estimate the relationship between food insecurity and HIV transmission risk behaviors and symptoms of STIs, we fitted a series of multivariable logistic regression models to the data, stratified by gender, with food insecurity as the primary exposure of interest. The covariates described above were included in the regression models as potential confounders. We conducted two sensitivity analyses. First, to assess the extent to which differential patterning of associations might be observed among women with migrant husbands versus women with non-migrant husbands, we re-fitted the regression models for women stratified by the husband's migrant status. Second, to ensure that our findings were generalizable to all women (and not just women with linked partners), we re-fitted the regression models to the dataset of all sexually active women.

Stata software (version 12.0, StataCorp L.P., College Station, TX, USA) was utilized for all analyses. With the exception of the analyses about concordance in condom use reporting, all point estimates and variance estimates were obtained by using the survey weights and clustering variables provided by ICF Macro. Additional inclusion of regional fixed effects changed the estimates little. For the purposes of illustration, we calculated predictive margins (i.e., predicted probabilities of the outcomes adjusted for covariates) for each category of the HFIAS [40].

Ethical Review

The data collection procedures for the 2011 Nepal Demographic and Health Survey were approved by ICF Macro Institutional Review Board and the Nepal Health Research Council. All participants provided oral informed consent. Additional details on staff training, pretesting, and other survey procedures are detailed in the Nepal DHS final report [36]. The specific analysis of the Nepal DHS data presented in this paper was reviewed by the Partners Human Research Committee and deemed exempt from full review because it was based on anonymous, public-use data with no identifiable information on participants.

Results

Data on 2,322 linked couples were provided. Food insecurity was common among households. The weighted prevalence of food secure households was 50.7 % nationally, whereas 13.0 % of households were mildly food insecure, 19.9 % were moderately food insecure, and 16.4 % were severely food insecure. The most highly prevalent components of the HFIAS had to do with anxiety/uncertainty about food and limitations in the varieties of food consumed (Table 5 in Appendix). Characteristics of the men and women are displayed in Table 1. The majority of participants belonged to the Brahmin/Chhetri and Janajati ethnic/caste groups. A higher proportion of men were household heads, had a professional occupation, or had attained a higher level of education. Men reported being away from home an average of 6.1 times in the

Table 1 Summary statistics of linked couples in the 2011 Nepal Demographic and Health Survey ($N = 2{,}322$)

	Mean or percentage (95 % CI)[a]	
	Women	Men
Age (years)	30.9 (30.4–31.4)	34.7 (34.2–35.1)
Ethnicity (%)		
Brahmin/Chhetri	33.4 (29.7–37.2)	33.5 (29.6–37.3)
Newar	4.4 (2.7–6.1)	4.5 (2.7–6.3)
Dalit	14.8 (11.2–18.4)	14.0 (10.8–17.3)
Janajati	35.4 (30.7–40.2)	36.3 (31.5–41.0)
Other	11.9 (0.82–15.5)	11.7 (8.2–15.3)
Household head (%)	2.0 (1.2–2.7)	68.8 (66.5–71.1)
Educational attainment (%)		
None	47.3 (43.6–51.1)	19.7 (16.3–23.1)
Primary	18.3 (16.2–20.4)	25.1 (22.5–27.7)
Secondary	28.1 (25.3–30.8)	42.7 (39.6–45.8)
Higher	6.3 (4.8–7.7)	12.5 (10.3–14.8)
Professional occupation (%)	3.3 (2.4–4.2)	12.7 (11.0–14.5)
Times away from home in past 12 months		6.1 (5.4–6.7)

[a] All point estimates and variance estimates obtained by using the survey weights and clustering variables provided by ICF Macro

Table 2 Multivariable-adjusted estimates of relationships between food insecurity and HIV risk factors and transmission risk behaviors among partnered women in the 2011 Nepal Demographic and Health Survey ($N = 2,322$)

	Adjusted OR (95 % CI)[a]			
	Condom use at last sexual intercourse	Consistent condom use, past 12 months	Abnormal genital discharge, past 12 months	Vaginal sore or ulcer, past 12 months
Household food insecurity				
Food secure	Ref	Ref	Ref	Ref
Mildly food insecure	1.23 (0.71–2.15)	1.32 (0.70–2.50)	**1.67 (1.07–2.60)**	**3.09 (1.41–6.75)**
Moderately food insecure	0.81 (0.46–1.44)	0.85 (0.45–1.61)	**2.10 (1.40–3.16)**	**2.62 (1.19–5.78)**
Severely food insecure	**0.38 (0.16–0.90)**	0.40 (0.14–1.13)	1.43 (0.92–2.22)	1.61 (0.53–4.93)
Household asset wealth				
Most poor	Ref	Ref	Ref	Ref
Very poor	1.84 (0.89–3.78)	1.42 (0.68–2.97)	0.77 (0.47–1.27)	0.74 (0.30–1.91)
Poor	1.98 (0.91–4.33)	1.47 (0.60–3.60)	0.89 (0.51–1.55)	0.95 (0.37–2.62)
Less poor	2.20 (0.98–4.93)	1.59 (0.66–3.82)	0.95 (0.54–1.68)	1.20 (0.45–3.38)
Least poor	**5.35 (2.32–12.3)**	**3.79 (1.52–9.45)**	0.89 (0.50–1.60)	0.84 (0.27–2.67)
Age (per 5 years)	**0.76 (0.67–0.86)**	0.86 (0.74–1.01)	1.04 (0.94–1.14)	**1.35 (1.10–1.65)**
Ethnicity				
Brahmin/Chhetri	Ref	Ref	Ref	Ref
Newar	1.24 (0.61–2.53)	1.32 (0.56–3.10)	1.63 (0.81–3.29)	**2.45 (1.03–5.84)**
Dalit	**0.42 (0.19–0.93)**	0.54 (0.20–1.46)	0.99 (0.59–1.68)	0.59 (0.20–1.75)
Janajati	1.06 (0.68–1.65)	0.92 (0.53–1.59)	0.80 (0.56–1.17)	0.68 (0.34–1.35)
Other	0.50 (0.22–1.16)	0.39 (0.11–1.33)	0.77 (0.36–1.65)	1.09 (0.37–3.22)
Household head (%)	1.09 (0.22–5.38)	0.94 (0.10–8.44)	0.96 (0.28–3.34)	1.07 (0.18–6.40)
Educational attainment (%)				
None	Ref	Ref	Ref	Ref
Primary	0.89 (0.51–1.56)	0.84 (0.40–1.77)	0.92 (0.62–1.39)	1.55 (0.68–3.53)
Secondary	**1.62 (1.01–2.61)**	**1.88 (1.02–3.46)**	1.45 (0.93–2.25)	0.96 (0.33–2.76)
Higher	1.92 (0.94–3.95)	2.17 (0.93–5.06)	1.27 (0.56–2.87)	2.74 (0.75–10.1)
Professional occupation (%)	1.15 (0.53–2.50)	1.53 (0.67–3.52)	1.74 (0.80–3.77)	0.12 (0.01–1.04)

Boldface text indicates statistical significance at $P < 0.05$ or greater

[a] Based on multivariable logistic regression models, with all point estimates and variance estimates obtained by using the survey weights and clustering variables provided by ICF Macro

previous 12 months [95 % confidence interval (CI) 5.4–6.7], and 21.1 % stated that they had been away from home for an extended period of time (>1 month) in the previous 12 months (95 % CI 18.6–24.0).

Among women, 7.3 % reported condom use at last sexual intercourse (95 % CI 5.9–8.7). With a 12-month recall period, 5.1 % reported consistent condom use with the most recent sexual partner (95 % CI 3.9–6.3). The consistency of condom use reporting between men and women was variable. There were 167 couples in which reporting about recent condom use was discordant (κ 0.61; 95 % CI 0.55–0.66). For consistent condom use there were 146 couples in which reporting about consistent condom use was discordant (κ 0.47; 95 % CI 0.40–0.54). With a 12-month recall period, 12.6 % of women reported an abnormal vaginal discharge (95 % CI 10.8–14.3), and 2.7 % reported a vaginal ulcer or sore (95 % CI 2.0–3.5).

In bivariate analyses, women in severely food insecure households were less likely to report recent condom use [odds ratio (OR) 0.16; 95 % CI 0.07–0.39] and consistent condom use (OR, 0.17; 95 % CI 0.06–0.47) (Table 6 in Appendix). The other outcomes also had statistically significant bivariate associations with food insecurity categories of lesser severity. After multivariable adjustment, food insecurity retained statistically significant associations with the outcomes (Table 2). Only severe food insecurity was associated with a reduced odds of recent condom use [adjusted OR (AOR), 0.38; 95 % CI 0.16–0.90] and consistent condom use (AOR, 0.40; 95 % CI 0.14–1.13), although the latter estimate was not statistically significant.

Table 3 Multivariable-adjusted estimates of relationships between food insecurity and HIV risk factors and transmission risk behaviors among partnered women in the 2011 Nepal Demographic and Health Survey, stratified by husband migrant status ($N = 2,322$)

	Adjusted OR (95 % CI)[a]			
	Condom use at last sexual intercourse	Consistent condom use, past 12 months	Abnormal vaginal discharge, past 12 months	Vaginal sore or ulcer, past 12 months
Women with migrant husbands				
Household food insecurity				
Food secure	Ref	Ref	Ref	Ref
Mildly food insecure	1.17 (0.55, 2.49)	1.47 (0.66, 3.30)	**2.05 (1.22, 3.44)**	**6.22 (2.50, 15.5)**
Moderately food insecure	1.07 (0.54, 2.10)	1.04 (0.49, 2.22)	**2.01 (1.24, 3.25)**	**4.31 (1.71, 10.8)**
Severely food insecure	0.38 (0.14, 1.03)	0.36 (0.10, 1.27)	**1.70 (1.05, 2.75)**	2.29 (0.62, 8.52)
Women with non-migrant husbands				
Household food insecurity				
Food secure	Ref	Ref	Ref	Ref
Mildly food insecure	1.26 (0.51, 3.14)	0.98 (0.34, 3.85)	0.85 (0.34, 2.15)	0.27 (0.03, 2.16)
Moderately food insecure	0.35 (0.11, 1.09)	0.56 (0.14, 2.15)	2.30 (0.96, 5.50)	0.91 (0.25, 3.30)
Severely food insecure	0.38 (0.08, 1.81)	0.57 (0.09–3.84)	0.65 (0.22, 1.91)	0.67 (0.12, 3.79)

Boldface text indicates statistical significance at $P < 0.05$ or greater

[a] Based on multivariable logistic regression models and adjusted for household asset wealth, age, ethnicity, household headship, educational attainment, and professional occupation; all point estimates and variance estimates obtained by using the survey weights and clustering variables provided by ICF Macro

In contrast, even food insecurity categories of lesser severity had statistically significant associations with self-reported abnormal vaginal discharge and vaginal sore or ulcer. These estimated associations were large in magnitude. For example, the predicted probability of recent condom use was 7.8 % among women in food secure households (95 % CI 6.2–9.5) and 3.3 % among women in severely food insecure households (95 % CI 0.8–5.9), a decline of more than five percentage points in absolute terms and 58 % in relative terms. When these regression models were estimated separately for women with migrant husbands versus women with non-migrant husbands, the magnitudes of the estimated associations were larger among women with migrant husbands (Table 3).

In the sensitivity analysis using the two-item hunger scale as the explanatory variable, each additional point on the hunger scale was associated with a reduced odds of recent condom use (AOR = 0.60; 95 % CI 0.41–0.90) but was not associated with consistent condom use (AOR = 0.63; 95 % CI 0.38–1.04) or the other HIV risk factor outcome variables. When the regression models were re-fitted to the entire dataset of sexually active women, severe food insecurity was associated with a reduced odds of both recent condom use (AOR = 0.36; 95 % CI 0.20–0.66) and consistent condom use (AOR = 0.42; 95 % CI 0.21–0.84).

Among men, 10.7 % reported recent condom use (95 % CI 8.9–12.4), 6.0 % reported consistent condom use (95 % CI 4.6–7.5), 0.9 % reported penile discharge (95 % CI 0.4–1.4), and 2.0 % reported a penile sore (95 % CI 1.3–2.7). In bivariate analyses, moderate and severe food insecurity were associated with a reduced odds of recent condom use but not with any of the other outcomes (Table 7 in Appendix). After multivariable adjustment, none of the food insecurity categories had a statistically significant association with any of the outcomes (Table 4). In the sensitivity analysis, the two-item hunger scale did not have a statistically significant correlation with any of the outcomes among men.

Discussion

Using nationally representative data on 2,322 linked couples in Nepal, we found that women in food insecure households were less likely to report condom use and more likely to report symptoms consistent with STIs. These associations were stronger among women with migrant partners. These patterns were absent among the men. This study has substantive implications for HIV and STI prevention in Nepal, a country where food insecurity is highly prevalent.

Our primary finding about the close relationship between food insecurity and HIV transmission risk behaviors and symptoms of STIs among women in Nepal is consistent with prior studies in different contexts based on qualitative interviews [2], single-item measures of hunger or food insufficiency [1, 3, 4], and multi-item food insecurity scales that have demonstrated good reliability and validity [5–7, 25]. The presumed narrative linking these findings is one of gendered patterning in economic marginalization, disempowerment, and exploitation

Table 4 Multivariable-adjusted estimates of relationships between food insecurity and HIV risk factors and transmission risk behaviors among partnered men in the 2011 Nepal Demographic and Health Survey ($N = 2,322$)

	Adjusted OR (95 % CI)[a]			
	Condom use at last sexual intercourse	Consistent condom use, past 12 months	Abnormal penile discharge, past 12 months	Penile sore or ulcer, past 12 months
Household food insecurity				
Food secure	Ref	Ref	Ref	Ref
Mildly food insecure	1.38 (0.84–2.25)	1.07 (0.58–1.97)	1.89 (0.45–7.86)	2.00 (0.83–4.79)
Moderately food insecure	0.85 (0.56–1.29)	0.55 (0.30–1.01)	0.47 (0.06–3.63)	0.63 (0.23–1.72)
Severely food insecure	0.79 (0.43–1.47)	0.65 (0.28–1.48)	2.59 (0.85–7.91)	2.06 (0.79–5.40)
Household asset wealth				
Most poor	Ref	Ref	Ref	Ref
Very poor	0.59 (0.33–1.05)	1.01 (0.47–2.14)	2.87 (0.18–44.7)	1.29 (0.41–4.08)
Poor	0.86 (0.48–1.56)	0.98 (0.42–2.28)	4.85 (0.58–40.6)	0.98 (0.32–2.99)
Less poor	0.78 (0.43–1.42)	0.86 (0.40–1.89)	3.61 (0.35–37.6)	1.17 (0.32–4.28)
Least poor	**1.76 (1.03–3.01)**	2.02 (0.97–4.22)	5.97 (0.65–54.6)	1.21 (0.31–4.72)
Age (5 years)	**0.84 (0.74–0.95)**	0.87 (0.75–1.02)	0.81 (0.57–1.17)	0.94 (0.69–1.26)
Ethnicity				
Brahmin/Chhetri	Ref	Ref	Ref	Ref
Newar	1.33 (0.73–2.42)	1.07 (0.50–2.30)	3.45 (0.53–22.5)	1.19 (0.29–4.94)
Dalit	0.36 (0.17–0.74)	0.38 (0.14–1.03)	1.43 (0.22–9.44)	1.93 (0.71–5.26)
Janajati	0.97 (0.65–1.44)	0.88 (0.50–1.52)	1.14 (0.27–4.81)	0.89 (0.37–2.15)
Other	**0.31 (0.13–0.70)**	**0.30 (0.11–0.80)**	1.85 (0.35–9.70)	**0.49 (0.08–2.99)**
Household head (%)	**0.60 (0.43–0.85)**	0.79 (0.52–1.21)	0.57 (0.26–1.25)	0.79 (0.39–1.49)
Educational attainment (%)				
None	Ref	Ref	Ref	Ref
Primary	0.63 (0.31–1.28)	0.50 (0.21–1.16)	0.61 (0.07–5.01)	0.87 (0.29–2.63)
Secondary	1.12 (0.63–1.99)	0.92 (0.45–1.87)	1.83 (0.31–10.7)	1.09 (0.32–3.66)
Higher	1.60 (0.84–3.02)	1.39 (0.63–3.08)	1.65 (0.21–13.1)	1.65 (0.34–7.92)
Professional occupation (%)	1.33 (0.90–1.97)	1.04 (0.62–1.75)	1.09 (0.18–6.72)	1.44 (0.45–4.61)

Boldface text indicates statistical significance at $P < 0.05$ or greater

[a] Based on multivariable logistic regression models, with all point estimates and variance estimates obtained by using the survey weights and clustering variables provided by ICF Macro

resulting from food insecurity [41–43]. Specifically, previous studies have reported that food insecure women in relationships did not feel empowered to insist on condom use with primary partners when they were dependent on their partners for food and other resources [2]. Other studies have found that food insecure women were more likely to exchange food and other resources for sex and to have multiple concurrent sexual partnerships [1]. Yet previous investigators have not used linked data from men and women in the same households to show *differential* effects for men and women. In our analysis, we showed that women and men were, on average, differentially affected by exposure to food insecurity: summarized simply, elevated HIV transmission risk behaviors and symptoms of STIs were observed among women in food insecure households but not for men. If we had, contrary to fact, obtained symmetric findings among men, then a different narrative not based on gendered and food security-related power differentials would be required to explain our findings. With the exception of a single study of Nepalese commercial sex workers [44], there is little qualitative research describing how gender-based power differentials reduce condom use and self-efficacy among women in this particular context. That said, our findings are potentially consistent with the compromised autonomy described by the commercial sex workers in that study. Similar themes have been identified in qualitative studies conducted in Uganda and Nigeria [2, 11]. Given that food

insecurity is highly prevalent in Nepal [28, 35], our findings suggest that interventions to address food insecurity among women may have beneficial implications for HIV prevention and gender equity in this context [45].

An important limitation of this study was our inability to examine condom use with a non-primary partner, which is arguably more relevant to HIV prevention research (i.e., if fidelity is assumed [46]). Sexual intercourse with casual and other non-spousal partners was rarely reported in the Nepal DHS, making these behaviors difficult to study. However, our findings about the differential impact of food insecurity on HIV transmission risk behaviors and symptoms of STIs among women and men are nonetheless relevant for HIV prevention in Nepal. First, in the sensitivity analysis of all sexually active women (i.e., not only women with linked partners), we obtained broadly similar findings. Second, we observed greater adverse impacts of food insecurity among women with migrant partners, which is notable given that migrants are a particularly vulnerable and high-risk sub-population in Nepal's HIV epidemic [47]. The bulk of the sizeable migrant worker population in Nepal consists of men, who may be gone for months or even years at a time [48]. While some migrants do send money home to their spouses and partners, many [49], perhaps even a majority [50], do not. Women who live in rural areas where plowing is a taboo activity [51] may experience considerable livelihood insecurity and economic dependence on men and may therefore be at even greater risk for HIV acquisition [50]. Definitive conclusions about whether Nepal's HIV epidemic is beginning to expand out of high-risk groups [31] and the extent to which migrant workers may act as a "bridge" to subgroups not typically thought of being at risk for HIV acquisition [47, 50], however, are constrained by the poor quality of available epidemiological evidence on HIV and sexual behavior in Nepal as a whole [29].

Interpretation of our findings is subject to three substantive limitations in addition to that described above. First, sexual intercourse with non-marital partners was rarely reported. As a result, our condom use outcomes should be regarded as specific to primary partners, and we were unable to analyze condom use with casual or other non-primary partners as an outcome. This could have confounded our estimates of the associations between food insecurity and HIV risk factors and transmission risk behaviors. However, if sexual intercourse with casual or other non-primary partners is more likely to be characterized by economic motivations, which has been described in the literature [52], this would have biased our estimates towards the null. Second, although the HFIAS has previously demonstrated good reliability and construct validity when administered in Nepal, some of its items (i.e., those related to anxiety about food, monotony of diet, and the extent to which food is being procured in a socially unacceptable manner) have been criticized for being more culture-specific than others [53]. The findings of several studies call into question the extent to which the HFIAS actually captures the same underlying construct across different contexts [39]. However, our sensitivity analyses limiting the explanatory variable to the two hunger items produced results that were broadly consistent with our main findings. Third, as with all cross-sectional analyses, we cannot infer causality from our associational estimates. Longitudinal or experimental studies would provide stronger evidence of the phenomena documented here.

Despite these limitations, our findings have important implications for HIV prevention program development. Given the consistency between our findings and those of other studies conducted in diverse settings [1–8], if the estimated association is causal, our findings suggest an additional rationale for hunger alleviation: interventions targeting food insecurity may have beneficial implications for the prevention of HIV and other STIs among women in Nepal. This structural approach to HIV prevention [54] stands in contrast to current HIV prevention efforts in Nepal, which largely target high-risk groups while neglecting to address broader social forces that may shape women's risk for HIV [50]. There are implications for future research studies as well. Our study design demonstrates the importance of including men in future studies of food insecurity and HIV risk to serve as a falsification test for the disempowerment framework that informs studies of this nature. Ultimately, randomized structural intervention studies [54, 55] are needed to assess the extent to which improved food security has a causal association with women's exposure to HIV risk, and to understand the pathways underlying these associations. If confirmed in future studies, our findings would strongly argue for potentially integrating food security programs (i.e., ranging from direct food assistance to structural interventions to enhance livelihoods) and HIV prevention services among women.

In conclusion, our study provides population-based evidence from Nepal that food insecurity is associated with HIV transmission risk behaviors and symptoms of STIs for women but not men. Although more intervention research is needed to establish an evidence base for concerted approaches to food insecurity and HIV prevention, we recommend that these potential synergies not be ignored.

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Appendix

See Tables 5, 6 and 7.

Table 5 Individual components of the modified HFIAS ($N = 2,322$)

In the past 12 months	Number (%) responding affirmatively, by category[a]				Mean
	Never	Rarely	Sometimes	Often	
…how frequently did you worry that your household would not have enough food?	1,237 (55.0)	187 (6.2)	428 (18.0)	470 (20.8)	1.05 (0.95–1.14)
…how often were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	1,297 (57.7)	246 (8.1)	432 (19.0)	347 (15.1)	0.92 (0.82–1.01)
…how often did you or any household member have to eat a limited variety of foods due to a lack of resources?	1,347 (59.6)	300 (10.9)	419 (19.0)	256 (10.4)	0.80 (0.72–0.88)
…how often did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	1,794 (77.5)	279 (11.4)	209 (9.2)	40 (1.9)	0.36 (0.30–0.41)
…how often did you or any household member eat fewer meals in a day because of lack of resources to get food?	1,937 (84.4)	223 (8.6)	133 (5.4)	29 (1.6)	0.24 (0.19–0.29)
…how often was there no food to eat of any kind in your household because of lack of resources to get food?	1,980 (84.9)	202 (8.4)	120 (5.8)	20 (0.9)	0.23 (0.18–0.28)
…how often did you or any household member go to sleep at night hungry because there was not enough food?	2,114 (90.9)	137 (5.6)	59 (3.1)	12 (0.5)	0.13 (0.09–0.17)

[a] Number refers to actual number of observations; percentage refers to percentage estimated using survey weights

Table 6 Bivariate correlates of HIV risk factors and transmission risk behaviors among partnered women in the 2011 Nepal Demographic and Health Survey ($N = 2,322$)

	OR (95 % CI)			
	Condom use at last sexual intercourse	Consistent condom use, past 12 months	Abnormal genital discharge, past 12 months	Vaginal sore or ulcer, past 12 months
Household food insecurity				
Food secure	Ref	Ref	Ref	Ref
Mildly food insecure	0.74 (0.45–1.27)	0.78 (0.42–1.44)	1.51 (0.97–2.35)	**2.70 (1.28–5.69)**
Moderately food insecure	**0.42 (0.26–0.69)**	**0.42 (0.24–0.75)**	**1.80 (1.23–2.63)**	**2.11 (1.03–4.32)**
Severely food insecure	**0.16 (0.07–0.39)**	**0.17 (0.06–0.47)**	1.18 (0.79–1.78)	1.24 (0.45–3.41)
Household asset wealth				
Most poor	Ref	Ref	Ref	Ref
Very poor	**2.08 (1.02–4.25)**	1.58 (0.77–3.26)	0.70 (0.43–1.14)	0.72 (0.31–1.71)
Poor	**2.53 (1.17–5.49)**	1.86 (0.80–4.31)	0.79 (0.48–1.30)	0.87 (0.35–2.16)
Less poor	**3.82 (1.84–7.89)**	**2.90 (1.28–6.54)**	0.89 (0.53–1.50)	1.02 (0.42–2.47)
Least poor	**9.30 (4.67–18.5)**	**7.70 (3.55–16.7)**	0.86 (0.54–1.36)	0.83 (0.37–1.86)
Age (5 years)	**0.79 (0.71–0.88)**	**0.87 (0.77–0.98)**	0.99 (0.92–1.08)	**1.29 (1.11–1.50)**
Ethnicity				
Brahmin/Chhetri	Ref	Ref	Ref	Ref
Newar	1.56 (0.77–3.18)	1.67 (0.72–3.86)	1.58 (0.78–3.22)	2.35 (0.94–5.85)
Dalit	**0.21 (0.10–0.45)**	**0.24 (0.10–0.58)**	0.97 (0.59–1.60)	0.62 (0.21–1.80)
Janajati	**0.66 (0.43–0.99)**	**0.54 (0.32–0.92)**	0.77 (0.53–1.11)	0.72 (0.36–1.44)
Other	**0.43 (0.20–0.93)**	**0.29 (0.09–0.89)**	0.62 (0.31–1.24)	0.80 (0.26–2.44)

Table 6 continued

	OR (95 % CI)			
	Condom use at last sexual intercourse	Consistent condom use, past 12 months	Abnormal genital discharge, past 12 months	Vaginal sore or ulcer, past 12 months
Household head (%)	1.11 (0.26–4.68)	0.97 (0.13–7.54)	0.90 (0.29–2.81)	0.94 (0.14–6.25)
Educational attainment (%)				
None	Ref	Ref	Ref	Ref
Primary	1.49 (0.86–2.57)	1.28 (0.64–2.56)	0.90 (0.62–1.30)	1.27 (0.60–2.69)
Secondary	**4.40 (2.86–6.77)**	**4.41 (2.47–7.87)**	1.34 (0.95–1.89)	0.68 (0.29–1.58)
Higher	**7.50 (4.37–12.9)**	**8.10 (4.16–15.8)**	1.27 (0.70–2.29)	1.17 (0.43–3.18)
Professional occupation (%)	**3.05 (1.48–6.28)**	**4.09 (1.90–8.79)**	1.71 (0.86–3.38)	0.15 (0.02–1.14)

Boldface text indicates statistical significance at $P < 0.05$ or greater

Table 7 Bivariate correlates of HIV risk factors and transmission risk behaviors among partnered men in the 2011 Nepal Demographic and Health Survey ($N = 2{,}322$)

	OR (95 % CI)			
	Condom use at last sexual intercourse	Consistent condom use, past 12 months	Abnormal penile discharge, past 12 months	Penile sore or ulcer, past 12 months
Household food insecurity				
Food secure	Ref	Ref	Ref	Ref
Mildly food insecure	0.97 (0.64–1.47)	0.77 (0.45–1.31)	1.32 (0.30–5.79)	1.90 (0.76–4.74)
Moderately food insecure	**0.54 (0.38–0.78)**	0.36 (0.20–0.65)	0.27 (0.03–2.30)	0.57 (0.21–1.56)
Severely food insecure	**0.40 (0.23–0.72)**	0.37 (0.17–0.79)	1.23 (0.27–5.67)	1.90 (0.74–4.89)
Household asset wealth				
Most poor	Ref	Ref	Ref	Ref
Very poor	0.66 (0.37–1.16)	1.09 (0.51–2.31)	3.06 (0.19–49.6)	1.18 (0.39–3.53)
Poor	0.99 (0.56–1.74)	1.15 (0.53–2.50)	5.67 (0.65–49.7)	0.88 (0.28–2.77)
Less poor	1.21 (0.74–1.98)	1.37 (0.72–2.60)	4.77 (0.46–49.5)	1.06 (0.32–3.45)
Least poor	**2.71 (1.80–4.09)**	**3.51 (2.02–6.11)**	7.11 (0.79–64.1)	1.08 (0.35–3.33)
Age (5 years)	**0.85 (0.76–0.95)**	0.92 (0.80–1.06)	0.75 (0.50–1.11)	0.88 (0.66–1.19)
Ethnicity				
Brahmin/Chhetri	Ref	Ref	Ref	Ref
Newar	1.57 (0.87–2.83)	1.29 (0.60–2.75)	4.03 (0.65–25.1)	1.17 (0.28–4.94)
Dalit	**0.25 (0.12–0.50)**	**0.24 (0.09–0.64)**	1.31 (0.20–8.66)	1.88 (0.74–4.79)
Janajati	**0.68 (0.47–0.99)**	0.60 (0.34–1.06)	0.89 (0.18–4.45)	0.76 (0.32–1.79)
Other	**0.27 (0.12–0.59)**	**0.27 (0.10–0.75)**	1.90 (0.29–12.3)	0.46 (0.06–3.40)
Household head (%)	**0.56 (0.34–0.63)**	**0.62 (0.42–0.91)**	0.39 (0.12–1.24)	0.67 (0.32–1.42)
Educational attainment (%)				
None	Ref	Ref	Ref	Ref
Primary	0.92 (0.48–1.78)	0.71 (0.32–1.58)	0.63 (0.06–6.16)	0.79 (0.26–2.40)
Secondary	**2.36 (1.39–3.99)**	1.91 (0.97–3.73)	2.36 (0.29–19.3)	0.94 (0.34–2.64)
Higher	**4.61 (2.59–8.19)**	**4.06 (1.94–8.52)**	2.15 (0.18–25.6)	1.43 (0.41–4.94)
Professional occupation (%)	**1.95 (1.35–2.81)**	**1.73 (1.07–2.80)**	1.24 (0.26–5.91)	1.56 (0.59–4.12)

Boldface text indicates statistical significance at $P < 0.05$ or greater

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