Household food insecurity, diabetes and hypertension among Mexican adults: Results from Ensanut 2012

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Abstract

Objective. To examine the independent association of household food insecurity (HFI) with diabetes and hypertension in a nationally representative cross-sectional sample from Mexico. **Materials and methods.** We assessed the association between HFI and self-reported doctor diagnosed diabetes and hypertension among 32 320 adult individuals using multiple logistic regression. HFI was measured using an adapted version for Mexico of the Latin American and Caribbean Food Security Scale (ELCSA). **Results.** HFI was a risk factor for diabetes among women but not men and for hypertension among both genders. Diabetes odds were higher by 31, 67 and 48%, among women living in mild, moderate, and severe food-insecure (vs. food-secure) households, respectively. Living in moderate to severe food-insecure (vs. food-secure) households was associated with hypertension odds that were 28 and 32% higher, respectively. **Conclusion.** Decreasing HFI may help improve public health and national development in Mexico.

Key words: diabetes mellitus; food security; hypertension; nutrition surveys; Mexico

Resumen

Objetivo. Examinar la asociación independiente entre la inseguridad alimentaria en el hogar (IAH) y la diabetes e hipertensión en una encuesta transversal nacionalmente representativa de México. **Material y métodos.** Se evaluó la asociación entre IAH y el autorreporte por un médico de diagnosis de diabetes o hipertensión en 32 320 adultos utilizando regresión logística múltiple. La IAH se midió con la Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA). **Resultados.** La IAH fue un factor de riesgo para diabetes en mujeres, pero no en hombres, y para la hipertensión en ambos géneros. Comparado con hogares con seguridad alimentaria, los momios de diabetes fueron 31, 67, y 48% más altos entre mujeres viviendo en hogares con inseguridad alimentaria leve, moderada y grave, respectivamente. La IAH moderada y grave se asoció con momios de hipertensión 28 y 32% más altos. **Conclusión.** Disminuir la IAH puede mejorar la salud pública y el desarrollo nacional de México.

Palabras claves: diabetes mellitus; seguridad alimentaria; hipertensión; encuestas nutricionales; México

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Household food insecurity (HFI) is defined as lack of access to a diet of sufficient quality and quantity to lead an active healthy life.[1] Type 2 diabetes and hypertension are chronic conditions that account for a significant proportion of the burden of disease in Mexico and the Latin American and Caribbean Region as a whole.[2] Because both conditions are often present simultaneously they represent a syndemic[3] with major public health implications. According to the 2012 Mexican National Health and Nutrition Survey (Ensanut 2012), over 9% of Mexican adults (6.4 million individuals) have been diagnosed with diabetes by a doctor with this, prevalence ranging from 5.6% in the State of Chiapas to 12.3% in Mexico City. Among those reporting diabetes almost half (47%) also reported having been diagnosed with hypertension,[4,5] which highlights the seriousness of this syndemic in the Mexican population. Ensanut 2012 also documented in a subsample of survey participants who had their blood pressures measured that 31.5% had hypertension and that almost half (47.3%) didn't know they had this condition.[6]

HFI is highly prevalent in Mexico[7] and there are theoretical reasons to expect that it may be an independent risk factor for the development of both type 2 diabetes and hypertension. HFI has been associated with poor dietary quality, obesity, depression, and stress.[8-14] Obesity is a well established risk factor for both diabetes and hypertension and poor dietary quality may also affect blood sugar levels and blood pressure independent of obesity.[15,16] High cortisol levels associated with mental and biological stress have been linked with higher visceral fat deposition, a major risk factor for type 2 diabetes.[8]

In spite of their high prevalence in Mexico, we are unaware of any study that has examined the association of HFI with diabetes and hypertension. Examining these relationships is crucial as both HFI and the diabetes epidemic have worsened over the past decade.[5,7] While 4.6% of the adult population reported having diabetes in the year 2 000, this prevalence increased to 7.3% by 2006 and by 9.2% in 2012.[5] Thus, the objective of this study is to examine the independent association of HFI with diabetes and hypertension in a nationally representative cross sectional sample from Mexico. Findings have major public health implications for preventing diabetes and hypertension in Mexico, where the Government is in the process of implementing major initiatives to reduce HFI.

Materials and methods

Ensanut 2012

Data were derived from the Ensanut 2012, a probabilistic survey with a complex sampling design involving stratification and clustering. Ensanut 2012 is representative at the national, regional and state level, as well as of the rural and urban strata. The sampling framework was drawn from the 2005 Population Census, disaggregated by primary sampling unit and taking into account the list of new localities identified in the 2010 Census. Additional specific survey design details including sampling procedures, have been reported elsewhere.[17] Ensanut 2012 data were collected between October 2011 and May 2012 in 50 528 households with a response rate of 87%. The households interviewed were distributed across all 31 states and the Federal District and represented the estimated 29 429 252 households that conformed Mexico in 2012 according to the 2010 Census and population growth estimates.

Household food insecurity measurement

HFI was measured with the well validated Latin American and Caribbean Food Security Scale (ELCSA).[18] This experience-based scale includes 15 items that capture different levels of severity of the HFI-hunger continuum, using as reference the three months preceding the survey. Eight of the items refer to aspects of the food insecurity situation in the household or among adults living in the household and seven items apply to minors (i.e., individuals under 18 years of age) living in the household. Each of the 15 questions is responded as yes, no, don't know or refused. The HFI level of each household is determined by adding the number of affirmative responses to each of the ELCSA questions. Per Ensanut 2012 protocol, ELCSA was mostly responded by the main household meal preparer, who in the great majority of cases was a woman. In the few instances when this was not possible ELCSA was answered by an alternative adult with knowledge of the food situation in the household.

Variables

Outcome variables: The two outcome variables were self report of diabetes and hypertension among adults in response to the question: '¿Algún médico le ha dicho que tiene diabetes o el azúcar alta en la sangre?' (Has a doctor told you that you have diabetes or high blood sugar?) and '¿Algún médico le ha dicho que tiene la presión alta o hipertensión?' (Has a doctor told you that you have high blood pressure or hypertension?).

Independent variable: The independent variable was HFI severity. Because we were interested only in the adult population we classified households into the following mutually exclusive categories based on the additive score of the 8 adult ELCSA items and the recommended cut-off points:[15] food-secure household (score=0); mild HFI (1-3); moderate HFI (4-6); severe HFI (7-8).

Covariates: The covariates included in the univariate analyses and multiple regression models were respondent's age (continuous in years), gender (female, male); attained education (none, elementary, junior high school ['secundaria'], senior high school ['preparatoria'], college, masters/doctorate, area of residence (urban, rural), socioeconomic level (quintiles derived from principal component analysis of household construction materials, urban services [water, sanitation, electricity], and household appliances), health care system affiliation (none, five public systems, private, 'other'), and body mass index (low, normal, overweight, obese). The inclusion of these covariates was based on known risk factors for diabetes and hypertension and the confounders that previous studies have included when examining the associations between HFI and chronic diseases.[8,19]

Data analyses

The analytic sample for this study was based on the 40 809 households with HFI data. These households represented a universe of 29 099 600 Mexican households.

Statistical analyses

The 'svy' module from Stata (version 12) was used to conduct univariate and multiple regression analyses adjusting estimates for the complex survey design, taking into account the expansion factor, strata and primary sampling unit parameters to ensure that the results were representative of the Mexican population. Univariate analyses compared the outcomes (diabetes and hypertension), covariates (respondent's age and education level) by gender as preliminary analyses identified a strong interaction between household food insecurity and gender on diabetes and hypertension. Multiple binomial logistic regression was used to assess the independent influence of HFI on diabetes and hypertension after adjusting for covariates. Separate regression models were run for diabetes and hypertension and for women and men. In each of the models the independent variable was HFI severity entered as a categorical variable. Covariates attained education, area of residence, socioeconomic level, health care system affiliation, and body mass index were entered as categorical variables and age as a continuous variable.

For categorical variables univariate analyses results were expressed as percentages and their corresponding 95% CIs. Differences between sub-categories were considered to be statistically significant if their 95% CIs didn't overlap. Multiple regression results were expressed as Adjusted Odds Ratios (AOR) and their corresponding 95% confidence intervals (95CIs). Results were considered to be statistically significant if the 95% CI excluded the value of 1.

Ethical considerations

All participants signed an informed consent form prior to responding to the survey. The Ensanut 2012, its survey and consent form were approved by the Ethics Committee of the National Institute of Public Health. Only unidentified public domain data were used in the secondary data analyses conducted for this study.

Results

Sample characteristics

The prevalence of self-reported doctor-diagnosed diabetes was 9.45%; 10.01% in women vs. 8.83% in men. Likewise the overall rate of hypertension was 16.21%, being higher in women than in men (19.17 vs. 12.98%) (table I). Women were less likely to live in food-secure households than men (27.54 vs. 30.46%). Consistent with this, women were less likely to have completed college (9.39 vs. 12.93%). Slightly over 30% of respondents lived in moderate to severe food-insecure households: 31.7% of women vs. 28.9% of men. Over 8% of respondents did not have formal education; 9.41% among women vs. 7.07% among men. Women and men were about 42y old (table I).

Household food insecurity, diabetes and hypertension: Univariate analyses

The prevalence of diabetes was higher among women living in mild, moderate and severe food-insecure households compared with their counterparts living in food-secure households (9.99, 12.29 and 11.27 vs. 7.88%). However, this association was not found among men where the corresponding prevalences were 8.65, 9.11 and 8.41% (vs. 9.06%), respectively (table II).

The prevalence of hypertension was higher among women living in moderate and severe food-insecure households compared with their counterparts living in food-secure households (21.10, 21.88 vs. 16.98%). However, this association was not observed among men, where the corresponding prevalences were 13.17, 13.46 and 11.14 vs. 13.06%, respectively (table II).

Among women, an inverse association was found between diabetes prevalence and education. By contrast, among men this association was U-shaped. Regarding hypertension an inverse association was found with education among women, but this association was U-shaped among men.

Table I
Sample descriptive characteristics by gender. Mexico, Ensanut 2012*

| | % (N, thousands) [95%CI] | | |
	All	Women	Men
Sample	100 (55235.3) [NA]	52.26 (28868.2) [51.43-53.09]	147.74 (26367.1) [46.91-48.57]
Diabetes	9.45 (5220.3) [9.01-9.91]	10.01 (2891.1) [9.38-10.68]	8.83 (2329.2) [8.18-9.54]
Hypertension	16.21 (8955.9) [15.57-16.87]	10.01 (2891.1) [9.38-10.68]	12.98 (3421.8) [12.18-13.82]
Food insecurity			
Food-secure	28.93 (15980.5) [27.97-29.91]	27.54 (7949.9) [26.40-28.70]	30.46 (8030.5) [29.20-31.74]
Mild FI	40.70 (22478.9) [39.86-41.54]	40.75 (11764.3) [51.43-53.09]	40.64 (10714.6) [39.44-41.85]
Moderate FI	19.09 (10543.5) [18.33-19.87]	19.74 (5699.6) [18.83-20.69]	18.37 (4843.9) [17.37-19.42]
Severe FI	11.28 (6232.4) [10.74-11.85]	11.97 (3454.4) [11.27-12.70]	10.54 (2778.0) [9.78-11.34]
Education			
None	8.30 (4582.7) [7.84-8.78]	9.41 (2717.3) [8.79-10.08]	7.07 (1865.4) [6.51-7.68]
Elementary	34.18 (18879.6) [32.22-35.16]	35.4 (10219.7) [34.24-36.58]	32.84 (8659.9) [31.53-34.18]
Junior high	27.69 (15297.0) [26.83-28.58]	27.0 (7795.5) [25.86-28.17]	28.45 (7501.5) [27.26-29.67]
Senior high	18.04 (9966.6) [17.31-18.8]	18.22 (5260.5) [17.25-19.24]	17.85 (4706.1) [16.83-18.91]
College	11.08 (6121.2) [10.34-11.87]	9.39 (2710.6) [8.60-10.24]	12.93 (3410.6) [11.92-14.03]
Masters/ Doctorate	0.71 (388.2) [0.64-1.12]	0.57 (164.5) [0.41-0.80]	0.85 (223.7) [0.55-0.89]
	Average Age ± SD yrs N		
Age	42.4±16.4 (55235.3)	42.4±16.3 (28868.2)	42.3±16.5 (26367.1)

* Expanded N reported throughout table
FI= food insecurity

The prevalence of diabetes and hypertension was higher in urban than rural areas among women and men. Socioeconomic level was not associated with diabetes among women but was positively associated among men. Regarding hypertension, socioeconomic level presented an inverse-U shaped relationship among women and a positive relationship among men. Among women, not being affiliated with any health care system was associated with lower prevalence of diabetes compared with being affiliated with any of the five public systems. Similar findings were found among men except that being affiliated with 'Seguro Popular' was not associated with a higher prevalence of diabetes (vs. no affiliation with any system). In both men and women hypertension prevalence was higher among those affiliated with any of the public systems (vs. no affiliation with any system). A dose-response relationship was found between BMI categories, and prevalence of diabetes and hypertension among both women and men.

Household food insecurity, diabetes and hypertension: Multiple regression analyses

The odds of reporting diabetes were higher among women living in food-insecure households but not among men (table III). Among women the odds of diabetes were 31% higher in mild FI, 67% higher in moderate FI, and 48% higher in severe FI households, compared with food-secure households. In women's hypertension model this association was evident only with the most severe level of HFI (OR [95%CI]): 1.28 [1.02-1.62]). Among men there was no significant association between household food insecurity level and diabetes, but there was a marginally significant association with hypertension (*p*=0.072). Among men the odds of hypertension were 25% higher in mild FI, 41% higher in moderate FI, and 35% higher in severe FI households (*p*=0.072) (table III). When combining men and women in a single model (data not shown) the odds of hypertension were 28% (95%CI: 1.08-1.52) higher among moderate

Table II
Prevalence of diabetes and hypertension across food insecurity categories by gender.
Mexico, Ensanut 2012

	Diabetes		Hypertension	
	Women	Men	Women	Men
	% [95%CI]		% [95%CI]	
Food Insecurity				
Food-secure	7.88 [6.92-8.96]	9.06 [7.82-10.47]	16.98 [15.33-18.77]	13.06 [11.62-14.65]
Mild FI	9.99 [9.03-11.03]	8.65 [7.66-9.74]	18.92 [17.51-20.42]	13.17 [11.91-14.55]
Moderate FI	12.29 [10.69-14,09]	99.11 [7.56-10.95]	21.10 [19.01-23.35]	13.46 [11.62-15.55]
Severe FI	11.27 [9.66-13.10]	8.41[6.53-10.77]	21.88 [19.37-24.60]	11.14 [8.98-13.73]
Education				
None	19.94 [17.41-22.74]	12.32 [9.85-15.30]	31.41[28.49-34.49]	17.02 [14.28-20.16]
Elementary	15.35 [14.08-16.71]	11.59 [10.37-12.92]	26.60 [25.02-28.23]	16.44 [15.02-17.96]
Junios high	5.74 [4.83-6.81]	7.06 [5.82-8.54]	13.43 [11.78-15.28]	10.08 [8.63-11.74]
Senior high	3.90 [3.12-4.86]	6.38 [5.02-8.07]	12.36 [10.38-14.66]	10.01 [8.26-12.08]
Senior high	4.63 [3.06-9.56]	6.98 [5.40-8.98]	9.16 [7.12-11.71]	11.90 [9.89-14.25]
College	1.38 [0.33-5.53]	12.63 [4.44-31.02]	10.13 [4.42-21.58]	21.26 [11.24-36.53]
Master / Doctorate	1.38 [0.33-5.53]	12.63 [4.44-31.02]	10.13 [4.42-21.58]	21.26 [11.24-36.53]
Socio-economic status				
A	8.45 [7.37-9.67]	5.05 [4.21-6.06]	16.00 [14.50-17.63]	8.83 [7.59-10.25]
B	10.48 [9.26-11.85]	7.99 [6.81-9.36]	18.01 [16.31-19.84]	10.49 [9.07-12.09]
C	10.84 [9.49-12.36]	8.04 [6.72-9.59]	22.35 [20.19-24.67]	12.52 [10.95-14.28]
D	10.14 [8.61-11.90]	10.64 [8.99-12.55]	20.16 [18.22-22.26]	14.26 [12.41-16.34]
E	9.95 [8.59-11.49]	10.91 [9.36-12.67]	18.41 [16.29-20.73]	16.50 [14.60-18.59]
Health care				
None	6.51[5.35-7.92]	6.60 [5.38-8.06]	14.98 [13.16-17.01]	7.84 [6.52-9.40]
IMSS	12.79 [11.58-14.11]	10.46 [9.14-11.94]	22.43 [20.75-24.21]	16.68 [15.14-18.35]
ISSSTE	15.24 [12.21-18.86]	17.58 [14.75-20.82]	23.56 [19.76-27.84]	23.93 [20.59-27.63]
Pemex	26.83 [14.66-43.91]	30.41 [14.00-53.99]	49.73 [35.62-63.88]	42.97 [26.04-61.72]
Army/Navy	24.73 [10.01-49.25]	26.19 [9.08-55.76]	35.73 [16.36-61.24]	25.68 [9.56-53.02]
Seguro Popular	9.02 [8.15-9.97]	7.32 [6.38-8.40]	17.91 [16.60-19.29]	11.15 [10.04-12.36]
Private	6.88 [2.27-19.07]	13.87 [5.10-32.53]	8.89 [3.33-21.66]	13.32 [6.31-25.97]
Other	3.55 [1.33-9.11]	6.38 [2.60-14.79]	22.57 [10.30-42.53]	17.86 [7.62-36.41]
Body mass index				
Low	3.08 [1.26-7.32]	2.68 [0.80-8.58]	9.67 [4.86-18.31]	8.13 [3.65-17.10]
Normal	7.16 [5.89-8.69]	5.93 [4.82-7.28]	12.16 [10.61-13.89]	8.58 [7.16-10.25]
Overweight	9.72 [8.68-10.87]	10.04 [8.84-11.38]	16.28 [14.85-17.82]	13.13 [11.87-14.49]
Obese	11.87 [10.86-12.97]	11.33 [9.70-13.2]	26.73 [25.09-28.43]	18.95 [16.99-21.07]
	Average Age ± SD (years)			
No	40.8±15.7	40.9±16.1	39.6±14.9	40.4±15.7
Yes	57.0±14.0	57.0±13.2	54.1±16.6	55.1±16.1

FI: food insecurity
IMSS: Instituto Mexicano del Seguro Social
ISSSTE: Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado
Pemex: Petróleos Mexicanos

FI and 32% [1.09-1.60] higher among individuals living in severe FI households.

Among women there was an inverse relationship between level of education and risk of diabetes and hypertension. Likewise among men there was an inverse relationship between level of education and risk of diabetes but there was no relationship with the odds of hypertension (table III).

As expected, age was a significant risk factor for both hypertension and diabetes in both genders, and each condition was a major risk factor for the other (table III).

Living in rural areas was associated with lower odds of reporting diabetes and hypertension among both men and women. Socioeconomic level was not associated with the odds of diabetes among women but it was strongly and positively associated with the odds of diabetes among men. Socioeconomic level was associated with the odds of hypertension following an inverse-U shaped pattern among women and was positively associated with the odds of hypertension among men. Overall, not being affiliated with any health care system was associated with lower odds of diabetes among women and men (vs. being affiliated with any of the five public systems). In addition affiliation with a private provider was also associated with higher odds of diabetes among women, but not men. Being affiliated with the ISSSTE or Pemex system (vs. no affiliation with any system) was associated with higher odds of hypertension among women. Except for the Army/Navy system, being affiliated with the public health care systems was associated with higher odds of hypertension among men (table III).

A strong positive association was found between BMI category and odds of diabetes and hypertension among both women and men (table III).

Discussion

Several studies conducted outside Mexico have previously reported associations between HFI (measured with experience-based scales similar to ELCSA) and self-reported chronic diseases including diabetes and hypertension.[8-14] Our findings indicate that household food insecurity is an independent risk factor for doctor-diagnosed self-reported diabetes among adult Mexican women but not men. It is possible that given the central role that women play with family affairs, household chores and increasingly as income earners, women may be more vulnerable to the consequences of HFI than men. HFI has been found to be more likely to be a risk factor for obesity among women

than men.[20] Our findings suggest that HFI is associated with hypertension among both men and women, although the association among men was marginally significant (p=0.072). Seligman *et al.*[8] found with 1999-2004 NHANES data that HFI was associated with self-reported hypertension but not diabetes. However it is difficult to compare their findings directly with ours as they did not assess the interaction between HFI and gender on these two conditions.

In our study both diabetes and hypertension were significantly more prevalent among adult women than men. Our findings suggest that preventing or addressing HFI may help women to prevent two of the strongest risk factors for cardiovascular disease, i.e., diabetes and hypertension. Designing effective interventions towards this end requires an understanding of possible mechanisms that may explain this finding. HFI may lead to unhealthy dietary habits as a coping mechanism.[21] Specifically HFI may increase the consumption of low-cost high energy dense diets that also tend to be very high in sodium and sugar.[16] Energy dense diets increase the risk of excessive weight gain[22] which in turn increases the risk of both type 2 diabetes and hypertension. Diets that are high in sodium and low in potassium may also increase through this mechanism the risk of hypertension and diets rich in refined carbohydrates have been associated with increased risk of diabetes.[15,16,23] HFI is a very stressful condition that has been consistently associated with mental health problems among women.[24] High stress levels are reflected in high stress hormone levels (e.g., cortisol) that may be responsible for increasing visceral adiposity, a well established risk factor for type 2 diabetes. High stress levels have also been linked with hypertension.[25]

The potential mechanisms by which HFI may influence the risk of diabetes and hypertension among women call for improving social, economic and gender equity policies as well as food assistance and health care programs in Mexico. Poverty and social marginalization are the root causes of HFI, thus in the long term improvements in access to quality education and jobs that provide adequate salaries is the best way to prevent HFI and associated chronic comorbidites. Because women are more affected than men with regards to diabetes and hypertension, and in our study they were the ones most affected by HFI it is crucial that this is done following a gender equity approach. Because these are long term solutions, in the meantime it is important that food assistance programs facilitate access to low energy density diets characterized by high fruit, vegetable and whole grains consumption and relatively low intake of foods rich in saturated fats.[19,26] Improving dietary patterns should involve not only facilitating access to healthy

Table III
HOUSEHOLD FOOD INSECURITY, DIABETES AND HYPERTENSION BY GENDER: MULTIPLE BINARY LOGISTIC REGRESSION.
MEXICO, ENSANUT 2012

	Women		Men	
	Diabetes	*Hypertension*	*Diabetes*	*Hypertension*
	N=18 909 OR [95% CI]		*N=13 411 OR [95%CI]*	
Food insecurity	**p=0.0005**	**p=0.037**	*p=0.349*	**p=0.072**
Food-secure	1.00	1.00	1.00	1.00
Mild FI	1.31 [1.06,1.62]	1.01 [0.84,1.21]	1.12 [0.87,1.46]	1.25 [1.01,1.53]
Moderate FI	1.67 [1.31,2.13]	1.22 [0.98,1.51]	1.25 [0.90,1.74]	1.41 [1.07,1.86]
Severe FI	1.48 [1.14,1.93]	1.28 [1.02,1.62]	1.42 [0.94,2.12]	1.35 [0.95,1.90]
Education	**p<0.0001**	**p=0.002**	*p=0.076*	*p=0.265*
None	1.00	1.00	1.00	1.00
Elementary	1.05 [0.83,1.33]	1.12 [0.91,1.38]	1.45 [1.00,2.10]	1.41 [1.04,1.91]
Junios high	0.64 [0.47,0.86]	0.96 [0.73,1.27]	1.49 [0.97,2.29]	1.27 [0.85,1.90]
Senior high	0.41 [0.28,0.59]	0.88 [0.65,1.19]	1.35 [0.80,2.27]	1.36 [0.89,2.10]
College	0.47 [0.29,0.79]	0.59 [0.40,0.87]	0.96 [0.55,1.65]	1.18 [0.76,1.84]
Master / Doctorate	0.06 [0.01,0.45]	0.50 [0.17,1.44]	0.98 [0.35,2.80]	1.78 [0.80,3.98]
Age (yrs)	**p<0.001**	**p<0.001**	**p<0.001**	**p<0.001**
	1.05 [1.04-1.06	1.05 [1.05-1.06]	1.06 [1.05-1.06]	1.05 [1.05-1.06]
Area of residence	**p<0.001**	**p=0.049**	**p=0.006**	**p=0.01**
Urban	1.00	1.00	1.00	1.00
Rural	0.68 [0.56-0.81]	0.87 [0.75-1.00]	0.73 [0.58-0.91]	0.78 [0.64-0.95]
Socioeconomic status	*p=0.304*	**p=0.013**	**p=0.001**	**p=0.047**
A	1.00	1.00	1.00	1.00
B	1.30 [1.02-1.65]	1.12 [0.93-1.35]	1.41 [1.03-1.94]	1.13 [0.87-1.48]
C	1.14 [0.89-1.47]	1.42 [1.16-1.72]	1.46 [1.04-2.07]	1.23 [0.92-1.64]
D	1.13 [0.85-1.52]	1.28 [1.02-1.62]	2.06 [1.46-2.92]	1.46 [1.10-1.95]
E	1.24 [0.91-1.68]	1.23 [0.95-1.59]	1.88 [1.28-2.76]	1.55 [1.11-2.15]
Health care	**p<0.0001**	**p=0.00005**	**p=0.00005**	**p=0.003**
None	1.00	1.00	1.00	1.00
IMSS	1.73 [1.34-2.22]	1.27 [1.02-1.58]	1.27 [1.02-1.58]	1.55 [1.18-2.05]
ISSSTE	1.99 [1.39-2.84]	1.10 [0.78-1.56]	1.10 [0.78-1.56]	1.92 [1.34-2.73]
Pemex	4.34 [1.69-11.17]	3.74 [1.94-7.21]	3.74 [1.94-7.21]	3.92 [1.42-10.82]
Army/Navy	2.21 [1.13-1.93]	2.85 [0.90-8.99]	2.85 [0.90-8.99]	1.97 [0.57-6.85]
Seguro Popular	1.48 [1.13-1.93]	1.29 [1.03-1.60]	1.29 [1.03-1.60]	1.31 [1.02-1.69]
Private	1.59 [0.43-5.86]	0.56 [0.18-1.69]	0.56 [0.18-1.69]	0.78 [0.73-4.35]
Other	0.40 [0.11-1.46]	1.33 [0.52-3.41]	1.33 [0.52-3.41]	1.68 [0.52-5.46]
Body mass index	**p=0.0001**	**p<0.0001**	**p<0.0001**	**p<0.0001**
Low	1.00	1.00	1.00	1.00
Normal	2.57 [0.93-7.13]	1.33 [0.59-3.03]	3.06 [0.78-12.05]	1.31 [0.56-3.07]
Overweight	3.55 [1.29-9.78]	1.80 [0.79-4.09]	5.06 [1.28-19.98]	1.90 [0.81-4.44]
Obese	4.07 [1.50-11.08]	3.31 [1.48-7.44]	6.52 [1.65-25.85]	3.41 [1.42-8.17]

FI: food insecurity
IMSS: Instituto Mexicano del Seguro Social
ISSSTE: Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado
Pemex: Petróleos Mexicanos
P values denote significance of variable effect in overall model based on adjusted Wald test. Significant *p* values are bolded

foods but also teaching the population to prepare them in healthy ways. Other studies discussed above suggest that stress management programs may be needed by women facing HFI to help them lower their risk for diabetes and hypertension.

Consistent with studies conducted in low- and middle-income countries we found that both diabetes and hypertension are more prevalent in urban than rural areas among both women and men. Migrants that move from rural to urban areas may be highly susceptible to develop chronic diseases. Thus, specific initiatives need to target these vulnerable groups.

As expected, BMI was a strong dose-response risk factor for both diabetes and hypertension among women and men. Furthermore HFI has been associated with obesity risk in Mexico, and other Latin American countries.[27,28] Mexico now has the highest obesity rates in the world.[29] National childhood obesity prevention programs following a maternal-child life course framework[30,31] are needed to prevent the chronic disease epidemic from further decimating the national budgets and productivity.[32]

Our study has four main limitations. First Ensanut 2012 is a cross sectional survey that precludes us from understanding the temporal sequence of events, thus reverse causality cannot be ruled out. In this instance it is possible that the biological and psycho-emotional stress associated with the diagnosis of diabetes and hypertension may have led to decreased work productivity and disposable income (because of cost of medical treatment) and this in turn to an increased risk of HFI (instead of HFI leading to diabetes and hypertension, as our hypothesis postulates). Likewise the finding that being affiliated with a health care system is associated with higher risk of diabetes and hypertension may be a simple reflection of the fact that individuals with chronic diseases are more likely to seek health care services and not that these services are causing the epidemic. Second, our analyses are based on self-report of a doctor diagnosis of diabetes and hypertension. Thus, it is possible that there is a degree of end point misclassification based on those individuals who had not been diagnosed by a doctor at the time of the survey that perhaps already had one or both of these conditions. Because Ensanut 2012 obtained blood samples form a sub-sample of participants, the next step in our research project is to replicate these analyses in the subsample that provided blood samples to find out if and how including non-diagnosed cases influences the relationships found in this study. Third, the self-reported diabetes variable did not distinguish between diabetes types, although it is well known that in representative population surveys the vast majority

of individuals reporting this condition have type 2 diabetes. Fourth, we did not assess the relationships between known dietary and nutrient risk factors for diabetes and hypertension (such as energy dense foods, sugar sweetened beverages, sodium, potassium, added sugars and solid fats) with either HFI or these two chronic conditions. Ensanut 2012 collects 24 hour recall data in only one out of every six participants, thus we could not examine these relationships in the analytical sample designed for this study. In addition individuals diagnosed with chronic diseases are likely to improve their lifestyles, including diet, thus dietary intakes post-diagnosis may not be reflective of the actual dietary patterns that contribute to the development of the chronic conditions. In spite of these limitations our study does confirm that HFI is a condition that is likely to have serious consequences for the national development of Mexico as diabetes and hypertension are risk factors for cardiovascular disease, the major cause of premature death and disability in the country. Indeed improving household food security is likely to have a positive impact directly in the health of adult women and men, and the well being of their families and at the end of the day the national development of Mexico.

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

References

1. Pérez-Escamilla R, Segall-Corrêa A. Food insecurity measurement and indicators. Revista de Nutrição 2008;21(Suppl):15s-26s.
2. CEPALO. El perfil epidemiológico de América Latina y el Caribe: desafíos, límites y acciones. Chile: CEPALO, 2011.
3. Mariachiara DC, Himmelgreen D, Romero-Daza N, Turkon D, Watson S, Okello-Uma I, *et al.* Addressing the HIV/AIDS-food insecurity syndemic in sub-Saharan Africa. Afr J AIDS Res 2009;8:401-412.
4. Hernández-Ávila M, Gutiérrez JP, Reynoso-Noverón N. Diabetes mellitus en México. El estado de la epidemia. Salud Publica Mex 2013;55 supl 2:S129-S136.
5. Jiménez-Corona A, Aguilar-Salinas CA, Rojas-Martínez R, Hernández-Ávila M. Diabetes mellitus tipo 2 y frecuencia de acciones para su prevención y control. Salud Publica Mex 2013;55 supl 2:S137-S143.
6. Campos-Nonato I, Hernández-Barrera L, Rojas-Martínez R, Pedroza-Tobías A, Medina-García C, Barquera S. Hipertensión arterial: prevalencia, diagnóstico oportuno, control y tendencias en adultos mexicanos. Salud Publica Mex 2013;55 supl 2:S144-S150.
7. Mundo-Rosas V, Shamah-Levy T, Rivera-Dommarco JA. Grupo de Seguridad Alimentaria en México. Epidemiología de la inseguridad alimentaria en México. Salud Publica Mex 2013;55 supl 2:S206-S213.
8. Seligman HK, Laraia BA, Kushel MB. Food insecurity is associated with chronic disease among low-income NHANES participants. J Nutr 2010;140(2):304-310.
9. Fitzgerald N, Hromi-Fiedler A, Segura-Pérez S, Pérez-Escamilla R. Food insecurity is related to increased risk of type 2 diabetes among Latinas. Ethn Dis 2011;21(3):328-334.

10. Vozoris NT, Tarasuk VS. Household food insufficiency is associated with poorer health. J Nutr 2003;133(1):120-126.

11. Seligman HK, Bindman AB, Vittinghoff E, Kanaya AM, Kushel MB. Food insecurity is associated with diabetes mellitus: results from the National Health Examination and Nutrition Examination Survey (NHANES) 1999-2002. J Gen Intern Med 2007;22(7):1018-1023.

12. Stuff JE, Casey PH, Szeto KL, Gossett JM, Robbins JM, Simpson PM, *et al.* Household food insecurity is associated with adult health status. J Nutr 2004;134(9):2330-2335.

13. Hamelin AM, Habicht JP, Beaudry M. Food insecurity: consequences for the household and broader social implications. J Nutr 1999;129(2S Suppl):525S-528S.

14. Hamelin AM, Beaudry M, Habicht JP. Characterization of household food insecurity in Québec: food and feelings. Soc Sci Med 2002;54(1):119-132.

15. Schulze MB, Liu S, Rimm EB, Manson JE, Willett WC, Hu FB. Glycemic index, glycemic load, and dietary fiber intake and incidence of type 2 diabetes in younger and middle-aged women. Am J Clin Nutr 2004;80(2):348-356.

16. Adrogué HJ, Madias NE. Sodium and potassium in the pathogenesis of hypertension. N Engl J Med 2007;356(19):1966-1978.

17. Romero-Martínez M, Shamah-Levy T, Franco-Núñez A, Villalpando S, Cuevas-Nasu L, Gutiérrez JP, *et al.* Encuesta Nacional de Salud y Nutrición 2012: diseño y cobertura. Salud Publica Mex 2013;55 supl 2:S332-S340.

18. Comité Científico ELCSA. Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA): Manual de uso y aplicación. Chile: Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO), Oficina Regional para América Latina, 2012.

19. Winkleby MA, Jatulis DE, Frank E, Fortmann SP. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. Am J Public Health 1992;82(6):816-820.

20. Schlüssel MM, Silva AA, Pérez-Escamilla R, Kac G. Household food insecurity and excess weight/obesity among Brazilian women and children: a life-course approach. Cad Saude Publica 2013;29(2):219-226.

21. Drewnowski A, Darmon N. The economics of obesity: dietary energy density and energy cost. Am J Clin Nutr 2005;82(1 Suppl):265S-273S.

22. Pérez-Escamilla R, Obbagy JE, Altman JM, Essery EV, McGrane MM, Wong YP, *et al.* Dietary energy density and body weight in adults and children: a systematic review. J Acad Nutr Diet 2012;112(5):671-684.

23. Dietary Guidelines Advisory Committee, 2010. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010, to the Secretary of Agriculture and the Secretary of Health and Human Services. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service, 2010.

24. Garcia J, Hromi-Fiedler A, Mazur RE, Marquis G, Sellen D, Lartey A, *et al.* Persistent household food insecurity, HIV, and maternal stress in Peri-Urban Ghana. BMC Public Health 2013;13:215.

25. Kulkarni S, O'Farrell I, Erasi M, Kochar MS. Stress and hypertension. WMJ 1998;97(11):34-38.

26. Ramírez-Silva I, Villalpando S, Moreno-Saracho JE, Bernal-Medina D. Fatty acids intake in the Mexican population. Results of the National Nutrition Survey 2006. Nutr Metab (Lond) 2011;8(1):33.

27. Leroy JL, Gadsden P, González de Cossío T, Gertler P. Cash and in-kind transfers lead to excess weight gain in a population of women with a high prevalence of overweight in rural Mexico. J Nutr 2013;143(3):378-383.

28. Schlüssel MM, da Silva AA, Pérez-Escamilla R, Kac G. Household food insecurity and excess weight/obesity among Brazilian women and children: a life-course approach. Cad Saude Publica 2013;29(2):219-226.

29. Barquera S, Campos-Nonato I, Hernández-Barrera L, Pedroza-Tobías A, Rivera-Dommarco JA. Prevalencia de obesidad en adultos mexicanos, Ensanut 2012. Salud Publica Mex 2013; 55 supl 2:S151-S160.

30. Jacoby E, Grajeda R, Contreras A, Hospedales J. The epidemic of childhood obesity in the Americas must be stopped: Governmental and PAHO leadership are crucial. Int J Obes Suppl 2013;3:S15-S17.

31. Pérez-Escamilla R, Kac G. Childhood obesity prevention: a life-course framework. Int J Obes Suppl 2013; 3:S3-S5.

32. Rivera-Dommarco JA, Hernández-Ávila M, Aguilar-Salinas CA, Vadillo-Ortega F, Murayama-Rendón C, ed. Obesidad en México: recomendaciones para una política de estado. México: Universidad Nacional Autónoma de México (UNAM), 2013.