Food Security (2018) 10:1163–1172
https://doi.org/10.1007/s12571-018-0836-x

ORIGINAL PAPER

Energy and nutrient supply according to food insecurity severity among Mexican households

Mariana Romo-Aviles[1] · Luis Ortiz-Hernández[1]

Received: 1 September 2017 / Accepted: 23 August 2018 / Published online: 17 September 2018

Abstract

Studies from Latin America have shown that food insecurity reduces dietary diversity. However, dietary diversity measures do not account for the energy and nutrient supply in households. The objective of our study was to know whether there are differences in food, energy and nutrients supplies in Mexican households according to their food insecurity level. We analyzed the database of the National Household Income and Expenditure Survey performed in Mexico in 2014. The modified Latin-American and Caribbean Food Security Scale was used to determine the existence of household food security or insecurity. Participants registered foods and beverages available at their homes during the previous week. The supply of energy and nutrients was estimated using Mexican and American food composition references. Mexican food secure households had greater supply of healthy (e.g., fresh fruits and vegetables, fish and seafood, and fresh meats) and unhealthy (e.g., processed meats, fries, sugar-sweetened beverages, desserts, and alcoholic beverages) foods. By contrast, food insecure households rely on cheap staple food (e.g. maize, rice, pulses, eggs, and sugar). There was a linear relationship between the energy density and severity of food insecurity. Households with mild and moderate food insecurity had greater total energy supplies than households with food security and severe food insecurity. Food insecure households had greater supplies of carbohydrates, cholesterol, iron, and magnesium, but lower supplies of protein, fat, vitamin C, vitamin A, potassium, calcium, and sodium. Most of the results suggest that food insecure households are exposed mostly to negative aspects of the nutrition transition because they have greater access to energy and lower availability of some micronutrients.

Keywords Food security · Food insecurity · Nutritional availability · Diet quality · Food availability

1 Introduction

Food insecurity at the household level occurs when there is a limited or uncertain capability of acquiring healthy and innocuous foods in socially acceptable ways (Pérez-Escamilla et al. 2012). Depending on its severity, household food insecurity experiences include concerns about running out of food, decreasing food quality or availability, and experiences of hunger among family members (Bickel et al. 2000). In Mexico, household food insecurity is a widespread social problem. During 2010, 50% of Mexican households presented some level of food insecurity; specifically, 24.9% suffered mild food insecurity, 14.6% experienced moderate food insecurity, and 10.5% suffered severe food insecurity (Valencia-Valero and Ortiz-Hernández 2014).

The nutrition transition describes changes at the population level in diet and physical activity, which are reflected in nutritional and physical outcomes, such as height and body composition (Popkin 1999). According to the theoretical frame of the nutrition transition, Mexico could be characterized by two phases: receding famine and degenerative disease (Rivera et al. 2004; Popkin 1999). The receding famine phase is characterized by low-fat and high-fiber diets which are associated with elevated prevalence of stunting, underweight and micronutrient deficiencies; whereas in the degenerative diseases phase, the diets have high content of fat, sugar and processed foods and are paralleled by high prevalence of obesity and bone density problems. Consequently, Mexico has been

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s12571-018-0836-x) contains supplementary material, which is available to authorized users.

✉ Luis Ortiz-Hernández
lortiz@correo.xoc.uam.mx

[1] Departamento de Atención a la Salud, Universidad Autónoma Metropolitana unidad Xochimilco, Calz. del Hueso 1100, Col. Villa Quietud, Coyoacán, 04960 Ciudad de México, Mexico

characterized as having a dual burden of poor nutrition in which obesity co-exists with undernutrition and other nutrient deficiencies (Rivera et al. 2004). On the one hand, in 2012, 5.6% of adolescents, 17.9% of pregnant women, 11.6% of non-pregnant women, 15.4% of older women and 17.8% of older men had anemia (Gutiérrez et al. 2012), and in most cases this condition was related to iron deficiency (De la Cruz-Góngora et al. 2012). Although the frequencies of underweight and wasting among Mexican infants are low (2.8 and 1.6%, respectively), the stunting rate is high (13.6%) (Gutiérrez et al. 2012). On the other hand, fruits, vegetables, milk, and meat purchases decreased, and soda and refined carbohydrates purchases increased (Rivera et al. 2004). Fiber intake is lower and saturated fat and added sugar intakes are higher than the recommended for more than 50% of the Mexican population (Lopez-Olmedo et al. 2016). These dietary changes have been reflected in negative health outcomes. In 2016, 72.5% of the adult population, 33.2% of schoolchildren and 9.7% of infants were overweight or obese (Instituto Nacional de Salud Pública and Secretaría de Salud 2016). The rates of diabetes and hypertension in adults were 9.4 and 25.5%, respectively (Gutiérrez et al. 2012).

Food insecurity has been associated with negative effects on health and well-being. In children, food insecurity is related to higher risk of overweight (Ortiz-Hernández et al. 2007a), symptoms of respiratory infection, hospitalizations for diarrhea and pneumonia (Bauermann et al. 2016), mental and somatic symptoms, low life satisfaction (Molcho et al. 2006), and anemia (Eicher-Miller et al. 2009). In adults, food insecurity is associated with overweight (Ortiz-Hernández et al. 2007b), diabetes, and hypertension (Seligman et al. 2010).

In terms of nutritional quality, most studies in Latin America have shown that food insecurity reduces dietary diversity, which is measured as the number of food groups available in the households (Melgar-Quiñonez et al. 2005; Hackett et al. 2007; Álvarez et al. 2006). Although dietary diversity is considered an indicator of diet quality (Ruel 2003), its use in the context of the nutrition transition has shortcomings. One limitation is that a household can buy more foods, but these foods are not necessarily healthy. For example, food secure Mexican households have higher dietary diversity because they have greater availability of healthy food groups (e.g., fresh fruits, fish and seafood, milk, or lean meats) as well as greater supply of medium and high energy density foods (processed meats, fries, and desserts) or low energy density and low nutrient density beverages (sugar-sweetened and alcoholic ones) (Valencia-Valero and Ortiz-Hernández 2014).

Another restriction of dietary diversity analysis is that it does not provide detailed information about the energy and nutrient supply, which can be risk factors for disease, independent of available food groups. Dietary diversity is focused on the prevention of malnutrition (Ruel 2003), whereas nutritional quality focuses on the prevention of malnutrition and obesity. Some authors have suggested that the higher risk of obesity (and other nutrition-related diseases) observed among food insecure people is related to the higher supply of high energy dense food in their households (Dietz 1995; Ortiz-Hernández et al. 2007b). Mexican food insecure households have a greater supply of foods with medium to high energy density, such as pulses, maize, and sugars (Valencia-Valero and Ortiz-Hernández 2014). In addition, a greater supply of pulses in food insecure households could imply a greater availability of some nutrients. However, there is a greater supply of most food groups in the food secure households; consequently, they tend to have a greater supply of energy and nutrients. Therefore, it is hard to hypothesize whether food insecure households will have higher or lower energy and nutrient supplies compared to food secure households. In other words, there is evidence describing the differences in food availability by the severity of household food insecurity; however, it is unknown what the variation is in energy and nutrient supplies between food secure and food insecure Mexican households.

To our knowledge, this is the first study in a middle-income country that analyzes energy and nutrient supply according to food insecurity level. In this field, most research has been conducted in low-income countries from Africa and Asia (Haddad et al. 1994; Vaitla et al. 2017). However, the social and food contexts differs by the income-level of the countries, which could affect the determinants and consequences of food insecurity. For example, the increase of energy supply (estimated based on balance sheets) from 1973 to 2013 was 1.4% in low-income African countries (from 2114 to 2144 Kcal per habitant), 17.6% in Asian low-income countries (2131 to 2507 Kcal per habitant), 24.7% in Latin-American middle-income countries (2358 to 2942 Kcal per habitant), and 30.3% in African lower-middle-income countries (2054 to 2676 Kcal per habitant) (FAOSTAT 2018) (see supplementary Table 1). These figures show that the food environment differs according to economic development because in Latin-American middle-income countries could have an energy supply up to 800 Kcal higher than in a low-income country. In the Mexican case, the increase of energy supply has been produced by the greater availability of cheap foods such as sugar, vegetable oils, and egg (Ortiz-Hernández et al. 2006). On the other hand, food insecurity in most Latin-American countries could hardly be explained by lack of food availability at the national level (which is the case in some African countries), some countries in this region have even become food exporters (Food and Agriculture Organization 2015). In Latin America, poverty (the main determinant of food insecurity) is driven by income inequality which is associated with high rates of unemployment, informal employment, and low wages (Food and Agriculture Organization 2015).

Based on the previous background, it is unknown whether the negative association of energy supply and food insecurity, which exists in low-income countries, can be observed in a middle-income country in Latin America. Therefore, the objective of our study was to analyze the food, energy and nutrients supply in Mexican households according to the severity of food insecurity. This information is necessary for the evaluation of the nutritional quality of foods available in the households, particularly among those whose occupants face financial hardship. Likewise, the identification of household characteristics related to food expenditure and the consequent energy and nutrient supply can inform the design of programs aimed to promote healthy diets (Smith and Subandoro 2007).

2 Materials and methods

The database of the National Household Income and Expenditure Survey (ENIGH, *Encuesta Nacional de Ingreso y Gasto de los Hogares*) performed in Mexico in 2014 was analyzed (Instituto Nacional de Estadística, Geografía e Informática 2014). The sample included 21,427 households nationwide; however, for the analysis, 1948 households were discarded since they did not have food availability data, or they were 5 standard deviations (SD) above the nutrient average (Smith and Subandoro 2007). Sampling was probabilistic with a bi-phasic sample, stratified (by geographic region and locality size) and clustered (by census tracts). The last selection unit was dwellings (i.e., house building), and the observation units were the households (i.e., people who share food expenditures). Primary sampling units were constituted of census tracts conformed by dwelling groups with similar socioeconomic characteristics.

A version of the Latin American and Caribbean Food Security Scale (ELCSA, *Escala Latinoamericana y Caribeña de Seguridad Alimentaria*) was used to determine the existence of household food security and insecurity (Pérez-Escamilla et al. 2012), which contained 16 items, of which seven referred to minors' experiences (<18 years old), five to adults' experiences, and four to households' experiences (see supplementary Table 2). The items about minors' experiences are problematic for households without minors; in these cases, the items were answered negatively due to the absence of minors, but not because there was food security. For this reason, only the nine questions related to households and adults' experiences were analyzed. Even with these items, households with minors had a higher frequency of food insecurity (see Table 1). Four groups were created according to the number of affirmative answers on the ELCSA: food security (no affirmative answer), mild food insecurity (one to three affirmative answers), moderate food insecurity (four to six affirmative answers) and severe food insecurity (seven to nine affirmative answers). With these cut-off points, there was correspondence of the item content with the conceptualization of food insecurity: mild food insecurity is characterized by a decrease in food variety or quality or concern about running out of food; moderate food insecurity is present when the food quantity for adults is reduced; and severe food insecurity occurs when food runs out, socially unacceptable ways are used to acquire food, or members of the household experience hunger (Pérez-Escamilla et al. 2012).

In the ENIGH, the respondents (usually the housewife or a household member who knew about the food expenditures) were trained to register any foods and beverages purchased during a week. Trained interviewers reviewed the information registered by respondents, and clarifications or probing of missing data was determined at the end of the week. Each respondent reported any foods and beverages acquired by any member living in the household during the week. The interviewers divided the reported foods into 233 categories of most-consumed single items (e.g., orange) or less-consumed food classes (e.g., mandarin, nectarine, and tangerine). Standardized procedures to clean and analyze the data of household expenditure surveys were conducted (Smith and Subandoro 2007; Fiedler et al. 2012). To analyze the household food supply, the amounts of foods (in grams per day) available per adult equivalent was estimated. The concept of an adult equivalent was necessary to conduct comparisons among households with different demographic compositions, because younger subjects require less resources to fulfill their needs (Teruel et al. 2005). Therefore, rather than using the total number of household members to make per capita estimations, children received a lower weighting than adults in order to be able compare households with different numbers of children and adults. The values used to estimate adult equivalents are specific to the Mexican population (Teruel et al. 2005). Food supply data that were greater than 5 SD of the average total grams for each food were truncated. Based on energy and nutrient content (Muñoz et al. 2010), processing level (Costa Louzada et al. 2015), and cost (Ortiz-Hernández 2006), we categorized the food items into 27 food groups. The items included in each food group are presented in supplementary Table 3.

The nutrients analyzed were selected because they are risk or protection factors (Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases 2003) for diseases that are the main causes of morbidity or mortality in Mexico (Instituto Nacional de Estadística, Geografía e Informática 2015; Organización Mundial de la Salud 2016; Gutiérrez et al. 2012): energy intake is associated with weight gain; saturated fat, sodium, and cholesterol consumption are associated with coronary heart disease and stroke; sodium and potassium are associated with hypertension; calcium is related to osteoporosis; fiber, vitamin A, and vitamin C are protectors for some chronic conditions; iron and vitamin A are linked with anemia; and zinc, vitamin A, and protein are associated with linear growth. The content of calories and nutrients was consulted from the national food composition reference

Table 1 Socio-demographic characteristics of Mexican households and their distribution by food insecurity

	Total [a]	Food security and insecurity [b]					ORM	
		FS	FI-Mi	FI-Mo	FI-S			
	%	%	%	%	%	*p*	OR	*p*
Total	100%	48.0	25.6	15.4	10.9			
HH sex								
Male	74.3	48.4	26.1	15.2	10.3	<0.000	Ref.	
Female	25.7	46.9	24.2	16.1	12.8		1.15	0.001
HH age, years								
34 or younger	19.4	47.6	26.5	14.9	11.0	0.003	Ref.	
35–49	36.1	45.5	26.8	16.6	11.1		1.10	0.048
50–64	26.8	50.1	23.8	15.2	10.9		0.91	0.092
65 or older	17.7	50.5	24.8	14.2	10.5		0.66	0.000
HH speaks indigenous language								
No	92.1	50.1	24.9	14.8	10.2		Ref.	
Yes	7.9	23.7	34.3	22.6	19.4	0.000	1.38	0.000
HH education								
No education	7.9	27.4	29.5	22.5	20.6	0.000	Ref.	
Primary	34.3	37.5	30.2	18.7	13.6		0.59	0.000
Junior high school	27.5	46.3	27.0	16.7	10.0		0.42	0.000
High school	14.7	56.4	22.2	12.4	9.0		0.30	0.000
Bachelor or more	15.6	76.6	14.4	5.4	3.6		0.13	0.000
Geographic region								
North	23.7	57.3	20.2	12.2	10.3	0.000	Ref.	
West	22.6	49.0	24.0	15.5	11.5		1.12	0.072
Center	31.3	50.5	25.2	14.5	9.8		1.17	0.011
South	22.4	33.8	33.6	20.1	12.5		1.47	0.000
Locality size								
City	49.8	58.7	20.7	12.1	8.5	0.000	Ref.	
Urban	14.7	43.9	27.3	16.7	12.1		1.37	0.000
Semi-rural	13.5	39.6	29.9	17.6	12.9		1.31	0.000
Rural	22.0	31.7	33.0	20.9	14.4		1.41	0.000
Minors								
No	51.2	54.7	22.4	13.1	9.8	0.000	Ref.	
Yes	48.8	41.1	28.9	17.9	12.1		1.45	0.000

FS, food security; *FI-Mi*, mild food insecurity; *FI-Mo*, moderate food insecurity; *FI-S*, severe food insecurity; *HH*, household head; *ORM*, ordinal regression model; *OR*, odds ratio; having food insecurity severity as outcome; *ref.*, reference group

[a] Distribution in the total population

[b] Percentages sum 100% in rows. Weighted estimates are reported

(Muñoz et al. 2010). If nutrient data were not found in this reference, then the USDA Food Composition Databases (United States Department of Agriculture 2016) were used. The percentages of the edible portions of 193 of the 233 foods included in the ENIGH were estimated. For the rest of the foods, it was not possible to estimate nutrient content because their description in the ENIGH was not specific (e.g., "other vegetables") or nutritional data did not exist (e.g. *mole*). Information about the codes used for nutrient estimates may be requested from the authors. Energy was analyzed as total kcal per day and as energy density per 100 g of food. The energy density of the food groups was estimated and classified into four categories: very low (<0.6 kcal/g), low (0.6–1.5), medium (1.6–3.9), and high (4.0–9.0) (Rolls and Hermann 2012). Macronutrients were expressed as the percentage of total energy supply, whereas micronutrients were estimated as the nutrient density per 1000 kcal.

The sex, age, ethnicity, and education of the household heads were evaluated. In Mexico, each participant defined who was the household head of his/her family. Education was categorized into five groups: without education (kindergarten or did not attend school), elementary, junior high school, high school (including technical careers), and bachelor and postgraduate (including specialties, masters and doctoral degrees). Ethnicity was defined according to the language spoken: an indigenous person is one who speaks a native language. The region (north, west, center and south) and locality size (city: >100,000 inhabitants, urban: 15,000 to 99,999, semi-rural: 2500 to 14,999 and rural: <2500) where the households were located was considered.

Statistical analysis was performed using the survey commands of STATA software version 14.0. These commands consider the complex design of the ENIGH. Frequencies of categorical variables and means of continuous variables were estimated. To identify whether differences between groups exist, chi-square tests were conducted. To identify whether the severity of food insecurity was associated with demographics, an ordinal regression model was estimated having food insecure severity as the ordinal outcome variable with the following coding: 0, food security; 1, mild food insecurity; 2, moderate food insecurity; and 3, severe food insecurity. The ordinal regression models estimate a link function from the actual cumulative odds of each category in the outcome variable. Odds ratios (OR) can be estimated from the regression coefficients of the ordinal regression models. An OR > 1.00 (or OR < 1.00) corresponds to an increasing (or decreasing) odd of being in one of the higher cumulative outcome categories.

To compare the means of food and nutrient supplies according to food insecurity, the respective confidence intervals (95% CIs) were calculated. The 95% CIs were estimated based on the Taylor series linearization method. Finally, linear regression models were estimated with energy and nutrient supplies as the outcomes and food insecurity as the exposure variable. The models were adjusted for age, sex, and ethnicity of the household head, minors in the household, geographical region, and locality size. These variables were considered confounders because minors in the household, living in the south region and living in rural localities were associated with higher probabilities of food insecurity and lower diet quality (Shamah-Levy et al. 2014; Valencia-Valero and Ortiz-Hernández 2014).

3 Results

Household heads were more likely to be males than females; were 35 to 49 years old; were Spanish rather than native speakers; or had primary education than other education levels (Table 1). Around one-third of the households were in the center region and one-half were in cities. Minors were present in almost half of the households. Households from urban or smaller localities and the south region, those with women or indigenous people as heads and those with minors were more likely to experience more severe levels of food insecurity. Conversely, households headed by individuals 65 years or older or more educated people had a lower probability of experiencing the more severe grades of food insecurity. The same trends were observed in the ordinal regression model. The only exception was that there were no differences between households with minors and those without minors.

Compared to food insecure households, those with food security had a higher supply of fifteen food groups: wheat, fresh fruits, fresh vegetables, processed vegetables, fresh meat, processed meat, chicken, fish and seafood, milk, cheese, fries, sugar-sweetened beverages, desserts, oilseeds, and alcoholic beverages (Table 2). Households with any level of food insecurity had a higher supply of six food groups: maize, rice, spices, pulses, eggs, and sugars. There were no significant differences for roots, animal fats, vegetable oils, fast food, coffee and tea, and baby food supplies. In total, two of the fifteen food groups with higher availability in food secure households had very low energy density, five had low energy density, six had medium energy density, and two had high energy density. Conversely, in food insecure households, there was lower availability of any food groups with very low energy density: however, two of the six food groups with higher availability in food insecure households were low energy density, three were medium energy density, and one was high energy density.

Mildly and moderately food insecure households had higher supplies of energy than food secure and severely food insecure households (Table 3). Energy density was higher as food insecurity became more severe. Food insecure households had a higher percentage of calories from carbohydrates and a higher iron and magnesium density than food secure households. The percentage of calories from protein, fats, and saturated fats was higher among the food secure households than those with any level of food insecurity. In these households, the food available had higher vitamin C, calcium, and sodium density than the food insecure households. Compared to mildly or moderately food insecure households, those with food security had foods with higher vitamin A density. There were no differences between food secure and insecure groups with respect to fiber, cholesterol, potassium, or zinc density.

After adjusting for demographic variables, the total energy supply was greater in the mild and moderate food insecure households than in the food secure households (Table 4). Energy density; the percentage of calories from carbohydrates; and the density of cholesterol, iron, and magnesium became greater as food insecurity severity increased; but the percentages of calories from proteins, fat, and saturated fat; and the densities of vitamin C, calcium, zinc, and sodium were less. The vitamin A supply was lower in mild and moderate food insecure households, although in the last case the difference was marginal ($p = 0.060$). The potassium supply was lower in moderately food insecure households, but the difference was marginal ($p = 0.060$).

4 Discussion

Mexican food secure households had a greater supply of more food groups that were both healthy and unhealthy. By contrast, food insecure households had greater supplies of maize, rice, spices, pulses, eggs, and sugar. Mildly and moderately food insecure households had greater total energy supplies than food secure or severely food insecure households. Energy density became higher as food insecurity increased. Food insecure households had a greater supply of carbohydrates, cholesterol, iron, and magnesium; but a lower supply of protein, fat, saturated fat, vitamin A, vitamin C, calcium, zinc, and sodium.

Our analysis confirms that food secure households have higher availability of more food groups (fifteen), including foods with different energy density (i.e. from very low to

Table 2 Availability of food groups by food insecurity among Mexican households, 2014

	Total population		ED	FS	FI-Mi	FI-Mo	FI-S
	% [1]	M [2]	(kcal/g)	M [2]	M [2]	M [2]	M [2]
Maize products	88.64	205.83	2.00	177.68	227.07[a]	238.55[a]	234.24[a]
Wheat products	83.92	58.03	3.67	59.94	57.95	55.54	53.33[a]
Rice	33.93	14.39	5.18	13.42	15.06	15.99[a]	14.83
Roots	45.23	25.43	0.62	25.13	26.54	25.72	23.76
Fresh fruits	55.23	86.19	0.44	108.40	73.22[a]	63.02[a,b]	51.22[a,b]
Fresh vegetables	82.57	146.54	0.26	154.06	147.05	138.04[a]	124.28[a,b]
Processed vegetables	21.41	4.25	1.18	4.54	4.01	4.34	3.42[a]
Spices	22.40	4.45	1.25	4.05	5.23[a]	4.34	4.52
Pulses	48.83	30.38	3.26	24.5	34.09[a]	36.87[a]	38.39[a]
Fresh pork and beef meat	57.14	34.89	1.86	42.83	32.24[a]	25.11[a,b]	19.88[a,b,c]
Processed meat	52.62	16.93	3.35	19.30	15.46[a]	15.10[a]	12.52[a,b,c]
Chicken	58.90	44.44	1.61	47.98	43.39[a]	41.18[a]	35.86[a,b]
Fish and seafood	22.19	9.55	1.51	10.65	8.22[a]	8.54	9.19
Milk	68.82	135.93	0.71	156.41	124.31[a]	118.54[a]	97.38[a,b,c]
Cheese	48.58	12.38	2.45	14.40	11.02[a]	10.61[a]	8.73[a,b,c]
Egg	65.85	37.30	1.33	35.13	38.64[a]	39.78[a]	40.29[a]
Animal fats	23.57	4.79	3.83	5.04	4.75	4.74	3.84
Vegetable oils	35.33	15.84	8.54	15.04	16.62	16.97	15.93
Fries	12.24	2.19	5.18	2.70	1.79[a]	1.91	1.27[a]
Fast food	33.70	74.12	1.94	76.73	70.78	68.75	77.96
Sugar-sweetened beverages	70.40	166.21	0.61	191.26	147.42[a]	144.45[a]	130.39[a]
Sugars	30.75	18.72	3.86	16.20	21.15[a]	21.80[a]	19.84[a]
Desserts	21.62	8.49	3.34	10.34	6.97[a]	6.88[a]	6.17[a]
Coffee and tea	17.50	1.74	0.00	1.79	1.64	1.75	1.79
Oilseeds	3.00	0.70	4.65	0.90	0.60	0.50[a]	0.37[a]
Alcoholic beverages	4.77	10.49	0.82	13.65	7.31[a]	6.14[a]	10.10
Baby food	0.99	0.27	1.55	0.34	0.14	0.32	0.14

ED, energy density; *FS*, food security; *FI-Mi*, mild food insecurity; *FI-Mo*, moderate food insecurity; *FI-S*, severe food insecurity

[1] Proportion of households that purchased the food group

[2] Average grams or milliliters of food per day per adult equivalent. Weighted estimates are reported

[a] significant difference from FS. [b] significant difference from FI-Mi. [c] significant difference from FI-Mo. Superscripts mean that 95% confidence intervals (estimated through Taylor series linearization method) do not overlap

high); whereas food insecure households had higher availability of fewer food groups (six) and most of them had medium energy density (Hackett et al. 2007; Álvarez et al. 2006; Melgar-Quiñonez et al. 2005; Valencia-Valero and Ortiz-Hernández 2014). Higher dietary diversity in the food secure households is driven by the higher cost of healthy foods, such as fresh fruits and vegetables, lean meats, fish and seafood, and dairy products (Ortiz-Hernández 2006). However, studies based on dietary diversity measures (Hackett et al. 2007; Melgar-Quiñonez et al. 2005) preclude a detailed analysis of the nutritional consequences of food insecurity on diet because some foods that are more available in food secure households are not healthy. To clarify these potential consequences, our estimates of household supplies can be compared with recommendations of food consumption to prevent chronic diseases. In Mexican food secure households, the supply of fresh fruits, fresh and processed vegetables, and pulses is 291.5 g/day, which corresponds to 58% of the recommendation (i.e. 500 g/day; (Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases 2003)); whereas in severely food insecure households the figures were 43% and 217.3 g/day, respectively. The supply of fish and seafood in food secure households corresponded to the 33% (10.6 g/day) of the consumption recommendation (32.0 g/day; U.S. Department of Health and Human Services, U.S. Department of Agriculture 2015)) and it corresponded to 26% (8.2 g/day) in mildly food insecure households. The supply of sweetened beverages in food secure households was nearer (80% or 191.3 ml/day) to the suggested limit (240 ml/day; (Rivera et al. 2008)) than in severely food insecure households (54% or 130.4 ml/day).

At the other extreme, the higher availability of maize, rice, pulses, eggs, and sugars in the food insecure households is explained by their lower cost (Ortiz-Hernández 2006). For example, moderately food insecure households had a sugar supply closer (44% or 21.8 g/day) to the maximum suggested consumption (50 g/day (Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases 2003)) than food secure households (32% or 16.2 g/day). Similarly, other factors could explain the differences in food

Table 3 Energy and nutrient supplies by food insecurity among Mexican households, 2014

	Total M	FS M	FI-Mi M	FI-Mo M	FI-S M
Energy (kcal/day)	1581.89	1551.62	1627.78[a]	1632.34[a]	1537.43[b,c]
Energy (kcal/g/day)	1.41	1.30	1.48[a]	1.54[a,b]	1.57[a,b]
Macronutrients (% of calories)					
Proteins	13.97	14.47	13.68[a]	13.39[a]	13.23[a,b]
Carbohydrates	57.80	56.06	58.67[a]	59.72[a,b]	60.68[a,b]
Fats	28.96	30.01	28.57[a]	27.85[a]	26.86[a,b]
Saturated fats	9.39	10.26	8.92[a]	8.46[a,b]	7.99[a,b,c]
Micronutrients (units/1000 kcal)					
Fiber (g)	5.96	5.90	6.01	5.98	6.05
Cholesterol (mg)	172.34	174.51	170.09	168.85	172.98
Vitamin A (μg)	229.91	246.24	213.71[a]	216.57[a]	215.07
Vitamin C (mg)	44.71	50.92	41.99[a]	38.04[a]	33.27[a,b]
Calcium (mg)	502.33	515.81	492.67[a]	490.33[a]	482.96[a]
Iron (mg)	7.54	7.32	7.63[a]	7.76[a]	8.01[a,b]
Magnesium (mg)	212.72	201.26	220.05[a]	224.69[a]	228.95[a,b]
Potassium (mg)	1213.48	1222.25	1214.13	1193.63	1201.57
Zinc (mg)	4.20	4.23	4.21	4.15	4.16
Sodium (mg)	718.25	785.06	679.03[a]	636.40[a,b]	632.86[a]

FS, food security; *FI-Mi*, mild food insecurity; *FI-Mo*, moderate food insecurity; *FI-S*, severe food insecurity; *M*, weighted means

[a] significant difference from FS. [b] significant difference from FI-Mi. [c] significant difference from FI-Mo. Superscripts mean that 95% confidence intervals (estimated through Taylor series linearization method) do not overlap

supply by the severity of food insecurity. For example, the acquisition of certain unhealthy foods (e.g., fries, sugar-sweetened or alcoholic beverages) by food secure households could be influenced by marketing (Chandon and Wansink 2012). In addition, some low-cost foods (e.g., maize, pulses, and sugar) are perceived to generate the satiety perception, and food insecure households tend to select these items for this reason (Hernández et al. 2013).

In the regression models, a linear relationship of energy density with severity of food insecurity was evident. This shows that as household resources are restricted, households prefer staple foods that are usually more energy dense and low cost. The total energy supply was higher among mildly and moderately insecure households compared to secure and severely insecure households. These differences in total energy correspond to the curvilinear relationship of food insecurity with body weight: the risk of being overweight is higher in people from mildly or moderately food insecure households, whereas it is lower among those from severely food insecure households (Morales-Ruán et al. 2014; Ortiz-Hernández et al. 2007a; Ortiz-Hernández and Rivera-Marquez 2010). These patterns may occur because mildly and moderately food insecure households give priority to buying, and can afford, greater amounts of medium and high energy density foods, which increase the risk of weight gain among their members. Although severely food insecure households prefer energy dense foods, they can only afford less of these foods than households with food insecurity of a lesser severity. The lower energy supply may explain the higher risk of low weight among members of severely food insecure households. Food secure households have greater dietary variety which includes very low, low, medium and high energy density foods; however, contrary to food insecure households, those with food security tend to acquire lower quantities of foods with high energy density, which could reduce the risk of their members being overweight and obese (Perez-Escamilla et al. 2012).

Protein, total fat, saturated fats, vitamin A, vitamin C, calcium, and sodium supplies became lower as food insecurity became more severe, whereas the proportion of energy from carbohydrates, cholesterol, iron and magnesium supply became greater. These patterns can be attributed, on the one hand, to the lower availability of fresh and processed meats, fruits, and vegetables in food insecure households; and on the other hand, to their higher supply of maize, rice, pulses, sugars, and eggs. In Canada, children and adults who live in food insecure households tend to have more energy dense carbohydrates and a greater proportion of them (Kirkpatrick and Tarasuk 2008) but iron and magnesium intake were higher in those living in food secure households, contrary to our results. Thus, food insecurity is consequent upon a diet based primarily on staple foods of moderate or high energy density but are not necessarily sources of nutrients associated with reduced health risks (Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases 2003). Simultaneously, in addition to their lower total fat and saturated fats supply, food insecure households have some elements in their diet that are healthy, such as higher supplies of pulses and eggs, which are important sources of protein and other nutrients. However, it remains controversial whether the excessive consumption of eggs represents a health risk (Shin et al. 2013).

Table 4 Linear regression models having as outcomes the energy, macronutrient and micronutrient supplies among Mexican households, 2014

	FI - mild		FI - moderate		FI - severe		Linearity test	
	B [1]	*p*	B [1]	*p*	B [1]	*p*	*t*	*p*
Energy (kcal/day)	47.44	0.024	52.39	0.024	−42.23	0.136	−0.06	0.955
Energy (kcal/g/day)	0.09	0.000	0.14	0.000	0.18	0.000	13.03	0.000
Macronutrients (% of calories)								
Proteins	−0.55	0.000	−0.78	0.000	−0.90	0.000	−8.04	0.000
Carbohydrates	1.77	0.000	2.67	0.000	3.51	0.000	9.92	0.000
Fats	−1.02	0.000	−1.65	0.000	−2.53	0.000	−7.59	0.000
Saturated fats	−0.83	0.000	−1.25	0.000	−1.72	0.000	−14.54	0.000
Micronutrients (density/1000 kcal)								
Fiber (g)	0.00	0.977	−0.02	0.820	0.07	0.695	0.25	0.801
Cholesterol (mg)	5.12	0.112	5.21	0.119	9.35	0.035	2.32	0.020
Vitamin A (μg)	−22.56	0.000	−17.12	0.060	−18.10	0.216	−1.76	0.079
Vitamin C (mg)	−6.31	0.000	−9.72	0.000	−14.55	0.000	−8.78	0.000
Calcium (mg)	−8.64	0.113	−10.25	0.077	−19.27	0.006	−2.90	0.004
Iron (mg)	0.33	0.000	0.46	0.000	0.70	0.000	8.81	0.000
Magnesium (mg)	13.75	0.000	18.22	0.000	23.91	0.000	10.39	0.000
Potassium (mg)	−5.45	0.638	−24.44	0.059	−18.83	0.262	−1.67	0.095
Zinc (mg)	−0.03	0.331	−0.09	0.014	−0.07	0.126	−2.24	0.025
Sodium (mg)	−60.64	0.000	−98.70	0.000	−103.5	0.000	−7.82	0.000

Models adjusted for age, sex, and ethnicity of the household head; minors in household, geographical region and locality size. Reference group: food security households. Weighted estimates are reported

FS, food security; *FI*, food insecurity; *B*, linear regression coefficient

Contrary to our expectations and to what was observed in Canadian adults (Kirkpatrick and Tarasuk 2008), food insecure Mexican households had higher iron and magnesium supplies than their counterparts. The higher availability of eggs (source of iron), fortified processed cereals, and pulses (sources of iron and magnesium) can explain this fact. However, the bioavailability of minerals from pulses is reduced compared to that from animal sources (Gibson 2007; Leroy et al. 2015).

This study presents limitations inherent in the analysis of household expenditure surveys (Smith and Subandoro 2007; Fiedler et al. 2012). These types of surveys are unable to determine the distribution of food among household members. Potential sources of bias could include the type of food purchased within the reference period (i.e., perishable food may be bought in higher quantities), inaccuracy of the reported food weights, the lack of information about food consumed away from home, and by the variability of the people who eat at home. In addition, the ENIGH is based on a cross-sectional design, which does not allow causal conclusions to be drawn. The average energy supply in Mexican households estimated in this study (1581 kcal/d) was lower than that estimated from FAO balance sheet data (3139 kcal) (Ortiz-Hernández et al. 2006). This may be due to the underestimation of the energy supply and because of the different levels of analysis (household versus national). Reported energy consumption by 24 h recall among Mexican adults (2030 kcal/d) (Lopez-Olmedo et al. 2016) is also lower than the FAO estimates. In Ugandan households, the energy supply derived from a household expenditure survey did not differ from estimates based on 24-h recalls (Dary and Jariseta 2012). However, we cannot dismiss the possibility that our estimates are an underestimation of household food supply because the kind and quantities of foods eaten away from home are not assessed in the ENIGH. In 2002, foods eaten away from home was 18.8% of total food expenditure (Ortiz-Hernández et al. 2006). Future studies are necessary to analyze the energy and nutrients of food consumed away from home. Because of this, estimates of total energy supply could be biased; however, this is not the case for energy density, which depends on the kinds of foods but not on food quantity.

Our results have implications for the conceptualization of household food insecurity. It has generally been considered (Melgar-Quiñonez et al. 2005; Hackett et al. 2007; Pérez-Escamilla et al. 2012; Leroy et al. 2015) that increasing severity of household food insecurity is associated with decreasing quality and quantity of foods; therefore, its energy supply is expected to decrease in a linear way. Based on this premise, a common practice is to validate new indicators of household food insecurity having the household energy supply as a gold standard (Melgar-Quiñonez et al. 2005; Vaitla et al. 2017; Haddad et al. 1994; Leroy et al. 2015). In other words, most authors assume that there is a linear negative association of household food insecurity severity with household energy supply. This may be the case in low income countries, especially those in Africa and Asia (Vaitla et al. 2017). However, our results challenge such a premise and suggest that in a middle-income country the relationship is positive and curvilinear i.e. households with mild or moderate food insecurity had higher energy supply than those with food security; but the latter is not different from those with severe food insecurity. This situation occurs in part because in this country there is a greater availability at the national level of cheap food which has moderate or high energy density (Ortiz-Hernández et al. 2006); such foods are affordable for households with mild or moderate food insecurity.

Regarding nutritional quality, although in food insecure households there is less availability of most food groups, there is greater availability of foods that are inexpensive, some of which have low nutrient density but medium or high energy density (sugar or rice). This may imply that their members are at an increased risk of consuming insufficient amounts of foods of high nutrient density and very low or low energy density (e.g., fresh fruits and vegetables) and nutrients (e.g., vitamin A, vitamin C, or calcium) that reduce the risk of chronic diseases (Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases 2003). It is imperative to recognize these facts because the negative effects of the nutritional transition are concentrated in households and individuals with food insecurity. Therefore, policies and programs to promote healthy eating should include the goal of eradicating food insecurity.

Finally, although food secure households have access to foods of good nutritional quality (e.g., fresh fruits and vegetables or lean meats), they also have access to low-quality foods (e.g. processed meats, fried foods, sugar-sweetened beverages, desserts, and alcoholic beverages). Consequently, having greater food variety does not always imply having a healthier diet because some of these food groups are nutrient sources (total fat, saturated fats, and sodium) that are related to detrimental effects on health. Regardless, food-secure households have access to more foods with very low and low energy densities than those households with any level of food insecurity.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

References

Álvarez, M. C., Estrada, A., Montoya, E. C., & Melgar-Quiñonez, H. (2006). Validación de la escala de la seguridad alimentaria doméstica en Antioquia, Colombia. *Salud Pública de México, 48*(6), 474–482.

Bauermann, M., Spaniol, A. M., Bortolini, G. A., & Pérez-Escamilla, R. (2016). Household food insecurity, nutritional status and morbidity in Brazilian children. *Public Health Nutrition, 19*, 2240–2245.

Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). *Guide to Measuring Household* Food Security, *Revised 2000*. (Department of Agriculture, Food and Nutrition Service). Alexandria VA.

Chandon, P., & Wansink, B. (2012). Does food marketing need to make us fat? A review and solutions. *Nutrition Reviews, 70*(10), 571–593.

Costa Louzada, M. L., Martins, A. P., Canella, D. S., Baraldi, L. G., Levy, R. B., Claro, R. M., et al. (2015). Ultra-processed foods and the nutritional dietary profile in Brazil. *Revista de Saude Pública, 49*. https://doi.org/10.1590/S0034-8910.2015049006132.

Dary, O., & Jariseta, Z. R. (2012). Validation of dietary applications of household consumption and expenditures surveys (HCES) against a 24-hour recall method in Uganda. *Food and Nutrition Bulletin, 33*, S190–S198. https://doi.org/10.1177/15648265120333S207.

De la Cruz-Góngora, V., Villalpando, S., Rebollar, R., Shamah-Levy, T., & Méndez-Gómez, I. (2012). Nutritional causes of anemia in Mexican children under 5 years. Results from the 2006 National Health and nutrition survey. *Salud Pública de México, 54*, 108–115.

Dietz, W. H. (1995). Does hunger cause obesity? *Pediatrics, 95*(5), 766–767.

Eicher-Miller, H. A., Mason, A. C., Weaver, C. M., McCabe, G. P., & Boushey, C. J. (2009). Food insecurity is associated with iron deficiency anemia in US adolescents. *American Journal of Clinical Nutrition, 90*, 1358–1371.

FAOSTAT (2018). Food Balance Sheets. http://www.fao.org/faostat/en/#data/FBS. Accessed 12 March 2018.

Fiedler, J. L., Lividini, K., Bermudez, O. I., & Smitz, M. F. (2012). Household consumption and expenditures surveys (HCES): A primer for food and nutrition analysts in low- and middle-income countries. *Food and Nutrition Bulletin, 33*(3 Suppl), S170–S184.

Food and Agriculture Organization (2015). Regional overview of food insecurity. Latin America and the Caribbean: Food and Agriculture Organization.

Gibson, R. S. (2007). The role of diet- and host-related factors in nutrient bioavailability and thus in nutrient-based dietary requirement estimates. *Food and Nutrition Bulletin, 28*, S77–S100.

Gutiérrez, J. P., Rivera-Dommarco, J., Shamah-Levy, T., Villalpando-Hernández, S., Franco, A., Cuevas-Nasu, L., et al. (2012). *Encuesta Nacional de Salud y Nutrición 2012. Resultados Nacionales*. Cuernavaca, México: Instituto Nacional de Salúd Pública.

Hackett, M., Zubieta, A. C., Hernandez, K., & Melgar-Quinonez, H. (2007). Food insecurity and household food supplies in rural Ecuador. *Archivos Latinoamericanos de Nutricion, 57*(1), 10–17.

Haddad, L., Kennedy, E., & Sulliva, J. (1994). Choice of indicators for food security and nutrition monitoring. *Food Policy, 19*, 329–343.

Hernández, E., Pérez, D., & Ortiz-Hernández, L. (2013). Consecuencias alimentarias y nutricionales de la inseguridad alimentaria: la perspectiva de madres solteras. *Revista Chilena de Nutricion, 40*(4), 351–357.

Instituto Nacional de Estadística, Geografía e Informática. (2014). *Encuesta Nacional de Ingresos y Gastos de los Hoagres 2014: diseño muestral. In Instituto Nacional de Estadística y Geografía*. México: Aguascalientes.

Instituto Nacional de Estadística, Geografía e Informática (2015). Principales causas de mortalidad por residencia habitual, grupos de edad y sexo del fallecido. http://www.inegi.org.mx/est/contenidos/proyectos/registros/vitales/mortalidad/tabulados/ConsultaMortalidad.asp. Accessed 31-05-2017.

Instituto Nacional de Salud Pública & Secretaría de Salud (2016). Encuesta Nacional de Salud y Nutrición de Medio Camino 2016. Informe final de resultados. Instituto Nacional de Salud Pública, Cuernavaca, México.

Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases. (2003). Diet, nutrition and the prevention of chronic diseases: A report of a joint WHO/FAO expert consultation. WHO technical report series. In *Geneva*. Switzerland: World Health Organization.

Kirkpatrick, S. I., & Tarasuk, V. (2008). Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. *Journal of Nutrition, 138*(3), 604–612.

Leroy, J. L., Ruel, M., Frongillo, E. A., Harris, J., & Ballard, T. J. (2015). Measuring the food access dimension of food security: A critical review and mapping of indicators. *Food and Nutrition Bulletin, 36*, 167–195.

Lopez-Olmedo, N., Carriquiry, A. L., Rodriguez-Ramirez, S., Ramirez-Silva, I., Espinosa-Montero, J., Hernandez-Barrera, L., et al. (2016). Usual intake of added sugars and saturated fats is high while dietary Fiber is low in the Mexican population. *Journal of Nutrition, 146*(9), 1856S–1865S.

Melgar-Quiñonez, H., Zubieta, A. C., Valdez, E., Whitelaw, B., & Kaiser, L. (2005). Validación de un instrumento para vigilar la inseguridad alimentaria en la Sierra de Manantlán, Jalisco. *Salud Pública de México, 47*(6), 413–423.

Molcho, M., Gabhainn, S. N., Kelly, C., Friel, S., & Kelleher, C. (2006). Food poverty and health among schoolchildren in Ireland: Findings from the health behaviour in school-aged children (HBSC) study. *Public Health Nutrition, 10*(4), 364–370.

Morales-Ruán, M. C., Méndez-Gómez, I., Shamah-Levy, T., Valderrama-Álvarez, Z., & Melgar-Quiñonez, H. (2014). La inseguridad alimentaria está asociada con obesidad en mujeres adultas en México. *Salud Publica de Mexico, 56*, 54–61.

Muñoz, M., Ledesma, J. A., & Chávez, A. (2010). *Composición de alimentos. Valor nutritivo de los alimentos de mayor consumo*. México, D.F.: McGraw Hill Interamericana.

Organización Mundial de la Salud (2016). Obesidad y sobrepeso. Organización Mundial de la Salud.

Ortiz-Hernández, L. (2006). Evolución de los precios de los alimentos y nutrimentos en México entre 1973 y 2004. *Archivos Latinoamericanos de Nutrición, 56*(3), 201–216.

Ortiz-Hernández, L., Acosta-Gutierrez, M. N., Nuñez-Pérez, A. E., Peralta-Fonseca, N., & Ruiz-Gómez, Y. (2007a). En escolares de la ciudad de México la inseguridad alimentaria se asoció positivamente con el sobrepeso. *Revista de Investigación Clínica, 59*, 32–41.

Ortiz-Hernández, L., Barrera, M. J., & Blanco, E. (2007b). Asociación de la inseguridad alimentaria con el sobrepeso y la obesidad en mujeres de la ciudad de México. *Nutrición Clínica, 10*(2), 63–70.

Ortiz-Hernández, L., Delgado-Sánchez, G., & Hernández-Briones, A. (2006). Cambios en factores relacionados con la transición alimentaria y nutricional en México. *Gaceta Médica de México, 142*, 13.

Ortiz-Hernández, L., & Rivera-Marquez, J. A. (2010). *Inseguridad alimentaria y riesgo de obesidad*. In Panamericana, La obesidad: perspectivas para su comprensión y tratamiento (pp. 35–42). México, D. F.

Perez-Escamilla, R., Obbagy, J. E., Altman, J. M., Essery, E. V., Mcgrane, M. M., Wong, Y. P., Spahn, J. M., & Williams, C. L. (2012). Dietary energy density and body weight in adults and children: A systematic review. *Journal of the Academy of Nutrition and Dietetics, 112*, 671–684.

Pérez-Escamilla, R., Segall-Correa, A. M., Álvarez, M. C., & Melgar-Quiñonez, H. (2012). *Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ELCSA): Manual de uso y aplicaciones* (Vol. 17). Roma, Italia: Food and Agriculture Organization.

Popkin, B. (1999). Urbanization, lifestyle changes and the nutrition transition. *World Development, 27*(11), 1905–1916.

Rivera, J. A., Barquera, S., Gonzalez-Cossio, T., Olaiz, G., & Sepulveda, J. (2004). Nutrition transition in Mexico and in other Latin American countries. *Nutrition Reviews, 62*, S149–S157.

Rivera, J. A., Muñoz-Hernández, O., Rosas-Peralta, M., Aguilar-Salinas, C. A., Popkin, B., & Willett, W. C. (2008). Consumo de bebidas para una vida saludable: recomendaciones para la población mexicana. *Salud Pública de México, 50*, 173–195.

Rolls, B., & Hermann, M. (2012). The ultimate Volumetrics diet. In *Broadway*. New York: HerperCollins.

Ruel, M. T. (2003). Operationalizing dietary diversity: A review of measurement issues and research priorities. *Journal of Nutrition, 133*(11 Suppl 2), 3911S–3926S.

Seligman, H. K., Laraia, B. A., & Kushel, M. B. (2010). Food insecurity is associated with chronic disease among low-income NHANES participants. *Journal of Nutrition, 140*(2), 304–310.

Shamah-Levy, T., Mundo-Rosas, V., & Rivera, J. (2014). La magnitud de la inseguridad alimentaria en México: su relación con el estado de nutrición y con factores socioeconómicos. *Salud Pública de México, 56*, S79–S85.

Shin, J. Y., Xun, P., Nakamura, Y., & He, K. (2013). Egg consumption in relation to risk of cardiovascular disease and diabetes: A systematic review and meta-analysis. *American Journal of Clinical Nutrition, 98*(1), 146–159.

Smith, L. C., & Subandoro, A. (2007). *Measuring Food Security Using Household Expenditure Surveys. Food security in practice*. Washington, D.C: International Food Policy Research Institute.

Teruel, G., Rubalcava, L., & Santana, A. (2005). *Escalas de Equivalencia para México*. Mexico: Secretaría de Desarrollo Social.

United States Department of Agriculture (2016). USDA Food composition databases. https://ndb.nal.usda.gov/ndb/search/list2016.

United States Department of Health and Human Services, United States Department of Agriculture. (2015). *2015–2020 Dietary Guidelines for Americans* (8th ed.)

Vaitla, B., Coates, J., Glaeser, L., Hillbruner, C., Biswal, P., & Maxwell, D. (2017). The measurement of household food security: Correlation and latent variable analysis of alternative indicators in a large multi-country dataset. *Food Policy, 68*, 193–205.

Valencia-Valero, R. G., & Ortiz-Hernández, L. (2014). Disponibilidad de alimentos en los hogares mexicanos de acuerdo con el grado de inseguridad alimentaria. *Salud Pública de México, 56*, 154–164.

Mariana Romo Aviles recently finished her B.Sc., majoring in nutrition. Her work as a research assistant at the Health Care Department in the *Universidad Autónoma Metropolitana* has been focused on nutrition and public health. She is interested in public health and nutrition, child nutrition, promotion of breastfeeding, and assessment of energy expenditure using indirect calorimetry.

Luis Ortiz-Hernández has a B.Sc. with a major in nutrition, a Masters in Social Medicine, and a doctoral degree in Public Health. He works as a professor at the Health Care Department in the *Universidad Autónoma Metropolitana* in Mexico City. His training and research experience is focused on critical public health and social epidemiology and he has interests in the following topics: analysis of health and nutrition inequities associated with socioeconomic position; racism and health; environment determinants of nutrition and diet; and LGBT health.