

BMJ Open Food insecurity and maternal–child nutritional status in Mexico: cross-sectional analysis of the National Health and Nutrition Survey 2012

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ABSTRACT

Objective To examine the association between household food insecurity (HFI) and risk of childhood stunting and to determine whether this association is modified by maternal–child overweight/obesity.

Design Observational cross-sectional study.

Setting Data come from the Mexican National Health and Nutrition Survey (*ENSANUT 2012* by its initials in Spanish), representative of rural and urban areas.

Participants Our study sample included 5087 mother–preschool child pairs and 7181 mother–schoolchild pairs.

Main outcome measures Differences in the prevalence (95% CI) of each HFI category by socioeconomic characteristics and maternal–child nutritional status were estimated. A logistic regression model was conducted for stunting and overweight among preschool children and for stunting and overweight/obesity among schoolchildren, adjusting for pertinent covariates. HFI was measured according to the Latin American and Caribbean Food Security Scale (ELCSA by its initials in Spanish). Weight and recumbent length or height measures were obtained from children. Overweight and obesity in women were determined according to the WHO Growth Reference Charts. The following covariates were included: sex of the child, urbanicity (urban/rural), region of residence and maternal education. Benefiting from food assistance programmes and socioeconomic status index were also included. Results were expressed as adjusted ORs.

Results Stunting proved more prevalent in preschool children with moderate or severe HFI (16.2% and 16.8%, respectively) ($p=0.036$ and $p=0.007$, respectively) than in their counterparts with mild or no HFI (13.2% and 10.7%, respectively). Furthermore, the interaction between HFI and maternal obesity had a significant impact on stunting in preschool children ($p<0.05$). Severe HFI increased risk of stunting in children with non-obese mothers but not in those with obese mothers.

Conclusion We have discovered a new relationship between HFI and maternal obesity on the one hand and risk of childhood stunting on the other hand. This may reflect a shared mechanism involving dual forms of malnutrition.

Strengths and limitations of this study

- The cross-sectional study design restricts the drawing of causal inferences, and our results cannot be generalised, as they refer specifically to children, adolescents and similar population groups in Mexico.
- The findings of the study provide a significant contribution to the limited research available on the relationship between household food insecurity and the nutritional status of mother–child pairs.
- This study is a pioneering study in the field, dealing specifically with the Mexican population.
- The large sample size of the study allowed us to introduce possible confounding variables in our statistical models and draw conclusions at the national level.

INTRODUCTION

Background

Food security ‘exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life, and is supported by an environment of adequate sanitation, health services and care’.^{1,2}

The term hunger refers both to a feeling of discomfort from not eating and to the state of undernutrition, particularly within the context of food insecurity (FI).³ Experience-based indices can serve to assess hunger directly at the household level.⁴

Household food insecurity (HFI) has been defined as ‘limited or uncertain availability of nutritionally adequate and safe food and also as limited and uncertain ability to acquire adequate food in socially acceptable ways’.⁵

FI is a growing concern worldwide. It is estimated that over one billion people suffer from insufficient availability of dietary energy

and at least twice that number suffer from micronutrient deficiency.⁶

FI in Mexico has evolved within a complex and contrasting environment where undernutrition and overweight/obesity, together, form part of an advanced nutritional transition characterised by widespread HFI. One out of three Mexican households suffers from moderate or severe FI. This condition heightens the risk of malnutrition in children and the incidence of diabetes, overweight and obesity in adults, principally among women.⁷

Recent studies have suggested a link between HFI and obesity,⁸ especially in adult women.^{9–11} For instance, it has been documented that women with FI are more likely to suffer from obesity than women without FI.¹² It has also been reported that racial/ethnic minority communities and low-income households are the population groups most severely affected by HFI.¹³

Generally viewed as separate public health problems, there is growing concern that FI and obesity may be related. FI can lead to weight gain because high-fat, high-calorie and energy-dense foods offer the least expensive option for obtaining calories,¹⁴ and these products, available at lower prices than healthful foods,¹⁵ have been identified as risk factors for child and adult obesity.¹⁶ Furthermore, HFI can trigger disorderly eating patterns characterised by bingeing and restricted eating, depending on the availability of supplies, thus negatively affecting the body's metabolism.¹⁷

Recent decades have witnessed alarming increases in prevalence of overweight/obesity among Mexican children: from 7.8% in 1988 to 9.7% in 2012 for children under 5 years old; from 26.9% in 1999 to 34.4% in 2012 for 5–11 years old; and from 11.1% in 1988 to 35.8% in 2012 for female adolescents aged 12–19 years. In the adult population aged 20 years and older, prevalence jumped from 61.8% to 71.3% in 12 years.¹⁸

In 2012, children under 5 years old living in severe-FI households had a 42% higher risk of stunting or chronic malnutrition than did their counterparts living in food-secure households.¹⁹ That same year, women aged 20–59 years old had an average body mass index (BMI) of 28.9. More specifically, those living in mild, moderate and severe HFI had BMIs of 28.3, 29.3 and 29.4 ($p < 0.001$, $p = 0.011$ and $p = 0.007$), respectively.¹¹

The double burden of malnutrition can occur within the same country, city or household (mother–child pairs) and also within the same individual at different stages of his or her life.²⁰ The fact that HFI may be associated with both undernutrition and obesity has been documented.¹⁷

The twofold purpose of this article is to examine the association between HFI and risk of childhood stunting and to determine whether this association is modified by maternal–child overweight/obesity.

METHODS

Study population

Data were drawn from *ENSANUT 2012*, a cross-sectional, probabilistic and cluster survey with national, regional, urban–rural and state-level representativity. Oversampling was directed to Mexican households of lower socioeconomic status (SES). A sample of 50 528 households of an estimated 29 429 252 households nationwide was obtained between October 2011 and May 2012. Details of sample size and sampling design have been described elsewhere.²¹

Our study consisted of a secondary analysis based on *ENSANUT 2012*. A total of 5087 preschool children (1–4 years old), 8401 schoolchildren (5–11 years old) and 9581 mothers were included in the survey. We used a matching process to identify mother–preschool child and mother–schoolchild pairs, and we included a total of 5087 mother–preschool child pairs in our analysis. None of the mothers in this group had more than one child. A total of 7181 mother–schoolchild pairs were included, with 2432 mothers having more than one schoolchild, in which cases where only one schoolchild was used in the matching process. Finally, the 2677 mothers in the sample who had preschool children and schoolchildren were included in both pair groups.

Our analytical sample included 5087 mother–preschool child pairs and 7181 mother–schoolchild pairs with complete data. When mothers had more than one schoolchild meeting the study criteria, the analyses considered all their children.

Informed consent was obtained from all respondents—or their parents/guardians in cases of children under 7 years old—prior to their participation in the study. The survey protocol was approved by the Ethics Committee of the National Institute of Public Health in Mexico.

HFI measurement

HFI was measured using a version of the Latin American and Caribbean Food Security Scale (*ELCSA* by its initials in Spanish). The scale included 15 questions targeting the head of the family or the woman in charge of preparing meals. Eight questions referred directly to HFI either in the household or specifically in the adults within the household; the remaining seven referred to HFI in minors (<18 years old). The reference time frame was 3 months prior to survey administration. Based on the number of positive responses, and depending on whether or not households included people under 18 years old, they were grouped into the following categories: households without minors: no HFI (0 positive responses), mild HFI (1–3), moderate HFI (4–6) and severe HFI (7–8) and households with adults and minors under 18 years old: no HFI (0 positive responses), mild HFI (1–5), moderate HFI (6–10) and severe HFI (11–15).²² *ELCSA* has been validated in populations in the United States as well as in Mexico and other Latin American countries.^{23–25}

Anthropometric measurements

Weight and recumbent length measures were obtained from children <2 years old and standing height measures were obtained from children aged 2 to <5 years following standard recommended procedures.^{26 27}

The anthropometric measures together with the age and sex of the children were used to calculate the weight-for-age, height-for-age and weight-for-height z-scores according to the WHO growth standards.²⁸ Prevalence of undernutrition in its different forms (underweight, wasting and stunting) was calculated using z-score cut-off point less than -2 using the WHO growth standards.

Overweight and obesity were determined according to the WHO Growth Reference charts,²⁹ with BMI (kg/m^2) z-scores adjusted for age: values between -5.0 and +5.0 were considered outside this range and regarded as implausible. There were no implausible values for BMI z-scores in children. For adults, the WHO standard BMI cut-off points were used to classify mothers into the following categories: underweight ($<18.5 \text{ kg}/\text{m}^2$), normal weight ($18.5\text{--}24.9 \text{ kg}/\text{m}^2$), overweight ($25\text{--}29.9 \text{ kg}/\text{m}^2$) and obese ($\geq 30 \text{ kg}/\text{m}^2$).³⁰ Only BMI values between 10 and 58 were considered; no BMI values were regarded as implausible.

Covariates

The following covariates were included in our statistical analyses: sex of the child, urbanicity (urban/rural), region of residence (northern, central, southern and Mexico City) and maternal education: none, primary, secondary, high school (*preparatoria* according to its Spanish equivalent) and university (bachelor's degree and beyond). Benefiting from a food assistance programme was also included.

Socioeconomic index

We used a standard SES index developed in Mexico on the basis of various household characteristics: type of floor, wall and ceiling materials; the ratio of number of rooms used for sleeping to number of persons residing in the household; basic service infrastructure including water source and water disposal; and possession of domestic appliances such as a refrigerator, washing machine, microwave oven, stove, boiler, radio, television, cable television signal, telephone and computer. This SES index was selected to facilitate comparison with previous surveys in Mexico.³¹

Ethical considerations

All study procedures involving human participants were approved by the Ethics Committee of the National Institute of Public Health in Mexico. Written informed consent was obtained from all survey participants. Parents/guardians served as proxies for minors <7 years old.

Statistical analyses

We calculated the prevalence (95% CI) of each HFI category by socioeconomic characteristics and maternal-child nutritional status. We then conducted logistic regression models for stunting and overweight among preschool

children and for stunting and overweight/obesity among schoolchildren, adjusting for pertinent covariates. The cluster effect for mothers with more than one schoolchild was tested and proved non-significant. No mothers had more than one preschool child. Results were expressed as adjusted ORs (AORs) with their corresponding 95% CIs. Prevalence estimates and logistic regression models considered clustered sample effects and sampling weights using STATA 13 SVY procedures for complex surveys.

RESULTS

Our analytical sample included 5087 pairs of mother-preschool children and 7181 mother-schoolchild pairs with complete data.

In the mother-preschool child pairs, moderate HFI was significantly more prevalent among those residing in the southern, as opposed to the northern or central, regions of Mexico. As expected, severe HFI was five and six times more prevalent in the low and very low quintiles, respectively, than in the top quintile. Moderate and severe HFI were more prevalent in households with mothers who had not studied beyond junior high school and with beneficiaries of government food assistance programmes (table 1).

Similarly, in the mother-schoolchild pairs, general HFI was more prevalent among those living in southern Mexico than among those living in the north. In addition, HFI was higher in the low and very low socioeconomic quintiles. Prevalence of moderate and severe HFI was significantly higher among those pairs where the mothers had not studied beyond junior high school, benefited from government food assistance programmes and belonged to an indigenous population group (table 1).

Table 2 describes the nutritional status of the population by household food security/insecurity level. Stunting in preschool children was more prevalent in households with severe/moderate HFI (over 16%, respectively) than in those with mild (13.2%) or no HFI (10.7%). Likewise, wasting was more prevalent in households with severe (3.7%) than in those with mild (1.7%), moderate (1.9%) or no HFI (2.2%).

Preschool children presented no significant differences in prevalence of overweight by HFI level.

While prevalence of stunting among schoolchildren was 10% in households with severe HFI, prevalence of overweight/obesity was markedly higher in households with food security (40%) as compared with households with mild (34.5%), moderate (32.1%) or severe (28.6%) HFI. Prevalence of maternal obesity was high regardless of HFI status: >70% overall and 77% in mild HFI households.

In the logistic regression model for preschool children, prevalence of stunting was significantly higher (AOR>1, $p<0.05$) in households with moderate or severe HFI as opposed to mild HFI (table 3).

We identified an interaction between HFI and maternal obesity. Estimated marginal prevalence rates and confidence intervals obtained from the logistic regression

Table 1 FI level according to the sociodemographic characteristics of the mother–preschool child and mother–schoolchild pairs

	Total		Secure		Mild		Moderate		Severe	
	n	N* (thousands)	%	95% CI	%	95% CI	%	95% CI	%	95% CI
FI level in preschool children										
Sex of child										
Female	2539	1452.9	24.2	21.7 to 26.79	43.8	40.9 to 46.6	21.6	19.5 to 23.8	10.5	9.0 to 12.2
Male	2548	1522.1	24.7	22.3 to 27.13	45.0	42.4 to 47.7	18.4	16.5 to 20.6	11.9	10.3 to 13.8
Urbanicity										
Urban	3142	2123.0	26.8	24.6 to 29.1	43.3	40.9 to 45.8	18.9	17.1 to 20.9	10.9	9.4 to 12.6
Rural	1945	851.9	18.5	16.3 to 20.9	47.0	43.8 to 50.2	22.4	20.1 to 25.0	12.0	10.3 to 14.1
Region										
Northern	1083	524.5	30.5	27.2 to 34.0	42.5	38.9 to 46.2	15.8	13.3 to 18.6	11.2	9.2 to 13.5
Central	1804	941.8	26.7	24.0 to 29.6	45.3	42.2 to 48.4	17.4	15.1 to 20.0	10.6	8.8 to 12.6
Mexico City	200	426.5	22.1	15.6 to 30.4	45.5	37.9 to 53.4	21.9	16.3 to 28.8	10.5	6.3 to 16.9
Southern	2000	1082.2	20.4	18.1 to 22.8	44.1	41.1 to 47.1	23.4	21.2 to 25.9	12.1	10.3 to 14.2
SES										
Very low (Q1)	1319	666.0	12.4	9.9 to 15.4	45.8	41.9 to 49.6	23.8	20.8 to 27.1	18.0	15.1 to 21.4
Low (Q2)	1187	629.8	17.6	15.0 to 20.6	43.4	39.3 to 47.7	25.1	21.5 to 29.2	13.8	11.2 to 16.9
Medium (Q3)	1028	584.5	20.0	17.1 to 23.4	48.4	44.8 to 52.1	20.3	17.3 to 23.8	11.1	8.7 to 14.2
High (Q4)	879	575.7	29.1	25.1 to 33.5	44.2	39.7 to 48.7	18.5	15.1 to 22.4	8.2	6.2 to 10.8
Very high (Q5)	674	519.0	47.7	42.3 to 53.2	39.5	34.4 to 44.7	10.0	7.2 to 13.6	2.8	1.8 to 4.6
Maternal education										
None	349	196.4	10.0	6.8 to 14.4	40.6	34.2 to 47.4	24.7	19.4 to 30.9	24.7	18.9 to 31.5
Primary and/or secondary school	3568	1951.6	19.1	17.4 to 20.9	46.1	43.7 to 48.5	21.5	19.6 to 23.6	13.3	11.8 to 15.1
Beyond secondary school	1165	823.0	40.4	36.4 to 44.6	41.4	37.6 to 45.3	15.1	12.5 to 18.1	3.0	2.0 to 4.6
Beneficiaries of food assistance programmes										
Beneficiaries	2246	1187.1	15.7	13.6 to 18.1	45.8	42.7 to 48.8	24.5	22.1 to 27.1	14.0	12.0 to 16.3
Non-beneficiaries	2400	1520.1	30.2	27.6 to 33.0	43.8	41.1 to 46.6	16.9	14.9 to 19.1	9.0	7.6 to 10.8
Indigenous										
Yes	101	1150.9	20.3	11.7 to 32.8	38.3	27.8 to 50.1	29.5	20.1 to 40.9	12.0	6.4 to 21.2
No	1906	41.9	23.5	21.2 to 25.9	44.1	41.2 to 47.1	20.3	18.0 to 22.9	12.0	9.9 to 14.3
FI level in schoolchildren										
Sex of child										

Continued

Table 1 Continued

	Total n	N* (thousands)	Secure		Mild		Moderate		Severe	
			%	95% CI	%	95% CI	%	95% CI	%	95% CI
Female	4269	2413.0	23.1	21.3 to 25.1	42.3	40 to 44.3	20.1	18.4 to 22.0	14.4	12.9 to 15.9
Male	4132	2337.1	24.0	21.9 to 26.2	43.6	41.3 to 45.9	19.8	18.1 to 21.6	12.6	11.1 to 14.2
Urbanicity										
Urban	5267	3444.7	26.2	24.3 to 28.1	42.0	39.9 to 43.9	18.4	16.8 to 20.1	13.5	12.1 to 15.1
Rural	3134	1306.3	16.7	14.8 to 18.8	45.8	43.2 to 48.3	24.2	22.1 to 26.4	13.4	11.8 to 15.3
Region										
Northern	1796	884.6	29.5	26.4 to 32.8	42.3	39.2 to 45.4	16.2	13.9 to 18.8	12.0	10.2 to 14.2
Central	2928	1446.1	25.8	23.2 to 8.5	45.1	42.3 to 47.9	16.8	14.8 to 19.0	12.3	10.6 to 14.2
Mexico City	353	717.3	25.6	20.4 to 31.7	36.2	30.4 to 42.4	21.6	16.7 to 27.5	16.6	12.0 to 22.3
Southern	3324	1738.9	18.0	16.2 to 19.9	44.2	42.1 to 46.5	23.8	21.8 to 25.9	14.0	12.4 to 15.7
SES										
Very low (Q1)	1977	980.7	9.6	7.9 to 11.6	42.5	39.1 to 46.1	26.2	23.3 to 29.4	21.7	18.7 to 25.1
Low (Q2)	1874	947.06	15.0	12.9 to 17.5	39.6	36.3 to 42.9	25.5	22.4 to 28.9	19.9	17.1 to 22.9
Medium (Q3)	1717	914.6	16.0	13.6 to 18.7	50.5	46.8 to 54.2	19.7	17.1 to 22.6	13.9	11.5 to 16.6
High (Q4)	1583	995.9	29.8	26.4 to 33.4	43.8	40.4 to 47.2	17.4	14.7 to 20.5	9.05	7.3 to 11.1
Very high (Q5)	1250	912.7	48.2	43.8 to 52.7	38.5	34.7 to 42.4	10.7	8.0 to 14.1	2.6	1.6 to 4.4
Maternal education										
None	651	339.1	13.4	10.0 to 17.7	40.9	35.8 to 46.2	21.6	17.6 to 26.1	24.1	19.5 to 29.5
Primary and/or secondary school	5970	3212.5	18.7	17.2 to 20.3	44.0	41.9 to 45.9	22.0	20.4 to 23.7	15.4	13.9 to 16.9
Beyond secondary school	1780	1199.4	39.5	35.9 to 43.1	41.0	37.8 to 44.4	14.1	11.8 to 16.8	5.4	4.2 to 6.9
Beneficiaries of food assistance programmes										
Beneficiaries	4527	2362.1	16.5	14.9 to 18.2	44.9	42.5 to 47.3	22.2	20.5 to 24.1	16.4	14.6 to 18.4
Non-beneficiaries	3299	2032.0	30.8	28.2 to 33.4	41.6	39.1 to 44.1	17.4	15.4 to 19.6	10.2	8.8 to 11.9
Indigenous										
Yes	595	228.1	10.8	8.0 to 14.3	44.4	39.2 to 49.8	26.1	21.8 to 30.9	18.7	14.7 to 23.5
No	7806	4522.9	24.2	22.7 to 25.8	42.9	41.2 to 44.5	19.7	18.3 to 21.1	13.2	12.1 to 14.5

*N refers to the sample population size.
FI, food insecurity; SES, socioeconomic status.

Table 2 Prevalence of nutritional status by level of food insecurity

Nutritional status	Food security			Moderate			Severe					
	n (thousands)	%	95% CI	n (thousands)	%	95% CI	n (thousands)	%	95% CI			
FI in preschool-age children												
Underweight	8.3	1.1	0.6 to 2.1	40.6	3.0	2.3 to 4.1	18.8	3.1	2.2 to 4.6	15.8	4.7	2.7 to 8.1
Stunting	77.6	10.7	8.6† to 13.2	175.4	13.2	11.4 to 15.4	96.2	16.2	13.1 to 19.8	56.0	16.8	12.8 to 21.6
Wasting	15.8	2.2	1.1 to 4.1	23.1	1.7	1.0† to 2.8	11.1	1.9	0.1† to 3.1	12.5	3.7	0.0* to 6.9
Overweight	75.9	11.0	8.8 to 13.5	120.7	9.7	8.2 to 11.5	47.6	8.3	6.1 to 11.2	31.5	9.6	6.8 to 13.3
FI in schoolers												
Stunting	48.4	4.4	3.3 to 5.8	128.7	6.4	5.4 to 7.4	75.8	8.0	6.3 to 10.3	64.2	10 to 10.1	7.9 to 12.7
Overweight	250.4	23.0	20.4 to 25.7	377.2	18.9	17.2 to 20.8	161.3	17.4	15.1 to 19.9	112.5	17.8	14.9 to 21.0
Obesity	190.6	17.5	15.1 to 20.2	310.8	15.6	14.0 to 17.3	136.4	14.7	12.5 to 17.3	68.6	10.8	8.3 to 14.0
Overweight and obesity	441.0	40.4	37.3 to 43.7	688.0	34.5	32.3 to 36.8	297.7	32.1	28.9 to 35.5	181.1	28.6	24.8 to 32.6
FI in women												
Underweight	20.9	1.2	0.6 to 2.1	22.7	0.69	0.5 to 0.9	19.1	1.2	0.6 to 2.5	12.9	1.3	0.8 to 2.3
Overweight	683.5	37.9	35.1 to 40.7	1301.7	39.8	37.7 to 41.9	563.9	37.2	33.9 to 40.8	344.7	35.6	31.9 to 39.5
Obesity	589.9	32.7	29.9 to 35.5	1206.9	36.9	34.9 to 38.9	584.1	38.6	35.3 to 41.9	365.7	37.8	33.6 to 42.3
Overweight and obesity	1273.4	70.5	67.7 to 73.3	2508.7	76.7	74.8 to 78.6	1148.0	75.9	73.1 to 78.4	710.4	73.5	69.8 to 76.8

z-score cut-off point of <-2 SD to classify low weight for age, WHO; z-score cut-off point of <-2 SD to classify low height for age, WHO; z-score cut-off point of <-2 SD to classify low weight for height, WHO; z-score cut-off point of $>+2$ SD to classify BMI for age, WHO; z-score cut-off point of $>+1$ and $\leq+2$ SD to classify BMI for age, WHO; BMI <18.5 kg/m²; BMI 25–29.9 kg/m²; BMI ≥ 30 kg/m².

*N refers to the sample population size.

BMI, body mass index.

Table 3 Logistic regression model for mother–preschool child pairs: stunting in children <5 years old

	AOR*	p Value	95% CI
Mild HFI	1.26	0.232	0.9 to 1.8
Moderate HFI	1.66	0.036	1.0 to 2.7
Severe HFI	1.99	0.007	1.2 to 3.3
Maternal obesity	1.40	0.266	0.8 to 2.5
Mild HFI and maternal obesity	0.62	0.207	0.3 to 1.3
Moderate HFI and maternal obesity	0.46	0.069	0.2 to 1.1
Severe HFI and maternal obesity	0.23	0.011	0.1 to 0.7
Age of children	0.89	0.007	0.8 to 0.9
Beneficiaries of food assistance programmes	1.24	0.119	0.9 to 1.6
Urbanicity			
Rural	1.42	0.006	1.1 to 1.8
Maternal education			
Primary school	0.53	<0.001	0.4 to 0.8
Secondary school	0.46	0.001	0.3 to 0.7
Senior high school (<i>preparatoria</i>)	0.34	<0.001	0.2 to 0.6
Bachelor or higher	0.48	0.042	0.2 to 0.9
Constant	0.26	<0.001	0.2 to 0.4

*Model included all independent variables listed in the table.
AOR, adjusted OR; HFI, household food insecurity.

model are plotted in [figure 1](#). Severe HFI raises the risk of stunting in children with non-obese mothers but not in children with obese mothers. Preschool children showed no significant interaction among HFI, overweight and maternal characteristics.

For schoolchildren, the logistic regression model revealed a significantly lower prevalence of overweight and obesity among those with mild, moderate or severe

HFI ($p < 0.05$) ([table 4](#)); mothers having higher levels of education (bachelor's and beyond) ($p < 0.001$); and residence in rural areas ($p = 0.007$).

The logistic regression model for stunting in schoolchildren documented significant associations of this condition with maternal characteristics but not with HFI (data not shown).

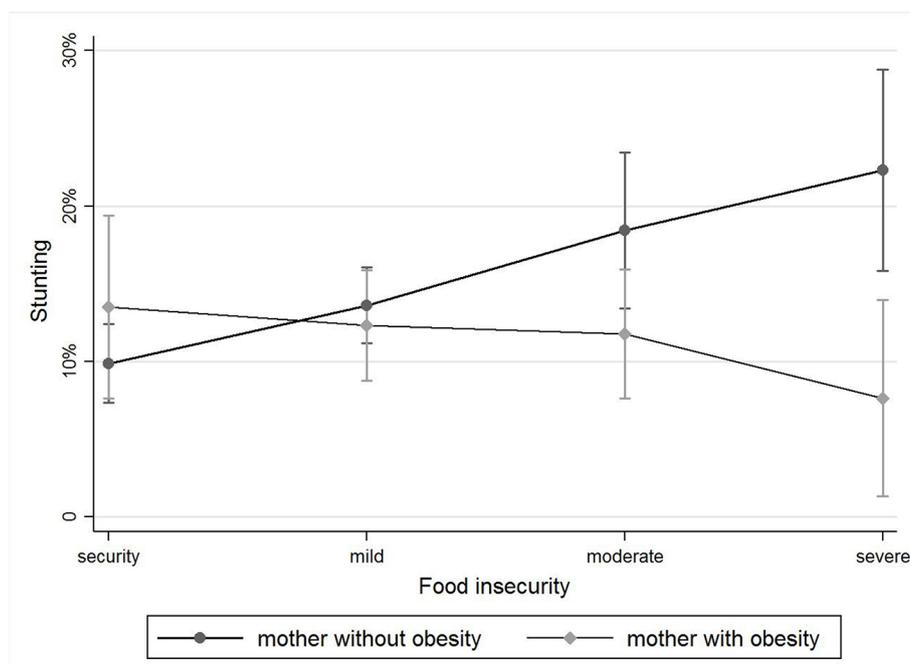

Figure 1 Effect of HFI-maternal obesity interaction on stunting among children <5 years.

Table 4 Logistic regression model for mother–schoolchild pairs: Both mother and child with overweight/obesity (overweight and obesity in schoolchildren)

	AOR*	p Value	95% CI
Mild HFI	0.79	0.017	0.6 to 0.9
Moderate HFI	0.72	0.005	0.57 to 0.90
Severe HFI	0.67	0.004	0.51 to 0.9
Maternal overweight	2.25	<0.001	1.8 to 2.8
Maternal obesity	3.96	<0.001	3.3 to 4.8
Age of child	1.12	<0.001	1.1 to 1.2
Beneficiaries of food assistance programmes	0.85	0.039	0.7 to 0.9
Urbanicity			
Rural	0.79	0.007	0.7 to 0.9
Maternal education			
Primary school	0.87	0.342	0.6 to 1.2
Secondary school	1.11	0.484	0.8 to 1.5
Senior high school (<i>preparatoria</i>)	1.12	0.485	0.8 to 1.6
Bachelor or higher	1.93	<0.001	1.3 to 2.9
Constant	0.12	<0.001	0.1 to 0.2

*Model included all independent variables listed in table.
AOR, adjusted OR; HFI, household food insecurity.

DISCUSSION

We sought to describe the nutritional status of children <11 years old and their mothers and to explore the relationship between their nutritional status and HFI. One of the strengths of this study concerns the fact that our research sample was representative of the Mexican population.

Many countries are witnessing an increase in the prevalence of adult overweight while still struggling with childhood stunting. Our study found that moderate and severe HFI were associated with low height in children who were under 5 years old and lived with mothers with overweight or obesity. Similar results have been obtained by other studies on the double burden of malnutrition, where stunted children live with overweight mothers in the same, and particularly in poor, households.^{32 33} The problem has been analysed at the household and individual levels both globally and within a number of countries, Mexico among them.³⁴

Studies conducted in the Latin American and Arctic regions have demonstrated that FI households exhibit a reduced variety of available food and also inadequate consumption of fruits and vegetables³⁵ and foods of animal origin.^{36 37} These findings have been explained by insufficient local food availability as well as the presence of inferior-quality, high-cost foods, both of which favour the choice of widely available cheaper foods of low nutritional value.³⁸ It has been reported that FI in Mexico has similar effects to those observed in the rest of Latin America as regards dietary diversity and food availability. Mexican children under 5 years old are not receiving the recommended daily energy intake³⁹ and female heads of household show diminished dietary diversity.⁴⁰

Evidence from a study of <5 children of Mexican origin living in immigrant communities in California and in Mexico itself underscores the fact that FI contributes not only to increased energy and fat intake as a result of consuming cheap and energy-rich foods such as snacks, sweets and fried foods but also to increased consumption of meat, especially fried chicken. For children living in Mexico, FI was associated with low consumption of carbohydrates, dairy products and vitamin B₆.⁴¹

The pathway through which FI can lead to an increase in body fat is based on the following factors: (1) Diets characterised by high quantities of fat and carbohydrates together with a limited variety of vegetables are associated with high energy intake and a subsequent increase in body fat.^{42 43} (2) According to one hypothesis, involuntary restriction of food including episodic lack of access can lead to compulsive eating and to ignoring internal signs of satiety,⁴⁴ as well as to physiological adaptations in response to the periodic scarcity of food.¹⁷

Conversely, our study demonstrated an association between FI and stunting among Mexican preschool children. The way in which FI negatively affects the nutritional state of these children relates largely to insufficient consumption of highly nutritious foods (such as products of animal origin, fruits and vegetables) coupled with recurrent infections and unhealthy living conditions linked to poverty. These factors contribute to loss of appetite, an increase in metabolic requirements and a deficit of nutrients.⁴⁵

Our results agree with those of a previous study where children from HFI households weighed less than their peers from food-secure households. Their average body

weight was within the normal range, whereas their peers were at risk of becoming overweight.

Adequate growth is not the only indicator of nutritional well-being among children living with HFI.³⁶ Nutritional status is also influenced by the quality of foods consumed. It has been demonstrated that obesity is an expected consequence of HFI for some subpopulations and at certain ages. Moreover, it has been shown that children and adolescents are often affected by HFI through both nutritional and non-nutritional pathways despite parental intentions or beliefs to the contrary.⁴⁶

A recent analysis of 16 Latin American countries revealed that all of them were running programmes aimed at preventing undernutrition, and most were in the process of implementing obesity prevention strategies as part of their policy agendas.⁴⁷ According to the literature, cash transfers and food distribution programmes may be triggering increased energy intake at the household level^{48 49} and exacerbating the HFI-obesity link in populations that do not need assistance programmes focused on caloric intake. This has raised concerns about the possible contribution of these programmes to obesity in populations who are not energy deficient, and this highlights the need for countries with a double burden of malnutrition to include obesity prevention strategies as an essential component of their cash and food transfer programmes.

The principal findings of our study are particularly relevant for countries undergoing nutritional transition. Mexico has been facing rapid epidemiological and demographic changes with nutritional and environmental components. The health profile of the Mexican population indicates a shift from high rates of mortality and infectious diseases—typical of poor countries—to low rates of mortality and high rates of non-communicable diseases (the main cause of mortality in wealthy countries).⁵⁰

Our study was subject to several limitations. First, its cross-sectional design restricts the drawing of causal inferences. Additionally, its findings refer specifically to Mexican children, adolescents and similar population groups and therefore cannot be generalised to others.

Nevertheless, our study also has a number of strengths. For instance, our findings contribute to the limited research available on the relationship between HFI and the nutritional status of mother-child pairs. In addition, this is one of the first studies in this field dealing specifically with the Mexican population. The large sample size of our study constitutes another strength. It allowed us to introduce possible confounders in the statistical models and to provide evidence useful at the national level.

In order to develop effective and integral nutritional strategies, policy-makers need to recognise the apparently contradictory presence of adult overweight/obesity and childhood stunting in the same household and understand its association with HFI. For households at different HFI levels to experience an actual improvement in their nutritional status, efforts to abate overnutrition,

undernutrition and inadequate dietary quality must be rooted in this knowledge.

Interestingly, our study found that, in preschool children, HFI severity increased the risk of stunting only if their mothers were not obese. This may be explained by the growth of urbanisation resulting in higher household incomes and greater food availability and as regards quantity, not quality.⁵¹ The foods available to poor urban households are likely to be energy rich but nutrient poor. The presence of non-obese mothers in FI households may indicate a dearth of adequate quality food for children redounding in micronutrient deficiencies and protein quality issues that hinder their growth—particularly in relation to height. By contrast, the presence of maternal obesity in FI households may indicate greater access to the calories and nutrients needed for adequate child development and may also account for the lower prevalence of stunting in these homes. This may explain the relative lack of any relationship of stunting to HFI severity in households with obese mothers.

CONCLUSIONS

The double burden of malnutrition in Mexico occurs most notably among mother-child pairs living with HFI. Crafting a sound approach to combat malnutrition is complex because of its multidimensional nature.⁵² These conditions hamper the implementation of effective measures capable of protecting vulnerable population groups and ensuring adequate livelihoods. Policies and programmes must tackle chronic undernutrition and overnutrition according to the food and nutritional needs of each age group, rather than assuming that their needs will be met by targeting the household as a homogeneous unit. Consistent with other studies, our work highlights the importance of monitoring household food security based on experience-related scales such as *ELCSA*. These have proved highly useful for food security governance.⁵³

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