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ORIGINAL PAPER

# The Household Food Insecurity and Health Outcomes of U.S.–Mexico Border Migrant and Seasonal Farmworkers

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**Abstract** Emerging evidence suggests chronic household food insecurity has an adverse effect on health. This study examined the prevalence, predictors and health outcomes associated with food insecurity in 100 migrant and seasonal farmworker (MSFW) households living on the U.S.–Mexico border. Data were collected using the U.S. Food Security Scale, California Agricultural Worker's Health Survey, and objective anthropometric, clinical and biochemical indicators. Food insecurity affected 82% of households; 49% also had hunger. Household food insecurity was predicted by the presence of minor children in the home and low maternal education. Food insecure households were more likely to have at least one member affected by symptoms of depression (*deprimido*), *nervios* (an ethnospecific condition), learning disorders, and symptoms suggestive of gastrointestinal infection. Although not directly associated with food insecurity, adult obesity, central body adiposity, elevated blood pressure, and blood lipid and glucose disturbances were common. These findings highlight the significant food security and health challenges faced by border area MSFW families.

**Keywords** U.S. Food Security Scale · Hispanic · Health outcomes · Obesity

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## Introduction

Households are considered to be food insecure when they experience a "limited or uncertain availability of food, or uncertain ability to acquire acceptable foods in socially acceptable ways," due to restricted financial resources [1]. Hunger, a more severe form of food insecurity, may occur when the members of a household start to skip meals or decrease their total food intake due to the decreased food supply available to them [2]. The recent development of a standard tool, the U.S. Household Food Security Scale (U.S. FSS), has greatly improved between- and within-group comparisons of the food security status of U.S. subpopulations [2].

The prevalence of food insecurity in Hispanics and other vulnerable low-income, minority groups is at least double the national average [1, 2]. For example, estimates from the 2004 Current Population Survey which used the U.S. FSS to collect data, indicated that 21.7% of Hispanic households were food insecure compared to 11.9% of the general U.S. population. The estimated prevalence of food insecurity was even higher for low-income Hispanics (i.e., 37.2%). Other surveys also have confirmed that household food insecurity is common among Hispanics especially those who are Mexican-American or Mexican-born

immigrants [3–5]. The latter accounts for three-fourths [6] of the estimated 4.2 million migrant and seasonal farmworkers (MSFWs) and their households who live and work in the U.S. [7]. Data on the household food security status of this important agricultural group are limited to four studies, all conducted in eastern states [8–11]. In these, prevalence estimates of household food insecurity, or alternatively food insufficiency, ranged from 8.2% in MSFW employed on Pennsylvania farms [8] to 98% in those working on northern Virginia/Delmarva Peninsula vegetable farms and poultry processing plants [11]. The reason for this wide variation is not clear. Some of it could be due to true population or sampling differences but it also is possible that the use of several different instruments to measure the food security status of households could be responsible.

The evidence from prior studies indicates that food security status of households has important health and nutritional implications. Although this relationship has not yet been examined in MSFW, chronic household food insecurity has been linked with compromised health outcomes in some U.S. subpopulations [12–15]. For example, some studies have shown that adults and children from food insecure homes are more likely to report poorer overall health and decreased physical functioning compared to those who are food secure [14–18]. Published data from national and local survey data also suggests that food insecure households are at-risk for less diverse and lower quality diets, reduced micronutrient intake, and iron-deficiency anemia [13, 17, 19–21].

Many of the above health outcomes are reported to be prevalent among MSFW subpopulations [9, 22–25] as is adult overweight, obesity and central body adiposity [22, 24] and obesity-related conditions such as type 2 diabetes, hypertension, and hyperlipidemia [22, 24, 26, 27]. Although not yet examined in MSFW, emerging evidence suggests that chronic food insecurity may promote the development of overweight/obesity in certain subpopulations [3, 5, 12–14] and perhaps speed the onset of or worsen existing type 2 diabetes [28, 29], hypertension, and other obesity-related chronic conditions [29]. One reason for this may be that food insecure households are more likely to purchase cheaper, higher calorie foods leading to excess energy intake and weight gain. Persons from food insecure households also may overeat during periods when more food is available such as immediately after payday or at the beginning of the monthly food stamp cycle [5, 14, 28, 29]. This type of cyclical eating behavior has the potential to lead to weight gain over time due to changes in metabolic efficiency such as that observed in the "yo-yo" dieting syndrome [10]. Furthermore, chronic stress and anxiety caused by an inability to procure an adequate food supply may cause the increased production of stress hormones such as cortisol and epinephrine, resulting in increased blood pressure, weight gain, and insulin resistance [16].

The prevalence of respiratory [30, 31], gastrointestinal, and urinary tract infections [26, 27, 32] is reported to be elevated in MSFW households. Although the potential role of food insecurity for increasing susceptibility to these illnesses has not been assessed, some studies of low-income children have linked it with an increased risk for acquiring colds, sore throats, ear and other infections [33, 34]. This susceptibility to infections could reflect the increased exposure to pathogenic microorganisms associated with poorer living conditions as well as the adverse effect of food insecurity on micronutrient status [35] and immunocompetence [36, 37].

Food insecurity may pose other consequences for adult and child health. For example, adults from food insecure households are more likely to describe more stress and anxiety, depressive symptoms [29, 38, 39], lower self-esteem [38], emotional distress [29], social isolation [19] and poorer overall mental health status [16]. Likewise, children from such homes are reported to be more likely to experience significant psychological and emotional distress [18, 40–42], decreased quality of life [43], learning disabilities [40, 41], and poorer academic performance [44]. Past authors have not specifically examined the relationship between chronic household food insecurity and poorer mental health outcomes in farmworkers. However poorer outcomes such as depression, anxiety, stress [22, 34, 45–47], *susto*, *corajes* and other ethnospecific conditions are more common in MSFW adults [22, 48, 49]. Children from these households also are more likely to show evidence of cognitive and other developmental delays [22, 48, 49].

The current study was conducted to examine the problem of chronic food insecurity in MSFW households living in the Paso del Norte region of far southwestern Texas and southeastern New Mexico. The major study objectives were to: (1) define levels of household food insecurity in this border group, (2) identify sociodemographic, immigration, and lifestyle predictors of household food insecurity, and (3) examine the association of household food insecurity with specific physical and metal health outcomes. Based on the evidence outlined in the previous section, it was hypothesized a priori that food insecure households would be at increased risk for generalized

overweight/obesity, abdominal obesity, elevated blood lipids and glucose, high blood pressure, and metabolic syndrome as well as a higher burden of other adverse physical and metal health outcomes.

## Methods and Materials

### Study Population

An estimated 12,000 MSFW and their households live and work on the U.S. side of the border in the Paso del Norte, a region located inside the Chihuahua Desert [50]. The majority are Mexican immigrants who cultivate and harvest crops such as cotton, nuts, chiles, and onions [51]. Different from many other MSFW, the Paso del Norte group tends to travel within a closed circuit of farms in southwestern Texas and southeastern New Mexico, which are located on narrow strips of land near the Rio Grande and other water supplies. The Paso del Norte group have annual household incomes averaging only $6,000 [51] or about half the national MSFW average [6].

### Household Sampling and Recruitment

The study was conducted during a 10-month period in 2003. Migrant and seasonal farmworker households were recruited from the two adjacent border counties of El Paso County, Texas, and Dona Ana County, New Mexico. To be eligible for the study, households were required to have at least one adult member who had performed paid farm work during the prior 12-months. A site-based convenience sampling strategy was used to identify prospective study households. This method is recommended for accessing hard-to-reach subpopulations for whom census listings are not available such as is the case for the Paso del Norte MSFW [52]. Prospective households were recruited from several different organizations and agencies serving farmworkers and their families in the region. Identified households who indicated their interest in participating in the study were visited by the study team in their homes, migrant centers, community centers, or another location chosen by them. Potential household participants went through the formal informed consent and/or assent process. The study protocol was reviewed and approved (#1669) by the Institutional Review Board of the University of Texas at El Paso.

### Data Collection

A four-person bilingual, bicultural study team conducted the household food security and health interviews and performed the anthropometric, clinical, and laboratory examinations. One adult respondent from each household, either an adult male or female, took part in the interviews. These were conducted in the respondent's language of preference. All of the subjects requested to be interviewed in Spanish. Household food security status was evaluated with the 18-item U.S. Food Security Survey (U.S. FSS) module, an instrument whose reproducibility and validity have been previously described [53–55]. The U.S. FSS measures food insecurity and hunger caused by a household's inability to afford enough food and not that caused by being too busy to eat or fasting for reasons such as weight loss, religious purposes, health fasting, or illness [54]. The responses of the adult respondent from each household were used to classify household food security status during the previous 12 months into three major categories: food secure, food insecure without hunger, and food insecure with hunger [54].

A modified (shortened) version of the main California Agricultural Worker Health Survey (CAWHS) and its female and male health supplements [56] were used to collect data from each household adult respondent. The validity and other characteristics of the instrument have been described previously [22]. The first set of questions focused on the characteristics of adult respondents and their respective households. These included household size, composition, and other characteristics such as age, birthplace, education, current employment, ethnicity/race, place of permanent residence, migration patterns, level of Spanish/English proficiency, living conditions, and use of food assistance, social services, and health care.

The second set of questions collected information on physical conditions that affected household members during the previous 12-month period such as gastrointestinal, respiratory, urological, musculoskeletal, dental, eye, and ear symptoms. Other questions asked about mental health and ethnospecific symptoms that had affected the household members during the same time period. *Nervios* or "nerves," is a condition that includes feelings of severe generalized anxiety, a sense of desperation, insomnia and desire to cry. It is believed to be caused by chronic stress and is manifested as a high degree of agitation or irritation [22]. *Corajes* is a condition characterized by frustration and/or anger. *Latidos* are rapid heart palpitations caused by stress, anxiety, fright. *Aires* refers to intracostal

muscular pain associated with a sudden change in ambient temperature. *Sustos/espantos* result from a frightening event; symptoms may include sleep difficulties, feelings of malaise, appetite disturbances, and gastrointestinal complaints. *Empacho* is a gastrointestinal illness caused by an obstruction in the stomach or intestines caused by food or another substance; symptoms usually include stomach pain, bloating, swelling, and hardness and loss of appetite.

The third set of questions asked whether any household members had ever been medically diagnosed with diabetes, hypertension, heart attack, stroke/embolism, cardiovascular and cerebrovascular disease, cancer, asthma, allergies, tuberculosis, hepatitis, arthritis, skin conditions, learning disabilities, or neurological disorders.

The anthropometric evaluations performed on each household adult respondent included body weight, height, and waist circumference. Body weight was obtained by weighing subjects without shoes on a calibrated electronic balance (Detecto, IN) to the nearest kilogram. The scale was recalibrated after each subject weighing. A portable stadiometer was used to measure standing height without shoes, hats or other headwear. The weight and height measurements were used to calculate body mass index (BMI) defined as weight (kg)/height ($m^2$). The cutoff points used to classify adults were based on CDC criteria [57]. These were: underweight (<18.5), normal (18.5–24.9), overweight (25–29.9) and obese (≥30). Waist circumference was used to identify adults with central body adiposity. It was measured using the narrowest point between the ribs and hips when viewed from the front after exhaling [58]. Waist circumferences of ≥102 cm in adult men and ≥88 in adult women were classified as positive for central body adiposity [59].

Evaluations of infants aged ≤24 months were made using established anthropometric measurement protocols [60] and CDC classification criteria [61]. Weight was assessed using a calibrated electronic infant scale (Detecto, IN) and recumbent crown-heel length with an infant measuring board. The weight of children >24 months and older was assessed by weighing subjects without shoes on a calibrated electronic balance (Detecto, IN) to the nearest kilogram. Standing height was assessed using a portable stadiometer. All shoes, headgear, coats, sweaters, and other heavy clothes were removed from children prior to weighing and measuring.

The Cholestech L-D-X System (Cholestech Corporation, Hayward, CA) was used to examine fasting blood total cholesterol, high-density lipoprotein (HDL-c), triglycerides, and blood glucose in adults. The capillary blood samples were obtained by fingerstick. The instrument was calibrated prior to each screening. Blood lipids and glucose values were classified according to NCEP criteria [59]. Metabolic syndrome was classified if a subject was positive for three or more indicators according to the 2005 AHA/NHLBI Scientific Statement criteria [58] such as abdominal obesity, high blood pressure, or high triglycerides, low HDL-c, and/or elevated glucose levels. Hemoglobin concentration was measured using the HemocueB analyzer (Hemocue Inc., CA) obtained from fingertip capillary blood. Iron-deficiency anemia was classified according to established hemoglobin concentration cutoff-points for anemia, age, sex, reproductive status and other factors [62].

Blood pressure data were collected from adult subjects using a calibrated manual mercury syphganometer obtained from the right arm of seated subjects. Systolic and phase 5 diastolic pressures were measured twice to the nearest 2 mmHg and the average of the two measurements recorded. The Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, 7th Report recommendations were used to classify subject blood pressure and hypertension risk [63].

## Data Analysis

The data were entered into an SPSS database (SPSS, Chicago, IL; version 13.5). Descriptive data are presented as means ± SD, frequency counts, and percentages. Students' *t*-test or Fisher's exact test, as appropriate were used in the initial bivariate analyses to examine differences between means. Predictors of household food security status identified as significant in the initial cross-tabulation analyses were subsequently analyzed with multiple logistic regression. Adjusted odds ratios and their 95% confidence intervals were calculated from the multiple logistic regression analyses, taking the influence of covariates into account. To facilitate calculation of odds ratios, household food security status was dichotomized as: food secure versus food insecure (with or without hunger) or hunger (food insecure with hunger) versus no hunger (i.e., food secure or food insecure without hunger).

Student's *t*-test and one-way ANOVA were used, as appropriate, to analyze mean between-group differences in observed BMI. Households that reported having at least one member affected by a specific symptom during the previous 12 months (e.g., diarrhea lasting ≥3 consecutive days) or a prior medical diagnosis of a particular condition (e.g., diabetes, cancer)

were classified as positive for that symptom or condition. Anthropometric, clinical, laboratory, and other categorical health outcomes identified as having a statistically significant association ($P < 0.05$) with food security status in the bivariate analyses were subsequently analyzed with multiple logistic regression, controlling for covariates. In addition to other identified covariates, age and sex were included in all multiple logistic regression models because of the wide range of ages in our sample and the well-known association of age and sex with the different health and nutrition outcomes investigated in our study.

## Results

### Sample Characteristics

The characteristics of the adult MSFW respondents and their households are displayed in Table 1. Most of the adult respondents self-identified themselves as Mexican rather than Hispanic, Mexican-American, or from another ethnic/racial group. The majority reported that they were born in Mexico, most in the three border states of Chihuahua (34%), Coahuila (16%), and Durango (16%). Over half also indicated that they had immigrated to the U.S. sometime during the prior decade. Most respondents said that they were currently married and had at least one minor child and/or grandchild residing with them. Only a fraction said that they had any formal secondary schooling. Most described having little or no English oral or reading proficiency. The majority also described Spanish as the only language spoken in their homes. Fewer than one-quarter said that they owned a personal vehicle or their own home in the United States and only half reported having regular access to cooking or refrigerated food storage facilities. As Table 1 also shows, the major food assistance program most frequently identified as used by households during the previous 12-months was Food Stamps, and to a lesser extent, WIC. Relatively few said that they had participated in school-based child feeding programs or used assistance from local food banks. Likewise, household utilization of non-food services provided by social service, medical and other public and private agencies and organizations was low.

### Household Food Security

Eighty-two percent of the MSFW households in the study reported experiencing some degree of food insecurity during the previous 12 months; 33% had

**Table 1** Characteristics of adult respondents ($n = 100$) and their households

| Adult head of household respondent characteristics | No. | (%) |
|---|---|---|
| Sex (% male) | 57 | (57.0) |
| Age | | |
| 18–20 years | 1 | (1.0) |
| 21–30 years | 10 | (10.0) |
| 31–40 years | 24 | (24.0) |
| 41–50 years | 30 | (30.0) |
| 51–60 years | 21 | (21.0) |
| >61 years | 14 | (14.0) |
| Ethnicity (self-described) | | |
| Mexican | 79 | (79.0) |
| Hispanic/Latino | 15 | (15.0) |
| Mexican-American | 4 | (4.0) |
| Mixed Hispanic/other | 2 | (2.0) |
| Marital status | | |
| Married | 71 | (71.0) |
| Other | 29 | (29.0) |
| Formal education | | |
| ≤6 years | 76 | (76.8) |
| 7–12 years | 19 | (19.2) |
| ≥12 years | 4 | (4.0) |
| Birth place | | |
| Mexico | 82 | (82.0) |
| United States | 18 | (18.0) |
| Length of residence in US | | |
| ≤10 years | 56 | (56.0) |
| English reading proficiency | | |
| Little or none | 64 | (64.0) |
| More or less | 22 | (22.0) |
| Good or perfect | 14 | (14.0) |
| Oral English proficiency | | |
| Little or none | 72 | (72.0) |
| More or less | 20 | (20.0) |
| Good or perfect | 8 | (8.0) |
| Spanish reading proficiency | | |
| Little or none | 8 | (8.0) |
| More or less | 16 | (16.0) |
| Good or perfect | 76 | (76.0) |
| Languages spoken in home | | |
| Spanish only | 75 | (75.0) |
| English and Spanish | 23 | (23.0) |
| Other | 2 | (2.0) |
| House hold use of food assistance and other social services during prior 12-month period | | |
| Food stamps | 53 | (53.0) |
| WIC | 18 | (18.0) |
| Food bank | 2 | (2.0) |
| School lunch/breakfast | 4 | (4.0) |
| Unemployment benefits | 13 | (13.0) |
| Housing assistance | 9 | (9.0) |
| Social security | 17 | (17.0) |
| Clinic services | 20 | (20.0) |
| Medicaid | 38 | (38.0) |
| Free legal services | 8 | (8.0) |
| Children's health insurance program (CHIP) services | 5 | (5.0) |
| Current house hold size | | |
| 1 person | 15 | (15.0) |
| 2 persons | 8 | (8.0) |
| 3 persons | 12 | (12.0) |

**Table 1** Continued

| Adult head of household respondent characteristics | No. | (%) |
|---|---|---|
| 4 persons | 14 | (14.0) |
| 5 persons | 24 | (24.0) |
| 6 persons | 13 | (13.0) |
| ≥7 persons | 14 | (14.0) |
| Minor children (<18 years) living in household | 74 | (74.0) |
| U.S. home ownership | | |
| Own home in U.S. | 22 | (22.0) |
| Other (rent, borrow, live in migrant shelter) | 78 | (78.0) |
| Own a personal vehicle in U.S. | 26 | (26.0) |
| Have regular access to food storage and cooking facilities (minimum of refrigerator and stove) | 53 | (53.0) |

food insecurity without hunger and 49% had food insecurity with hunger. As Table 2 shows, food insecurity was more prevalent among households characterized by a larger size (≥5 members), the presence of minor children, and low maternal education (≤6 years) but was less frequent in those headed by an adult respondent born in the U.S. rather than Mexico. As Table 2 also indicates, hunger was more prevalent among households headed by an adult who had resided in the U.S. for 10 years or less compared to those with a longer residence time. Although a greater proportion of food insecure households with (51%) or without hunger (63.6%) participated in the Food Stamp Program compared to food secure households (38.9%), the difference was not statistically significant ($X^2 = 3.02$; $P = 0.22$). Likewise, household participation in other types of assistance programs was not a significant predictor of food security status.

Table 2 presents the results of the multiple logistic regression analysis that investigated independent predictors of household food insecurity and hunger. Minor children and low maternal education retained their positive associations with household food insecurity. However, the large 95% confidence intervals suggests an unstable association. In contrast, the previously identified associations of large household size and U.S. birthplace with food insecurity were no longer significant. In contrast, shorter (≤10 years) U.S. residence was still associated with hunger even after covariate adjustment.

## Overweight and Obesity

The average BMI of the adult respondent from each household was 30.8 ± 6.3 kg/m$^2$. Based on their BMI's, 15% were classified as normal weight, 19% as overweight, and 66% as obese. The majority of subjects also had a high waist circumference (66%) indicative of central body adiposity. The mean BMI of women respondents was significantly increased compared to their male counterparts ($\bar{X} = 33.5 \pm 6.6$ vs. $28.8 \pm 5.3$; $t = 4.0$; $P = 0.0001$). In addition, a significantly greater proportion of women than men had BMI's classifying them as overweight (92.9% vs. 73.7%; $X^2 = 6.0$; $P = 0.015$) or obese (73.8% vs. 40.4%; $X^2 = 10.2$; $P = 0.001$) and they were more likely to show evidence of central body adiposity (85.7% vs. 36.4%; $X^2 = 21.7$; $P = 0.0001$).

No statistically significant differences were identified among households classified as food insecure without hunger versus food insecure with hunger versus food secure regarding the proportion of women who were classified as overweight (100% vs. 90.9% vs. 85.7%; $X^2 = 0.44$; $P = 0.44$), obese (69.2% vs. 77.3% vs. 71.4%; $X^2 = 0.30$; $P = 0.86$), or with central body adiposity (84.6% vs. 86.4% vs. 85.7%; $X^2 = 0.20$; $P = 0.99$). Likewise, no statistically significant differences were observed in the proportion of men from food insecure without hunger versus food insecure with hunger versus food secure households identified as overweight (80.6% vs. 65.4% vs. 81.8%; $X^2 = 1.71$; $P = 0.43$), obese (100% vs. 90.9% vs. 85.7%; $X^2 = 1.15$; $P = 0.56$) or with central body adiposity (40% vs. 34.6% vs. 36.4%; $X^2 = 0.14$; $P = 0.93$). The same general pattern was found in the other analyses examining household hunger and these anthropometric indicators (results not shown).

Table 3 presents the results of bivariate analyses that investigated the association of household food security status and adult anthropometric indicators. As shown, there was a lack of statistically significant differences in the proportion of food insecure versus food secure adults classified with overweight, obese, or central body adiposity. However, several of the previously identified covariates associated with household food security status also were associated with these anthropometric indicators. For instance, living in a household with minor children was positively associated with adult overweight ($P = 0.049$). Residence in a home head by an adult born in the U.S. was positively associated with obesity ($P = 0.007$) and a high waist circumference ($P = 0.023$). Residence in a households with five or more members was associated with both increased adult obesity ($P = 0.046$) and a high waist circumference ($P = 0.034$). Low maternal education was negatively associated with a high waist circumference ($P = 0.022$). However, the inclusion of these covariates in their respective multiple logistic regression models did not significantly alter the initial bivariate results (Table 3).

Based on their BMI's, 57.6% of the study children had normal weight for their age and sex. The rest

**Table 2** Predictors of household food insecurity and hunger

| | Any food insecurity | | | Food insecurity with hunger | | |
|---|---|---|---|---|---|---|
| | No. (%) | Crude odds ratio (95% CI) | Adjusted odds ratio (95% CI)[a] | No. (%) | Crude odds ratio (95% CI) | Adjusted odds ratio (95% CI)[a] |
| Minor children | | | | | | |
| Any present | 65 (87.8) | 3.82 (1.32, 11.2) | 9.29 (1.34, 14.7) | 39 (52.7) | 1.78 (0.72, 4.44) | 2.30 (0.47, 11.2) |
| None present | 17 (65.4) | 1.00 (ref. category) | 1.00 (ref. category) | 10 (38.5) | 1.00 (ref. category) | 1.00 (ref. category) |
| Household size | | | | | | |
| ≥5 persons | 46 (90.2) | 3.32 (1.08, 10.2) | 1.45 (0.29, 7.20) | 27 (52.9) | 1.38 (0.63, 3.03) | 1.10 (0.38, 3.15) |
| <5 persons | 36 (73.5) | 1.00 (ref. category) | 1.00 (ref. category) | 22 (44.9) | 1.00 (ref. category) | 1.00 (ref. category) |
| Maternal education | | | | | | |
| 0–6 years | 53 (91.4) | 4.24 (1.14, 15.8) | 19.41 (1.73, 218) | 30 (51.7) | 1.18 (0.43, 3.20) | 1.30 (0.41, 4.09) |
| 7–11 years | 12 (80.0) | 1.00 (ref. category) | 1.00 (ref. category) | 9 (60.0) | 1.00 (ref. category) | 1.00 (ref. category) |
| ≥12 years | 3 (50.0) | 0.12 (0.02, 0.72) | 0.06 (0.006, 0.49) | 1 (16.7) | 0.17 (0.02, 1.57) | 1.83 (0.48, 6.90) |
| Birthplace | | | | | | |
| United States | 11 (61.1) | 0.24 (0.08, 0.76) | 0.17 (0.34, 7.58) | 5 (27.8) | 0.33 (0.11, 1.02) | 0.38 (0.10, 1.44) |
| Mexico | 71 (86.6) | 1.00 (ref. category) | 1.00 (ref. category) | 44 (53.7) | 1.00 (ref. category) | 1.00 (ref. category) |
| Time in U.S. | | | | | | |
| ≤10 years | 38 (86.4) | 1.73 (0.59, 5.05) | 1.60 (0.34, 7.58) | 27 (61.4) | 2.46 (1.09, 5.52) | 2.65 (1.02, 6.90) |
| >10 years | 44 (78.6) | 1.00 (ref. category) | 1.00 (ref. category) | 22 (39.3) | 1.00 (ref. category) | 1.00 (ref. category) |

[a]Adjusted for other variables in model

were classified as at risk for underweight (4.6%), at risk for overweight (10.4%), or overweight (27.4%). No statistically significant differences were observed in the prevalence of overweight girls versus overweight boys. Food insecure families were more likely to have at least one overweight child compared to their food secure counterparts (56.8% vs. 14.3%; Fisher's $P = 0.047$). However, this statistically small difference disappeared in the multivariate analysis after controlling for covariates. Although a greater proportion of households with hunger had at least one overweight child, the difference also was not statistically significant (63.6% vs. 36.4%; $X^2 = 2.27$; $P = 0.13$).

## Laboratory and Clinical Indicators

The laboratory and clinical data analyses revealed that approximately half of the adult respondents had elevated total blood cholesterol (51%), elevated blood triglycerides (58%), or low HDL-c (45.8%). Around 30% had high systolic and diastolic blood pressures (≥130/85 mmHg) or fasting glucose levels (>100 mg/dl). Fifty-six percent of the adults were positive for three or more AHA/NHLBI criteria [58] suggestive of metabolic syndrome. In addition, nearly one-quarter (23.2%) had blood hemoglobin levels falling below the cut-off point for iron-deficiency anemia (IDA) after adjustment for age, sex, smoking and reproductive status [62]. In the bivariate analyses, no statistically significant associations were identified between household food security status and the categorical laboratory and clinical indicators of adult health status (Table 3). However, one of the previously identified covariates, minor children in the household, was associated with elevated blood glucose ($P = 0.037$) and blood triglycerides ($P = 0.049$). Another covariate, U.S. birthplace, was associated with higher blood glucose. However, the inclusion of these and the other covariates in the multiple logistic regression models did not significantly change the findings from the initial bivariate analyses.

## Self-Reported Health Symptoms

The physical health symptoms most frequently reported as having affected at least one household member during the previous 12 months were: dental caries (73.9%), itchy or irritated eyes (50%), and musculoskeletal problems such as pain in the back (58%), knee (63%), hand (30%), foot (30%) or neck (19%) that had lasted for at least one week. Other frequently reported symptoms were diarrhea lasting for three or more consecutive days (17%), and stomach aches (18%) or vomiting (11%) that occurred three or more times in a single week, painful/difficult urination (19%), earache (20%), wheezing (18%), chronic cough (11%), serious cuts/abrasions (16%) and broken bones (10%).

The two household food insecurity categories (with and without hunger) were collapsed into a single category, any household food insecurity, after the initial $3 \times 2$ contingency table analyses with $X^2$ showed no statistically significant between-group differences in

**Table 3** Association of Household Food Security Status with Anthropometric, Clinical and Laboratory Indicators of Adult Health Status

| Indicators | No. (%) | Odds ratio (95% CI) | Adjusted odds ratio (95% CI)[a] |
|---|---|---|---|
| Overweight (BMI > 25 kg/m$^2$) | | | |
| Food insecure with hunger | 38 (77.6) | 0.54 (0.19, 1.52) | 3.03 (0.57, 16.1) |
| Food insecure without hunger | 29 (87.9) | 0.88 (0.23, 3.43) | 2.52 (0.19, 33.6) |
| Food secure | 15 (83.3) | 1.00 (ref. category) | 1.00 (ref. category) |
| Obesity (BMI ≥ 30 kg/m$^2$) | | | |
| Food insecure with hunger | 30 (61.2) | 1.59 (0.72, 3.52) | 0.69 (0.23, 2.03) |
| Food insecure without hunger | 17 (51.5) | 1.64 (0.59, 4.59) | 1.36 (0.24, 7.7) |
| Food secure | 8 (44.4) | 1.00 (ref. category) | 1.00 (ref. category) |
| Abdominal obesity: high waist circumference (adult males: ≥102 cm.; adult females ≥88 cm) | | | |
| Food insecure with hunger | 28 (58.3) | 1.06 (0.48, 2.36) | 0.99 (0.43, 2.27) |
| Food insecure without hunger | 20 (60.6) | 1.11(0.40, 3.10) | 0.91 (0.31, 2.70) |
| Food secure | 10 (55.6) | 1.00 (ref. category) | 1.00 (ref. category) |
| Elevated total blood cholesterol (>200 mg/dl) | | | |
| Food insecure with hunger | 20 (40.8) | 0.53 (0.24, 1.17) | 0.53 (0.73, 1.21) |
| Food insecure without hunger | 22 (66.7) | 1.16 (0.42, 3.21) | 1.22 (0.42, 3.53) |
| Food secure | 9 (50.0) | 1.00 (ref. category) | 1.00 (ref. category) |
| Low HDL blood cholesterol (males < 40 mg/dl; females < 50 mg/dl) | | | |
| Food insecure with hunger | 19 (39.6) | 1.18 (0.53, 2.64) | 1.49 (0.63, 3.51) |
| Food insecure without hunger | 11 (36.7) | 0.81 (0.29, 2.27) | 1.08 (0.36, 3.26) |
| Food secure | 9 (50.0) | 1.00 (ref. category) | 1.00 (ref. category) |
| Elevated blood triglycerides (>150 mg/dl) | | | |
| Food insecure with hunger | 28 (57.1) | 0.93 (0.42, 2.07) | 1.20 (0.52, 2.80) |
| Food insecure without hunger | 21 (63.6) | 1.48 (0.53, 4.13) | 2.04 (0.66, 6.29) |
| Food secure | 9 (50.5) | 1.00 (ref. category) | 1.00 (ref. category) |
| Elevated fasting blood glucose (>100 mg/dl) | | | |
| Food insecure with hunger | 12 (24.5) | 0.60 (0.25, 1.42) | 1.29 (0.41, 4.1) |
| Food insecure without hunger | 10 (30.3) | 0.46 (0.16, 1.31) | 1.99 (0.36, 11.2) |
| Food secure | 8 (44.0) | 1.00 (ref. category) | 1.00 (ref. category) |
| Elevated blood pressure (≥130/85 mmHg) | | | |
| Food insecure with hunger | 12 (24.5) | 0.53 (0.22, 1.26) | 0.56 (0.23, 1.36) |
| Food insecure without hunger | 12 (37.5) | 0.66 (0.23, 1.91) | 0.71 (0.23, 2.15) |
| Food secure | 7 (38.9) | 1.00 (ref. category) | 1.00 (ref. category) |
| Metabolic syndrome[b] | | | |
| Food insecure with hunger | 26 (53.1) | 0.79 (0.36, 1.75) | 0.82 (0.36, 1.85) |
| Food insecure without hunger | 20 (60.6) | 1.02 (0.43, 2.85) | 1.02 (0.59, 2.97) |
| Food secure | 10 (55.6) | 1.00 (ref. category) | 1.00 (ref. category) |
| Iron-deficiency anemia[c] | | | |
| Food insecure with hunger | 3 (16.7) | 1.44 (0.57, 3.70) | 1.63 (0.60, 4.40) |
| Food insecure without hunger | 7 (21.9) | 1.63 (0.43, 6.25) | 1.32 (0.32, 5.41) |
| Food secure | 13 (26.5) | 1.00 (ref. category) | 1.00 (ref. category) |

[a]Adjusted for model covariates: minor children living in household, maternal education, U.S. residence time, age and sex

[b]Based on AHA/NHLBI criteria [58]

[c]Based on established hemoglobin concentration cutoff-points for anemia adjusted for age, sex, reproductive status and other factors [62]

the frequency of reported physical symptoms. The results of the subsequent $2 \times 2$ contingency table analyses with $X^2$ revealed that a significantly greater proportion of food insecure compared to food secure households had at least one member who had experienced diarrhea episodes lasting for ≥ 3 consecutive days (24.5% vs. 30% vs. 0%; $P = 0.010$) or ≥3 days of stomach aches within a single week (22% vs. 0%; Fisher's $P = 0.037$). Within families, children and adults were equally affected. Household food security status was not associated with the other physical health symptoms noted above. Although one of the covariates, ≤10 years residence in U.S., was positively associated with stomach ache ($P = 0.008$), the inclusion of

this covariate in the multiple logistic regression analysis did not significantly alter the initial bivariate analysis results.

*Nervios* (41%), *deprimido* or depression (37%), and *corajes* (24%) were the ethnospecific/mental health symptoms most often reported by adult respondents to have affected one or more of their household members during the prior 12 months. Other conditions such as *latido* (17%), *aires* (15%), *sustos/espantos* (12%), *empachos* (11%), *embrujado* (7%), and *mal de ojo* (3%) were reported with less frequency. For the analyses of the association of food security status with ethnospecific/mental health symptoms, we collapsed the two household food insecurity categories into a single category, food insecurity, after the initial $3 \times 2$ contingency table analyses with $X^2$ showed a lack of statistically significant differences between these two and the outcomes analyzed. The results of the subsequent $2 \times 2$ cross-tabulation analyses revealed that symptoms of *deprimido* (42.7% vs. 11.1%; OR = 6.0; 95% CI = 1.28, 27.6) or *nervios* (53.1% vs. 29.4%; OR = 2.71; 95% CI = 1.19, 6.18) were more common among food insecure compared to food secure households. However, no other statistically significant associations were identified between household food security status and the other ethnospecific or mental health symptoms reported by the adult respondents for their households.

One of the previously identified covariates, minor children, was associated with both *deprimido* ($P = 0.01$) and *nervios* ($P = 0.04$) symptoms. However, even after adjustment for these, the previously identified positive association of any household food insecurity with *deprimido* symptoms was still apparent in the multiple logistic regression analysis (AOR = 4.80; 95% CI = 1.02, 22.9). Similar results were found for the multiple logistic regression model that examined the association of food insecurity with hunger (AOR = 2.41; 95% CI = 1.04, 5.63).

### Physician-Diagnosed Conditions

The physician-diagnosed conditions most often reported by the respondents for any of the children or adults in their households were: allergies (34%), hypertension (30%), diabetes (28%), skin disorders (25%), arthritis/rheumatism (16.2%), learning disabilities (15%), and neurological disorders (11%). Asthma (7%), cardiovascular disease (5%), tuberculosis (8%) hepatitis (5%), and cancer (4%) were reported with less frequency. The bivariate analyses results identified a greater proportion of households that were food insecure than food secure households had at least one child who had been previously diagnosed with a learning disability (18.3% vs. 0%; Fisher's $P = 0.031$). However, no other statistically significant associations were identified between household food security status and other physician-diagnosed conditions including neurological disorders, hypertension, cardiovascular diseases, diabetes, arthritis/rheumatism, asthma, skin disorders, cancer, tuberculosis or hepatitis.

## Discussion

The overall prevalence of food insecurity (82%) reported by the U.S.–Mexico border MSFW households in the study was very high as was that of hunger (49%). Although similar to low-income Hispanic and Asian legal immigrants [4], food insecurity was increased two-to-eightfold over figures recorded for the general U.S. population, low-income Hispanics [1, 2] and east coast MSFW [8, 9] by studies that all used the same U.S. FSS measurement tool. The presence of minor children and low maternal education were significant predictors of household food insecurity, a finding that is consistent with reports on North Carolina MSFW [9], legal Hispanic/Asian immigrants [4], and other low income U.S. groups [16, 64, 65]. The participation of the border MSFW families in public or private assistance programs was low but not unlike what has been reported for other MSFW [6, 8, 9] and non-MSFW immigrants [4]. At 53%, the enrollment of border families in the Food Stamp Program was somewhat higher than that recently noted for other MSFW households [8, 9].

It has been suggested that participation in the Food Stamp Program can reduce the risk of families for food insecurity [64]. However, this did not seem to be the case for the study households, similar to the situation reported for some MSFW [9] and non-MSFW groups [4, 66]. While this could be due to a disparity between food needs and the amount provided by food stamps and other supplemental programs, it also is possible that it could have resulted from other barriers not directly addressed by our study. For example, some of the families may have not known about the services or believed that they were not eligible. It also is possible that some eligible households were not able to access services on a regular basis due to a lack of transportation or work and travel schedules. It also is unclear whether they experienced access barriers to food banks, soup kitchens, and other private services providing food or meals to disadvantaged groups. These important questions require further investigation.

To the best of knowledge, the present work is the first to explore the relation between the food security

status of Hispanic MSFW households and their health outcomes. It also is the first to examine the association of household food security with ethnospecific symptoms in any U.S. minority group. The finding that symptoms of *nervios* and depression were more common in food insecure MSFW households is noteworthy as it reinforces findings from prior studies of other subpopulations linking food insecurity (or food insufficiency) with depression and other adverse mental health outcomes [15, 16, 38, 40]. Our results suggest that having an inadequate supply of food may exacerbate the already high level of stress and anxiety suffered by this immigrant group [22, 45–47, 67, 68] due to low wages, unstable employment, workplace violence, difficult working and living conditions, social and linguistic isolation, and in the case of the undocumented, fear of deportation.

The study results confirmed that learning disabilities were more frequent among the MSFW children from food insecure homes similar to what prior authors have reported for children who live in homes with inadequate food supplies are more likely to be affected by learning disabilities [40, 41], poor academic performance [44], and the need for special education classes [69]. Having access to a regular supply of food is particularly important for children since they are vulnerable to the adverse effects of inadequate dietary energy, protein, and micronutrients during critical periods of brain and central nervous system development [70]. The study results underscore the need to improve the existing food safety net of MSFW families especially those with children.

In our study, gastrointestinal tract symptoms suggestive of infection were more frequent in food insecure compared to food secure households. Children and adults were equally affected. Although not yet studied in adults, prior authors have reported a high frequency of stomach ache, diarrhea, and infectious illnesses in children from food insecure homes [33, 34]. Susceptibility to infections could be the result of reduced immune response associated with poorer nutrition [35] and/or increased exposure to food- and waterborne pathogens caused by reduced access to adequate sanitary food storage and preparation facilities. In addition, food insecure families may purchase sale food near or past the expiration date or engage in other behaviors such as eating leftovers that others would normally discard, remove spoiled sections from decayed foods, scavenging leftover or discarded food from garbage dumpsters, and eating road kill [71]. Although these practices may help families to stretch their food supply, at the same time, it may increase their exposure to illness.

In this study, of every ten adults, eight were classified with overweight, seven with central body adiposity, and five with obesity or elevated total blood cholesterol, high blood triglycerides, or low HDL-c levels. In addition, three of every ten exhibited evidence of elevated blood pressure or glucose. Nearly six out of every ten adults was positive for three or more indicators that were suggestive of metabolic syndrome. These figures, along with those recently published for other Hispanic Texas and California MSFW [8, 9] suggests that despite an ostensibly physically active lifestyle, this group is at high risk for developing diabetes, hypertension, cardiovascular disease, and other serious obesity-related chronic diseases. Different from our a priori hypothesis, no statistically significant associations were identified in the dataset between household food security status and these health indicators.

Since this is the first study to investigate the association of household food security status with indicators of central body adiposity, blood glucose and lipids, blood pressure, and metabolic syndrome, we cannot compare our results with other authors. However, our results are in agreement with several reports showing a lack of association between household food insecurity (or food insufficiency) and child overweight in non-MSFW groups [5, 15, 72]. They also concur with other multivariate studies that reported a similar lack of statistically significant associations between household food insecurity (or concern about food) and overweight/obesity in adult men [12, 29] and women [73], after controlling for confounders. However, our results differ from other authors who identified an increased risk for overweight [12] or obesity [3, 13, 14] among food insecure Hispanic and non-Hispanic women. The reason(s) for this is not immediately evident. They could be the result of differences in the characteristics of the populations studied but it also is possible that they reflect differences in the instruments used to measure the different but related concepts of food insecurity, food insufficiency, and concern about food. In addition, the use of self-reported rather than direct measurements of weight and height to calculate BMI and differences in BMI cut-off points, subject selection methods, sample size, and covariate control could have influenced the results.

It is important to consider both the strengths and limitations of this study when interpreting its data. One strength was the utilization of objective anthropometric, laboratory, and clinical indicators. This approach reduces memory bias and other potential sources of random and systematic error when using self-reports of body weight, height, blood pressure, and blood glucose

and lipid levels. Another strength was the use of the CAWHS and U.S. Food Security Scale instruments both of which have been previously validated in Hispanic groups such as MSFW and other Mexican immigrants [1, 22]. The use of these two established instruments also makes it possible to compare our findings with national, regional and/or other local populations. In the present study, all of the adult respondents were interviewed in their preferred language (Spanish) by native speakers from the same border area. Thus, many potential sources of bias were minimized which can occur when interviews are conducted in more than one language, e.g., response frequency and interpretive bias. Another study strength was the use of multivariate analytic techniques that controlled for potential sources of confounding.

Some possible limitations of the study were the use of non-random sampling methods and a small sample size which could have introduced bias. It was necessary to use a site-based convenience sampling method because no census data were available for MSFW households in the Paso del Norte study area. Although not ideal, this type of sampling procedure was the only way that we were able to access this mobile, difficult-to-reach group. Convenience sampling requires caution when generalizing the findings to the larger population or even other MSFW groups. However, our data were in very close agreement on multiple objective and self-reported health outcomes with studies recently carried in a large study of California MSFW [22] and Paso del Norte border region MSFW [23]. This increases confidence that any sampling bias that may have occurred was minimal.

Another possible limitation was the unexpectedly high prevalence of household food insecurity and adult overweight/obesity, blood lipids, metabolic syndrome and several other health outcomes. This affected the amount of statistical contrast available for some of the analyses and could have reduced the study's ability to detect significant differences if they existed. Another possible limitation pertains to the uniform assignment of all household members to only one food security category when using the U.S. Food Security Scale. This classification scheme does not take into account potential individual differences in eating patterns, food coping strategies, or other behaviors that could occur within the same household. Finally, the cross-sectional design of the study limits our ability to infer causation. In this study, household food security status was linked with different developmental, mental and physical health outcomes. This suggests that multiple pathways are involved in these relationships. Future studies that employ a prospective longitudinal instead of a cross-sectional design and the use of a standardized instrument with the ability to differentiate the food security status of individuals within a household are needed in order to ascertain the true nature of the associations reported here.

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