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Household Food Insecurity And Sleep Patterns Among Mexican Adults: Results From Ensanut-2012

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Abstract

Objective: To examine the independent association of household food insecurity (HFI) with sleep duration and quality in a nationally representative cross-sectional survey of adults in Mexico.

Methods: We analyzed data from ENSANUT-2012. We assessed the association between HFI and self-reported sleep duration and quality among 11,356 adults using weighted multinomial and binomial logistic regression.   The Latin American and Caribbean Food Security Scale (ELCSA) was used to categorize food security level as secure (25.5%), mild HFI (43.7%), moderate HFI (19.0%), or severe HFI (11.8%).

 Results: Overall, 20.8% of individuals reported getting less than the recommended 7-8 hours of sleep/night, 20.4% reported getting more than the recommended amount of sleep, and 20.7% reported poor sleep quality. In unadjusted analyses, severe HFI was significantly associated with getting both less than and more than the recommended amount of sleep. After adjusting for potential confounders, there remained a significant association between severe HFI and getting too little sleep (adjusted odds ratio [AOR]=1.83, 95% confidence interval [CI]=1.37-2.43). Compared with food-secure individuals, odds of poor sleep quality increased with level of food insecurity (AOR=1.27, 95% CI=1.04-1.56 for mild HFI; AOR=1.71, 95% CI=1.36-2.14 for moderate HFI; and AOR=1.89, 95% CI=1.45-2.45 for severe HFI).

Conclusions: HFI is associated with inadequate sleep duration and poor sleep quality among Mexican adults. This study adds evidence to how detrimental HFI is to the well-being of the Mexican population, increasing urgency to address HFI in Mexico.

Introduction

The importance of adequate sleep for good health has gained increasing attention in recent years [1]. Epidemiological data shows that, among adults, the optimal daily sleep duration is of 7-8 hours, as this duration has been associated with good health outcomes [2]. Sub-optimal sleep is a risk factor for diabetes, hypertension, depression, heart attack, and stroke [1, 3-5]. It is also associated with high body mass index (BMI) [5, 6] and increased mortality risk [7].

Given the link between inadequate sleep and morbidity and mortality, it is important that we better understand factors associated with sub-optimal sleep. The primary known determinants of sub-optimal sleep are stress, older age, lower socioeconomic status (SES), and behavioral factors, including smoking, heavy alcohol use, and limited physical activity [2]. Depression is the main psychosocial factor associated with sleep duration and quality [5].

Recently, studies in the United States have shown associations between household food insecurity (HFI) and sub-optimal sleep [8-10]. Food insecurity, as defined by the Food and Agriculture Organization, is the lack of access to a diet of sufficient nutritional quality and quantity [11]. To our knowledge, the association between HFI and sleep adequacy has not been studied in low- and middle-income countries, where levels of HFI are much greater [11] and the burden of non-communicable diseases is growing [12].

The present study examines the association between HFI and sub-optimal sleep in Mexico, a country with high prevalence of HFI. Mexico offers a special opportunity to study this association as it is a country that has collected recent data on HFI and sleep in a nationally representative sample, the 2012 Mexican National Health and Nutrition Survey (ENSANUT-2012). This survey estimated 28% of households in Mexico have moderate

or severe food insecurity [13]. ENSANUT-2012 data also show that the greatest proportion of HFI exists in the poorest populations of Mexico, specifically indigenous and rural populations [13]. Understanding the consequences of HFI in Mexico can help strongly justify effective prevention efforts.

Methods

Data Source and Study Sample

Data for this study came from the 2012 Mexican National Health and Nutrition Survey (ENSANUT-2012). The survey has been described in detail elsewhere [13]. Briefly, ENSANUT-2012 is a probabilistic survey that employed a multistage stratified cluster sampling design. The survey is representative at the national, regional, and state levels, and includes rural and urban strata. The sampling frame was drawn from the 2005 Population Census primary sampling units, along with the new localities identified in the 2010 Census. ENSANUT-2012 data were collected in 50,528 households, between October 2011 and May 2012, with a response rate of 87%. These households represent an estimated 29,429,252 households across all 31 Mexican states and the Federal District. ENSANUT-2012 obtained data on sleep from 11,656 adults who represented 22,394,730 people. In total, the sample included 11,356 adults aged 18-69 years. A proxy was permitted to answer questions when an individual was unable to answer questions without assistance.

Household Food Insecurity Measurement

The Latin American and Caribbean Food Security Scale (ELCSA) is a validated tool that was employed to measure HFI for ENSANUT-2012 [14]. ECLSA consists of 15

questions for each household, with eight items referring to adults and seven items

referring to minors aged <18 years (see Appendix for full list of questions). Questions

from the ELCSA scale were directed to the main person responsible for preparing food in

the home. The majority of the time, this was a woman, but in a few instances, an

alternative adult with knowledge of the household food situation responded to the food

security questions. The response options for each of the 15 ELCSA questions were yes,

no, don't know or refused. The reference period for the questions is the previous 3

months. The summary HFI score was calculated for each household by adding the

number of positive responses to the questions. In households where minors lived, all 15

questions were asked. However, in households where only adult individuals lived only

the 8 questions that applied to adults or the households as a whole were asked.

Households were classified into four categories based on their additive ELCSA score in

response to the 8 household/adult specific items: household food secure (score=0); mild

HFI (1-3); moderate HFI (4-6); severe HFI (7-8).

Outcome variables: The two outcome variables were self-report of sleep duration and

sleep quality.

Sleep duration

Individuals were asked to respond to the question, "¿Cuántas horas en promedio duerme

en un día?" (How many hours on average do you sleep in a day?), and were provided

with the following response options: ≤5, 6, 7, 8, ≥9 hours. For this study, sleep duration

responses were combined into three categories based on the evidence indicating that

optimal sleep duration for adults 18 and older is 7-8 hours [2, 15, 16]. Thus, the three

sleep duration categories reflected: less than the recommended amount of sleep (≤6 hours), recommended amount of sleep (7-8 hours), and greater than the recommended amount of sleep (≥9 hours).

Sleep quality

Self-reported sleep quality was assessed with the question, "Durante la última semana ¿no durmió bien?" (During the past week, have you not slept well?). Response options for this question were: never, 1-2 days, 3-4 days, 5-7 days. Sleep quality responses were combined to create a binary variable reflecting fair to good sleep quality (sleep difficulties rarely/1-2 times per week) and poor to very poor sleep quality (sleep difficulties 3-4 times/all the time per week).

Covariates: Data were also collected on a broad range of sociodemographic and health status characteristics. Sociodemographic characteristics included respondent's age (examined as both continuous and categorical [18-39, 40-59 and 60-69]); sex (female, male); area of residence (urban ≥2500 inhabitants, rural <2500 inhabitants); household size; and socioeconomic level (quintiles). A previously constructed and validated socioeconomic status (SES) index was used to determine SES quintile from a principal component analysis creating a summary score from 8 variables: household building materials including floor, walls and ceiling; number of bedrooms; water accessibility; car ownership; number of household appliances and electrical goods. Health status measures included depression (assessed from the question, "¿Alguna vez le ha dicho un médico u otro personal de salud que sufre o ha sufrido depresión?" or "Have you ever been told by a doctor or other health professional that you suffer or have suffered depression?"); and

body mass index (underweight <18.5 kg/m^2, normal 18.5-24.9 kg/m^2, overweight 25.0-

29.9 kg/m^2, obese ≥30.0 kg/m^2). Weight and height were measured to the nearest 0.1 kg

and 0.1cm, in order to determine BMI. These covariates were included based on being

known risk factors for HFI [8-10] and sub-optimal sleep [2, 5].

Data Analysis

The analyses for this study proceeded in the following steps. First, descriptive

statistics were used to characterize the sample by level of HFI. Unadjusted associations

between HFI category and the sample characteristics were examined by using the

analysis of variance (ANOVA) F-test for continuous variables or the Pearson χ^2 test for

categorical variables.

Second, bivariate analyses were conducted to examine the associations of HFI and

each of the covariates with the two outcomes of interest (sleep duration and sleep

quality). Unadjusted associations were assessed by using ANOVA and χ^2 as appropriate.

Post-hoc analyses of continuous variables were performed to detect significant

differences between subgroups.

Next, multinomial logistic regression was used to assess the independent effect of

HFI on the three-level sleep duration outcome (≤6, 7-8, ≥9 hours), after adjusting for

covariates. In the multinomial model, the recommended category of 7-8 hours of sleep

was used as the reference category. Specifically, the regression model estimated the odds

that individuals with varying levels of food insecurity would report less than or greater

than the recommended amount of sleep as compared with food-secure individuals. Two

multivariable models were run: the first included all of the covariates except for

depression and then another with depression added. This was done to test whether history of depression was a potential mediator of any observed association between HFI and sleep duration, as suggested by previous research in the United States [5].

Finally, binomial logistic regression was used to examine the independent effect of HFI on perceived sleep quality. Multivariable analyses adjusted for covariates as noted above. All logistic regression analyses yielded adjusted odds ratios (AORs) and 95% confidence intervals (CIs).

All analyses were performed using SAS version 9.3. Weighted analyses were performed using the SURVEY procedures to account for the complex survey design. A p-value of <0.05 was considered statistically significant. Study analyses included adults ≥ 18 years of age with complete data for the independent and dependent variables.

Ethical Considerations

All participants signed an informed consent form prior to responding to the survey. The ENSANUT-2012 was approved by the Ethics Committee of the National Institute of Public Health of Mexico. Only de-identified public domain data were used in the secondary data analyses conducted for this study. For this reason, this study was exempt from human subjects review by Yale University.

Results

Sample Characteristics

Overall, sleep data from ENSANUT-2012 included 11,656 respondents aged 18-69 years. We excluded respondents with missing data for the weighting variable (n=203, 1.7%), HFI (n=87, 0.7%), and sleep duration (n=10, 0.08%). Thus, the final sample size

for the present study was 11,356, representing an estimated 22,123,770 Mexican adults. When analyzing the self-perceived sleep quality outcome, an additional 1,637 individuals were excluded because the survey was completed by a proxy and values were missing.

Table 1 provides a description of the sample by HFI level. Except for sex and age as a continuous variable, HFI was significantly associated with the rest of covariates. The mean age was 35.8 years. Among households with severe HFI, 28% are in the lowest socio-economic quintile while only 8% are in the highest quintile. Respondent's obesity prevalence ranged from 31% in food secure households to 37% in severely food insecure households. There was a strong association between area of residence (urban vs. rural) and level of food insecurity. Among food secure households, 15% of individuals reside in rural areas, compared with 28% of individuals with severe HFI from rural areas. As expected, there is a dose-response association between history of depression and HFI. Approximately 10% of food secure individuals have a history of depression, whereas 15% of severely food insecure individuals report a history of depression.

Unadjusted Associations between HFI and Sleep Duration and Quality

Table 2 presents the unadjusted associations between the study variables and average nightly sleep duration. HFI and all the covariates except household size were significantly associated with sleep duration. A dose-response relationship was found between increasing food insecurity level and getting both less than and more than the recommended amount of sleep. Individuals with severe HFI are overrepresented in both less than and greater than recommended amount of sleep. The percentage of individuals

sleeping more than recommended was greater in: ages 18-39 years, females, low and normal weight individuals, rural residents, and individuals in the lowest SES quintiles.

Table 3 presents the unadjusted associations between study variables and self-report of sleep quality. There is a significant dose-response relationship between sleep quality and HFI. While only 17% of food secure individuals report poor sleep, 27% of individuals with severe HFI report poor sleep quality. Sleep quality is significantly associated with all covariates except SES and household size. The percentage of individuals with poor sleep was greater in: ages 40-59, females, urban residents, and both underweight and obese individuals.

Multinomial Logistic Regression Analysis of Sleep Duration

Table 4 shows the adjusted and unadjusted associations between HFI and sleep duration. In the unadjusted analyses, severe HFI is associated with greater odds of getting both less than and more than the recommended amount of sleep [1.63, 95% CI= 1.26-2.11) and 1.73, 95% CI= 1.18-2.56), respectively]. After controlling for potential confounders, severe HFI is only significantly associated with less than the recommended amount of sleep. Individuals with severe HFI are 1.83 times as likely than food secure individuals to get less than the recommended amount of sleep, compared to the recommended amount of sleep (95% CI= 1.37-2.43). The association between HFI and sleeping longer than recommended was attenuated after controlling for SES quintile (data not shown). Mediation analysis showed that depression was not mediating the effect of HFI on sleep (data not shown). The findings reporting the full adjusted model for the study covariates and sleep duration are shown in Appendix 2. Significant associations

were found with SES and sex. Lower SES status was associated with increased likelihood of getting more than the recommended amount of sleep. Female sex was associated with getting more than the recommended amount of sleep.

Binomial Logistic Regression Analysis of Sleep Quality

Table 5 shows the analysis of the outcome of sleep quality with HFI. Significant associations exist between poor sleep and mild, moderate and severe HFI. This association increased after adjusting for all potential confounders. Individuals with moderate HFI have 1.71 the odds of poor sleep, compared to food secure individuals (95% CI= 1.36-2.14). Severe HFI individuals have 1.89 the odds of poor sleep, compared to food secure individuals (95% CI= 1.45-2.45). The findings for the full adjusted model of the study covariates and sleep quality are reported in Appendix 3. In particular, females were more likely to report poor sleep than males.

Discussion

This study examined whether HFI is independently associated with sleep duration and sleep quality in a representative cross-sectional sample of adults in Mexico. We found a significant association between individuals experiencing HFI and both less than and greater than the recommended amount of sleep. SES attenuated this significance in the relationship between HFI and greater than the recommended amount of sleep. This is likely because lower SES individuals were overrepresented in getting more than the recommended amount of sleep. The relationship remained significant for less than the recommended amount of sleep, even after controlling for potential confounders. This

suggests that a distinct relationship exists between HFI and getting less than recommended sleep that was not explained by the other factors in the model.

Our analyses also show a strong association between mild, moderate and severe HFI and poor sleep quality. This relationship remained significant after adjusting for potential covariates, suggesting a distinct relationship between mild, moderate and severe HFI and poor sleep quality. Depression was not found to be a mediator in the analyses of either of our outcome variables. This was unexpected as previous studies have linked depression with both HFI [17, 18] and poor sleep patterns [5, 19, 20].

Previous studies conducted in the United States have examined the association between HFI and sleep. Significant associations in these studies were found between short, insufficient sleep and severe HFI [8-10]. Our study confirms this relationship in a sample of Mexican adults. Our data on sleep quality adds to the literature in showing a significant relationship between moderate and severe HFI and poor sleep quality. To our knowledge no previous study has examined the association between HFI and sleep quality in a sample outside the U.S.

One possible explanation behind this association is that HFI leads to prolonged mental distress. Previous studies conducted in the U.S. and Ghana have shown an association between HFI and mental distress in women [21, 22] and children [23]. One study has shown a general effect of HFI on mental distress [9]. Prolonged mental distress can affect the quality of an individual's sleep [8, 24]. Significant associations have been found between stress and frequent nighttime arousals [25, 26]. These arousals have been shown to worsen subjective sleep quality [26].

The association between HFI and short sleep duration can also be driven by the low economic position held by most individuals with severe HFI, although our analyses controlled for key SES confounders. In Mexico many individuals of low SES work jobs that require very early morning arrivals at work. Some individuals are forced to work multiple jobs, leaving insufficient time for sleep. This confirms results from studies showing a direct association between SES and both short sleep and poor sleep quality [10, 27, 28].

Limitations

There are several important limitations to our study. First, ENSANUT-2012 is a cross-sectional survey that examines simultaneously levels of HFI and sleep only in the last three months. There is evidence to support using a life course framework to study the impact of HFI on health outcomes. This framework theorizes that exposure to HFI at critical development points predisposes an individual to poor health outcomes at later points in time [29]. In this study, it is possible that individuals with high levels of HFI throughout their lives are more likely to have poor sleep duration and quality than individuals who only recently experienced HFI. Furthermore, we are unable to ascertain the directionality of influence with a cross-sectional survey. We cannot rule out reverse causality. It is possible that individuals who experience poor sleep quality and sub-optimal duration of sleep have less work productivity and income, leading to an increased risk of HFI.

Second, our analysis of sleep duration and quality relied on self-report. One study suggests that people may over-report sleep duration [30]. It is possible that more people are getting less than the recommended amount of sleep than reported. It is also possible

that the self-report of sleep quality would not accurately reflect objective measures of sleep [31]. Despite this possibility, participants were asked to rate how well they slept over the past week. It is likely that with such a short recall period, participants were likely to accurately assess their sleep quality.

Third, our analysis of sleep quality excluded substantially more individuals than the analysis of sleep duration (1,637 vs. 10, respectively). Individuals who used a proxy to participate in the survey were not asked about sleep quality. These individuals were generally older adults with cognitive impairments. We recommend that further research be conducted examining HFI and sleep quality in a sample of older adults.

Lastly, our study used a measure of depression that examined an individual's history of depression. It did not capture the individual's current state of depression. It also only examined self-reported clinically diagnosed depression. It is likely that more individuals have experienced depression, but have either never recognized the signs, or not reported the signs to a health professional due to stigma or embarrassment. More complete analysis would entail examining depressive symptoms using a depression symptoms scale such as the Center for Epidemiologic Studies Depression Scale (CES-D) [32] in relation to HFI and sleep.

Despite these limitations, our study demonstrates a significant relationship between HFI and sleep duration and quality in Mexican adults. Addressing household security in Mexico is an urgent priority and this study adds another piece of evidence as to how detrimental this condition is to the well-being of the Mexican population. Improving sleep can help improve the overall quality of life, not only for adults, but for their families.

Table 1. Description of the sample by Household Food Insecurity *

Characteristic	N=11,356 %	Food Secure N=2,895 %	Mild Food Insecurity N=4,958 %	Moderate Food Insecurity N=2,163 %	Severe Food Insecurity N=1,340 %	P[a]
Age (years), mean (SE)	35.8 (0.28)	35.7 (0.53)	35.9 (0.37)	36.5 (0.70)	34.9 (0.94)	0.600
Age (years)						<.001
18-39	61.87	62.60	61.97	59.73	61.11	
40-59	29.45	28.89	29.06	31.15	29.61	
60-69	8.68	8.52	8.97	9.12	7.28	
Sex						0.246
Male	44.90	45.59	44.42	44.09	46.27	
Female	55.10	54.41	55.58	55.91	53.73	
Area of Residence						<.001
Urban	76.93	84.80	74.10	74.67	72.55	
Rural	23.07	15.20	25.89	25.33	27.45	
Household Size mean (SE)[b]	4.56 (0.03)	4.1 (0.05)	4.6 (0.05)	4.8 (0.09)	5.0 (0.12)	<.001
Socio-economic Status, by quintiles						<.001
1 (Lowest)	14.73	7.64	13.59	19.51	28.04	
2	18.26	11.28	14.47	22.50	27.20	
3	19.45	15.15	21.53	21.62	18.44	
4	23.73	24.96	25.12	21.89	18.60	
5 (Highest)	23.83	40.98	21.28	14.48	7.72	
History of Depression[c]						<.001
Yes	10.44	9.75	9.52	11.61	14.07	
No	89.56	90.25	90.49	88.39	85.93	
BMI (kg/m^2)[d]						<.001
Low (<18.5)	1.03	1.15	0.88	1.17	1.05	
Normal (18.5-24.9)	28.67	29.14	28.70	26.85	30.32	
Overweight (25-29.9)	36.37	38.57	35.76	37.18	31.60	
Obese (≥30)	33.74	31.14	34.67	34.81	37.02	

*Note: Numbers may not sum to totals due to missing data, and column percentages may not sum to 100% due to rounding. All numbers are unweighted, and all percentages, means, and standard errors are weighted.

[a] P-value for analysis of variance F-test (continuous variable) or χ^2 test (categorical variable)

[b] Post-hoc analysis showed significant differences existed between level of HFI and mean household size in all groups except between moderate and severe HFI

[c] N=1,549 missing

[d] N=1,256 missing

Table 2. Unadjusted associations between study variables and average nightly sleep duration*

Characteristic	N=11,356	≤6 Hours N=2,343 %	7-8 Hours (Recommended) N=6,703 %	≥9 Hours N=2,310 %	P[a]
Household Food Security					0.006
Food Secure	2,895	19.27	61.49	19.23	
Mild HFI	4,958	20.33	60.40	19.27	
Moderate HFI	2,163	21.60	57.28	21.12	
Severe HFI	1,340	24.92	48.69	26.39	
Age (years), mean (SE)[b]	11,356	39.7 (0.68)	36.0 (0.31)	31.4 (0.63)	<.001
Age (years)					<.001
18-39	6,142	16.75	58.82	24.44	
40-59	3,915	26.99	59.71	13.31	
60-69	1,299	28.82	55.13	16.04	
Sex					0.018
Male	4,573	21.29	60.73	17.98	
Female	6,783	20.42	57.16	22.42	
Area of Residence					<.001
Urban	7,301	22.25	59.32	18.43	
Rural	4,055	16.00	56.89	27.11	
Household size, mean (SE)	11,356	4.5 (0.08)	4.6 (0.43)	4.2 (0.08)	0.352
Socio-economic Status, by quintiles					<.001
1 (lowest)	2,398	17.47	54.48	28.06	
2	2,451	18.92	57.41	23.67	
3	2,325	19.96	57.17	22.86	
4	2,185	23.50	59.72	16.78	
5 (highest)	1,997	22.34	62.78	14.89	
History of Depression[c]					<.001
Yes	992	28.84	55.63	15.54	
No	8,815	21.26	61.25	17.48	
BMI (kg/m^2)[d]					<.001
Low (<18.5)	99	14.73	58.06	27.21	
Normal (18.5-24.9)	2,674	18.34	61.13	20.56	
Overweight (25-29.9)	3,809	23.32	60.97	15.71	
Obese (≥30)	3,518	25.17	60.90	14.73	

*Note: Numbers may not sum to totals due to missing data, and row percentages may not sum to 100% due to rounding. All numbers are unweighted, and all percentages, means, and standard errors are weighted.
[a] P-value for analysis of variance F-test (continuous variable) or χ^2 test (categorical variable)
[b] Post-hoc analysis showed significant differences between means of age in all sleep categories
[c] N=1,549 missing
[d] N=1,256 missing

Table 3. Unadjusted association between study variables and sleep quality*

Characteristic	N=9,719	Rarely Reporting Poor Sleep %	Poor Sleep[a]	P[b]
HH Food Security				<.001
Food Secure	2,451	83.24	16.76	
Mild HFI	4,250	79.91	20.09	
Moderate HFI	1,868	74.98	25.02	
Severe HFI	1,150	73.51	26.49	
Age (years), mean (SE)[c]	35.8 (0.28)	39.6 (0.26)	41.7 (0.45)	<.001
Age (years)				<.001
18-39	4,792	81.44	18.56	
40-59	3,713	76.40	23.61	
60-69	1,214	78.71	21.29	
Sex				<.001
Male	3,773	83.18	16.82	
Female	5,946	76.31	23.69	
Area of Residence				0.025
Urban	6,165	78.57	21.43	
Rural	3,554	81.63	18.37	
Household size, mean (SE)	4.6 (0.03)	4.5 (0.37)	4.4 (0.08)	0.690
Socio-economic Status, by quintiles [d]				0.161
1 (lowest)	2,132	82.75	17.25	
2	2,146	78.90	21.10	
3	1,980	73.14	20.86	
4	1,825	77.38	22.62	
5 (highest)	1,636	79.27	20.73	
History of Depression				<.001
Yes	979	59.91	40.09	
No	8740	81.56	18.44	
BMI (kg/m^2) [e]				0.007
Low (<18.5)	88	77.86	22.14	
Normal (18.5-24.9)	2,490	81.16	18.84	
Overweight (25-29.9)	3,614	80.61	19.39	
Obese (≥30)	3,335	76.42	23.58	

*Note: Numbers may not sum to totals due to missing data, and row percentages may not sum to 100% due to rounding. All numbers are unweighted, and all percentages, means, and standard errors are weighted.
[a] Poor sleep is defined reporting trouble sleeping 3-4 times per week of every night of the week.
[b] P-value for analysis of variance F-test (continuous variable) or χ^2 test (categorical variable)
[c] Post-hoc analysis showed significant differences between means of age in all sleep categories
[d] SES quintile 1 represents the lowest income quintile
[e] N=1,256 missing

Table 4. Household Food Insecurity and Sleep Duration: Multinomial Logistic Regression

Characteristic	≤6 Hours OR [95% CI]	7-8 Hours*	≥ 9 Hours OR [95% CI]
UNADJUSTED			
HH Food Security			
Food secure*	1.00	1.00	1.00
Mild HFI	1.07 [0.89, 1.30]	1.00	1.02 [0.78, 1.33]
Moderate HFI	1.20 [0.88, 1.63]	1.00	1.18 [0.88, 1.57]
Severe HFI	1.63 [1.26, 2.11]	1.00	1.73 [1.18, 2.56]
ADJUSTED [b]			
HH Food Security			
Food secure	1.00	1.00	1.00
Mild HFI	1.05 [0.84, 1.31]	1.00	1.05 [0.84, 1.30]
Moderate HFI	0.97 [0.75, 1.25]	1.00	1.08 [0.83, 1.41]
Severe HFI	1.83 [1.38, 2.43]	1.00	1.32 [0.96, 1.81]

*Food-secure households are the reference for HFI; 7-8 hours of sleep is reference category for sleep duration
[b] Analysis is adjusted for age, sex, area of residence, household size, SES, and BMI.

Table 5. Household Food Insecurity and Sleep Quality: Binomial Logistic Regression

Characteristic	Poor Sleep vs. Rarely Reporting Poor Sleep*
UNADJUSTED	
HH Food Security	
Food secure*	1.00
Mild HFI	1.25 [1.03, 1.52]
Moderate HFI	1.66 [1.34, 2.05]
Severe HFI	1.79 [1.40, 2.29]
ADJUSTED [b]	
HH Food Security	
Food secure	1.00
Mild HFI	1.28 [1.04, 1.57]
Moderate HFI	1.72 [1.37, 2.17]
Severe HFI	1.91 [1.47, 2.48]

*Food secure households are the reference for HFI; individuals reporting rarely having trouble sleeping or having trouble sleeping 1-2 times a week are the reference category for sleep quality. Poor sleep is defined reporting trouble sleeping 3-4 times per week of every night of the week.
[b] Analysis is adjusted for age, sex, area of residence, household size, SES, and BMI.

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Appendix 1: **Harmonized Latin American and Caribbean Household Food Security Scale**
Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA)

1. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Usted se preocupó de que los alimentos se acabaran en su hogar?
1. During the last 3 months, were you worried that your household would run out of food because of a lack of money or other resources to get food?
2. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿En su hogar se quedaron sin alimentos?
2. During the last 3 months, did your household run out of food because of a lack of money or other resources to get food?
3. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿En su hogar dejaron de tener una alimentación (saludable, nutritiva, balanceada, equilibrada)?

3. During the last 3 months, did your household lack enough money or other resources to get healthy and nutritious food?
4. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Usted o algún adulto en su hogar tuvo una alimentación basada en poca variedad de alimentos?

4. During the last 3 months, did you or any adult in your household have to consume a diet based on only a few kinds of foods because of a lack of money or other resources to get food?
5. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Usted o algún adulto en su hogar dejó de desayunar, (comer, almorzar) o cenar?
5. During the last 3 months, did you or any adult in your household not eat breakfast, lunch or dinner [or skip a meal] because of a lack of money or other resources to get food?
6. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Usted o algún adulto en su hogar comió menos de lo que debía comer?
6. During the last 3 months, did you or any adult in your household eat less than you thought you should because of a lack of money or other resources to get food?
7. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Usted o algún adulto en su hogar sintió hambre pero no comió?

7. During the last 3 months, did you or any adult in your household feel hungry but did not eat because of a lack of money or other resources to get food?
8. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Usted o algún adulto en su hogar solo comió una vez al día o dejó de comer todo un día?

8. During the last 3 months, did you or any adult in your household eat only one meal in a day or go without eating for a whole day because of a lack of money or other resources to get food?
The following questions are about children up to age 18 living in your household.
9. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Algún menor de 18 años en su hogar dejó de tener una alimentación (saludable, nutritiva, balanceada, equilibrada)?

9. During the last 3 months, did any child, aged XX or younger, in your household not eat healthy because of a lack of money or other resources to get healthy and nutritious food?
10. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Algún menor de 18 años en su hogar tuvo una alimentación basada en poca variedad de alimentos?

10. During the last 3 months, did any child, aged XX or younger, in your household have to consume a diet based on only a few kinds of foods because of a lack of money or other resources to get food?
11. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Algún menor de 18 años en su hogar dejó de desayunar, (comer, almorzar) o cenar?

11. During the last 3 months, did any child in your household not eat breakfast, lunch or dinner because of a lack of money or other resources to get food?

Appendix 1: **Harmonized Latin American and Caribbean Household Food Security Scale**
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12. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Algún menor de 18 años en su hogar comió menos de lo que debía?

12. During the last 3 months, did any child, aged XX or younger, in your household eat less than you thought he/she should because of a lack of money or other resources to get food?

13. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Tuvieron que disminuir la cantidad servida en las comidas a algún menor de 18 años en su hogar?

13. During the last 3 months, did you have to serve less food to any child in your household because of a lack of money or other resources to get food?

14. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Algún menor de 18 años en su hogar sintió hambre pero no comió?

14. During the last 3 months, did any child in your household feel hungry but did not eat because of a lack of money or other resources to get food?

15. En los últimos 3 meses, por falta de dinero u otros recursos, alguna vez ¿Algún menor de 18 años en su hogar solo comió una vez al día o dejó de comer todo un día?

15. During the last 3 months, did any child in your household eat only one meal in a day or go without eating for a whole day because of a lack of money or other resources to get food?

Appendix 2. Associations between study variables and sleep duration (fully adjusted)

Characteristic	≤6 Hours OR [95% CI]	7-8 Hours*	≥ 9 Hours OR [95% CI]
ADJUSTED [a]			
HH Food Security			
Food secure	1.00	1.00	1.00
Mild HFI	1.05 [0.84, 1.31]	1.00	1.04 [0.84, 1.30]
Moderate HFI	0.96 [0.75, 1.24]	1.00	1.08 [0.83, 1.41]
Severe HFI	1.83 [1.37, 2.43]	1.00	1.32 [0.96, 1.81]
Age			
18-39	1.00	1.00	1.00
40-59	1.04 [0.76, 1.42]	1.00	1.14 [0.82, 1.59]
60-69	1.00 [0.56, 1.80]	1.00	1.89 [1.05, 3.38]
Sex			
Male	1.00	1.00	1.00
Female	1.15 [0.96, 1.38]	1.00	1.50 [1.25, 1.80]
Area of Residence			
Urban	1.00	1.00	1.00
Rural	0.84 [0.70, 1.01]	1.00	1.29 [1.01, 1.54]
Household Size	0.99 [0.95, 1.04]	1.00	0.98 [0.93, 1.04]
Socio-economic Status, by quintiles			
1 (lowest)	0.87 [0.67, 1.12]	1.00	1.64 [1.20, 2.23]
2	0.89 [0.69, 1.15]	1.00	1.34 [1.01, 1.79]
3	0.98 [0.76, 1.25]	1.00	1.20 [0.90, 1.61]
4	1.01 [0.78, 1.31]	1.00	0.94 [0.70, 1.27]
5 (highest)	1.00	1.00	1.00
BMI (kg/m^2)			
Low (<18.5)	0.84 [0.41, 1.72]	1.00	1.24 [0.60, 2.55]
Normal (18.5-24.9)	1.00	1.00	1.00
Overweight (25-29.9)	1.09 [0.86, 1.37]	1.00	0.82 [0.67, 1.01]
Obese (≥30)	1.15 [0.92, 1.43]	1.00	0.81[0.65, 1.01]

*7-8 Hours of sleep is reference category for sleep; food secure households are the reference for HFI

[a] Analysis is adjusted for age, sex, area of residence, household size, SES, and BMI

Appendix 3. Associations between study variables and sleep quality (fully adjusted)

Characteristic	Poor Sleep vs. Rarely Reporting Poor Sleep*
ADJUSTED [a]	
HH Food Security	
Food secure	1.00
Mild HFI	1.27 [1.04, 1.56]
Moderate HFI	1.71 [1.36, 2.14]
Severe HFI	1.89 [1.45, 2.45]
Age	
18-39	1.00
40-59	0.91 [0.68, 1.23]
60-69	0.61 [0.37, 1.01]
Sex	
Male	1.00
Female	1.70 [1.41, 2.04]
Area of Residence	
Urban	1.00
Rural	0.91 [0.77, 1.09]
Household Size	1.00 [0.96, 1.05]
Socio-economic Status, by quintiles	
1 (lowest)	0.76 [0.57, 1.02]
2	0.97 [0.74, 1.29]
3	0.96 [0.74, 1.24]
4	1.08 [0.89, 1.31]
5 (highest)	1.00
BMI (kg/m^2)	
Low (<18.5)	1.31 [0.63, 2.72]
Normal (18.5-24.9)	1.00
Overweight (25-29.9)	0.94 [0.77, 1.09]
Obese (≥30)	1.08 [0.89, 1.31]

*7-8 Hours of sleep is reference category for sleep; food secure households are the reference for HFI. Individuals reporting rarely having trouble sleeping or having trouble sleeping 1-2 times a week are the reference category for sleep quality. Poor sleep is defined reporting trouble sleeping 3-4 times per week of every night of the week.

[a] Analysis is adjusted for age, sex, area of residence, household size, SES, and BMI