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Trabajo Original

Epidemiología y dietética

Food insecurity was associated with low quality diet and low HDL level in mothers of Northwest Mexico relying on fisheries for livelihood

La inseguridad alimentaria se asoció con una dieta de baja calidad y bajo nivel de HDL en madres de familia del noroeste de México que dependen de la pesca como medio de subsistencia

Karla D. Murillo-Castillo[1], Edward A. Frongillo[2], Verónica López-Teros[1], Michelle M. Haby[1], María A. Corella-Madueño[1], Rolando G. Díaz-Zavala[1] and Trinidad Quizán-Plata[1]

[1]Department of Chemical and Biological Sciences. University of Sonora. Hermosillo, Sonora. Mexico. [2]Department of Health Promotion, Education, and Behavior. Arnold School of Public Health. University of South Carolina. Columbia, South Carolina. United States

Abstract

Background: food insecurity occurs when quality and quantity of food is insufficient for maintaining healthy nutritional and food profiles.

Objectives: to determine if food insecurity is associated with dietary and biochemical measures in mothers of the northwest of Mexico, which relies primarily on fisheries for livelihood.

Methods: a cross-sectional study was conducted with 116 mothers of the Northwest of Mexico. A socioeconomic survey, food security scale, and two non-consecutive 24-hour recalls were applied. Anthropometric measurements were made and hemoglobin, glucose and cholesterol levels were measured. The association between key measures and food insecurity was assessed using logistic and linear regression.

Results: two-thirds (68%) of households experienced food insecurity. Mothers with mild insecurity had 3.7 and 3.2 times higher odds of not consuming fruits and vegetables, respectively, and 4.9 times higher odds of consuming sweetened non-dairy drinks ($p = 0.04$; 0.04 and 0.05, respectively). In addition, they consumed less protein ($\beta = -3.22\%$; $p < 0.01$) and more carbohydrates ($\beta = 6.04\%$; $p = 0.02$) compared with mothers with food security. Mothers with severe insecurity consumed less iodine ($\beta = -24.41$ µg; $p = 0.03$) and had lower levels of HDL cholesterol ($\beta = -12.01$ mg/dl; $p = 0.03$) than mothers with food security.

Conclusions: food insecurity was associated with low quality diet and low levels of HDL cholesterol in mothers of Northwest Mexico relying on fisheries for livelihood.

Key words:

Food insecurity. Dietary measures. Biochemical measures. Mothers of Northwest Mexico. Fisheries.

Resumen

Introducción: la inseguridad alimentaria ocurre cuando la calidad y la cantidad de alimentos son insuficientes para mantener un perfil nutricional y alimentario saludable.

Objetivos: determinar si la inseguridad alimentaria está asociada con indicadores dietéticos y bioquímicos en madres del noroeste de México que dependen principalmente de la pesca como medio de subsistencia.

Métodos: se realizó un estudio transversal con 116 madres del noroeste de México. Se aplicó una encuesta socioeconómica, una escala de seguridad alimentaria y dos recordatorios de 24 horas. Se realizaron mediciones antropométricas y se midieron los niveles de hemoglobina, glucosa y colesterol. La asociación entre las medidas clave y la inseguridad alimentaria se evaluó mediante regresión logística y lineal.

Resultados: dos tercios (68%) de los hogares experimentaron inseguridad alimentaria. Las madres con inseguridad leve tuvieron una probabilidad 3,7 y 3,2 veces mayor de no consumir frutas y verduras, respectivamente, y 4,9 veces más probabilidad de consumir bebidas endulzadas no lácteas ($p = 0,04$; 0,04 y 0,05, respectivamente). Además, consumieron menos proteínas ($\beta = -3,22\%$; $p < 0,01$) y más carbohidratos ($\beta = 6,04\%$; $p = 0,02$) en comparación con madres con seguridad alimentaria. Las madres con inseguridad severa consumieron menos yodo ($\beta = -24,41$ µg; $p = 0,03$) y tuvieron niveles más bajos de colesterol HDL ($\beta = -12,01$ mg/dl; $p = 0,03$) que las madres con seguridad alimentaria.

Conclusiones: la inseguridad alimentaria se asoció con una dieta de baja calidad y bajos niveles de colesterol HDL en madres del noroeste de México que dependen de la pesca como medio de vida.

Palabras clave:
Seguridad alimentaria. Indicadores dietéticos. Medidas bioquímicas. Madres de familia del noroeste de México. Pesca.

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Correspondence:

Trinidad Quizán Plata. Department of Chemical and Biological Sciences. University of Sonora. Boulevard Luis Encinas y Rosales, s/n. Colonia Centro. 83000 Hermosillo, Sonora. Mexico
e-mail: trinidad.quizan@unison.mx

INTRODUCTION

Food security exists "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (1). This definition covers many of the dimensions and components of food security, including temporality and shocks; physical, social, and economic access to food; sufficient quantity and quality of food to meet nutritional requirements; the safety of food; and the ability of individuals to make choices and consume culturally acceptable and preferred foods (1). Food insecurity is experienced by households and individuals when there is uncertainty about future food availability and access, insufficiency of the amount and kinds of foods (quality) required for a healthy lifestyle, or the need to use socially unacceptable ways to acquire food (1).

In Mexico, according to the National Health and Nutrition Survey of 2012, the prevalence of food insecurity was 69.8% among Mexican households (2). The survey reported mild food insecurity in 41.6%, moderate food insecurity in 17.7%, and severe food insecurity in 10.5%. According to these data, 28.2% of households reduced the amount of food consumed and/or an adult or child spent a whole day without eating (2). This high prevalence of food insecurity is important because food insecurity is manifested physically and emotionally through symptoms that lead to a deterioration in well-being and quality of life (3).

When Mexican mothers living in high marginality conditions have a little extra money, they buy seasonal fruits because they are inexpensive, but they prefer that their children consume them. Also, mothers buy certain foods (e.g., bread and pasta) because they perceive that they will produce a feeling of satiety (4,5). Food-insecure households have greater availability of maize, wheat, eggs and sugar, but less availability of fresh fruits and vegetables, lean meats, chicken, fish, and milk (6).

Overweight, obesity, and weight loss are problems associated with food insecurity. Women in their role as mothers may consume a less varied diet even though they know it is not healthy for them (4,5). Food insecurity in adult women is associated with low high-density lipoprotein (HDL) cholesterol and high low-density lipoprotein (LDL) cholesterol, triglycerides, and glucose, increasing the risk of developing dyslipidemia and metabolic syndrome (7-11).

In coastal areas of Mexico, the fisheries sector is the main source of income. In the fisheries sector, the storage, transport, and distribution techniques are generally insufficient. These deficiencies force fishermen to sell most of the fish they catch at low prices, since they cannot preserve it in good condition for a long time. Consequently, their income, purchasing power and access to other nutrient-dense foods are limited, which may affect food security and economic development adversely, and reduce the social welfare of the population (12).

In addition, although coastal zones have been part of programs to improve food security, most of the strategies and objectives have focused only on the agricultural and livestock sectors, without making any recommendations for activities related to fishing. Programs aimed at improving food security must seek to reduce or prevent the negative impacts on the population by reinforcing the survival mechanisms of the most vulnerable groups. In addition, they must begin with an initial phase of analysis to understand the vulnerability and need of the population to which they are directed. They should study the socio-economic, cultural, and natural factors that affect food security, as well as health and health conditions (12,13).

Therefore, the objective of this study was to determine if food insecurity is associated with dietary and biochemical measures of nutritional well-being in mothers of the Northwest coast of Mexico, which relies primarily on fisheries for livelihood. This information can serve as a starting point for the design, implementation, and evaluation of programs that seek to improve food security, adapted to the needs and culture of these coastal areas.

MATERIAL AND METHODS

The study population consisted of mothers of Kino Bay, a fishing community located in the Northwest of Mexico. The study had a cross-sectional design and was approved by the Research Ethics Committee of the University of Sonora, Mexico. Sixty percent of the streets in the community were randomly selected. Each household of the selected streets was visited, inviting mothers of children attending elementary school (grades 1-5) to participate in the study. Informed consent was obtained from those who accepted to participate. One hundred sixteen mothers agreed to participate (90% of those eligible), and they were surveyed from September 2016 to September 2017. The biochemical assessment was performed in 60% of the sample.

A socioeconomic survey was administered, asking about the number of household members, marital status, schooling, work status, monthly income, and food expenditure. The Mexican Scale of Food Security (14) was administered. This scale consists of 12 items, each with two possible responses: whether the experience described occurred or not. With these items, households were classified into: a) food security (i.e., responded affirmatively to zero items on the scale); b) mild food insecurity (i.e., responded affirmatively to one to three items); c) moderate food insecurity (i.e., responded affirmatively to four to seven items); or d) severe food insecurity (i.e., responded affirmatively to eight to 12 items).

Two non-consecutive 24-hour dietary recalls were carried out; one of them was on the weekend. The amount of each food and drink consumed by the mother, including recipes and forms of preparation, was recorded. For the analysis of dietary information, nutrient composition tables (from the United States Department of Agriculture, Nutrition Labeling Software, and the National Institute of Medical Sciences and Nutrition Salvador Zubiran) and a manual for the dietary estimation procedure were used (15). We recorded the frequency of consumption of 14 food groups, using the methodology of the 2016 National Health and Nutrition Survey. To consider a food as consumed, mothers should have consumed ≥ 10 grams of such food. To consider a food group as consumed, mothers should have consumed it for two days. We also calculated the average intake of energy, macronutrients, and

micronutrients, and compared them with the recommendations for their age (16,17).

Weight, height, and waist circumference were measured according to internationally standardized procedures to obtain body mass index (BMI) and abdominal obesity. The classification of BMI was made according to the references of the World Health Organization (WHO) (18). The cut-off for high waist circumference to define abdominal obesity was > 80 cm according to the criteria for Mexican women of the Mexican Social Security Institute (16). For the biochemical analysis, fasting blood samples were taken to evaluate the concentrations of hemoglobin; total, HDL, and LDL cholesterol; and glucose.

For the statistical analyses, we used as independent variable the four categories of food security (i.e., food security, mild, moderate and severe food insecurity), where food security was the reference category. The dependent variables were the consumption of food groups, macronutrients, and micronutrients, and the concentration of hemoglobin and total cholesterol, HDL and LDL. Consumption of food groups was handled as a dichotomous variable. For food groups expected to have lower risk (i.e., fruits, vegetables, legumes, unprocessed meats, pure water, eggs, dairy products and cereals), 0 = consumed the food group and 1 = did not consume the food group. For the food groups expected to have higher risk (i.e., processed meats, fast food and greasy foods, snacks, sweets and desserts, sweet cereals, non-dairy beverages and sweetened non-dairy, and dairy drinks), the categorization was reversed. The age, head of household, household size, marital and employment status, and education level were used as adjustment variables. Due to non-normal distributions, χ^2 and Kruskal-Wallis tests were used for bivariate analyses. For the association between the dependent variables and the categories of food security, logistic and linear regression without and with logarithmic transformations were used; the results were the same, so the untransformed results are reported. The analyses were performed in Stata version 11 and NCSS version 11 programs. A p-value ≤ 0.05 was considered as statistically significant.

RESULTS

Participating mothers had a mean ± SD age of 36.4 ± 8.9 years; BMI of 31.5 ± 6.6 kg/m^2, and waist circumference of 101.9 ± 17.2 cm (Table I). The prevalence of overweight and obesity was 88.4% and the prevalence of abdominal obesity was 94.5%. Sixty-nine percent of mothers were housewives, 42% completed basic education, and 25% of them were head of household. Mothers reported a mean monthly family income of 386 ± 183 USD, and used 80.7% of the total income for food acquisition. Two-thirds (68%) of mothers reported experiencing food insecurity, with 36% experiencing mild food insecurity, 21% moderate, and 11% severe.

The consumption of vegetables, legumes, unprocessed meats, eggs, and snacks, sweets and desserts was higher in food-secure households than in those with food insecurity on bivariate analyses, but the difference was only significant for the consumption of vegetables (Table II). The intake of protein, added sugar, potassium, sodium, vitamin A and zinc differed significantly according to the category of food insecurity in bivariate analyses (Table III).

Table I. Anthropometric, socio-demographic and economic characteristics of 116 mothers of the Northwest coast of Mexico

Variables	Mean ± SD or %	Range
Age (years)	36.4 ± 8.9	22-65
BMI (kg/m^2)	31.5 ± 6.6	16.9-55.0
Waist circumference (cm)	101.9 ± 17.2	64-192
Abdominal obesity (%)	94.5	-
Overweight and obesity (%)	88.4	-
Household size	6 ± 2	2-12
Number of children	3 ± 1	1-8
Basic education (%)	42	-
Married or living in a common-law marriage (%)	91	-
Housewives (%)	69	-
Female headed households (%)	23	-
Monthly family income (USD)	385.9 ± 183.1	53.7-1,004.8
Monthly food expenditure (%)	80.7 ± 40.8	26.3-237.2

After adjusting for socio-demographic and economic variables, food insecurity was significantly associated with the consumption of fruits, vegetables, and sweetened non-dairy drinks (Table IV). Mothers with mild food insecurity had a 3.68 and 3.22 times higher odds of not consuming vegetables and fruits, respectively, and 4.87 times higher odds of consuming sweetened non-dairy drinks compared to mothers with food security. In addition, mothers with severe food insecurity had 7.95 times higher odds of not consuming vegetables compared to mothers with food security.

After adjusting for socio-demographic and economic variables, mothers with mild food insecurity had lower intake of protein (β = -3.22%, p < 0.01), but higher intake of carbohydrates (β = 6.04%, p = 0.02) compared to mothers with food security (Table V). In addition, mothers with severe food insecurity had lower intake of iodine (β = -24.41 µg, p = 0.03) than mothers with food security.

Overall, participants had normal hemoglobin (12.2 ± 0.95 g/dl), glucose (94.15 ± 24.93 mg/dl), and total cholesterol levels (178.30 ± 31.07 mg/dl), but they had inadequate levels of HDL (50.16 ± 9.07 mg/dl) and LDL cholesterol (114.38 ± 31.24 mg/dl). The levels of total and HDL cholesterol differed significantly between categories of food insecurity. Mothers with food security had 12.01 mg/dl more of HDL cholesterol than those with severe food insecurity (Table VI).

Table II. Frequency of food-group consumption according to the category of food insecurity in mothers of the Northwest coast of Mexico (n = 116)*

Level of food (in)security	Food groups											
	Fruits	**Vegetables**	**Legumes**	**Unprocessed meats**	**Pure water**	**Egg**	**Dairy products**	**Processed meats**	**Snacks, sweets and desserts**	**Cereals and tubers**	**Sweet cereals**	**Sweetened non-dairy drinks**
Food security	57.1	39.4	33.3	33.3	45.8	34.9	33.3	39.4	46.7	33.0	50.0	33.3
Mild FI	19.0	31.8	26.2	30.6	20.8	27.9	40.0	39.4	33.3	35.1	36.4	37.6
Moderate FI	14.3	22.7	28.6	22.2	25.0	23.3	17.8	12.1	13.3	20.2	1.6	16.1
Severe FI	9.5	6.1	11.9	13.9	8.3	13.9	8.9	9.1	6.7	11.7	0.0	12.9
p	0.13	0.03	0.26	0.81	0.40	0.50	0.77	0.39	0.57	0.58	0.15	0.07

**Values are percentages; significant difference ($p \leq 0.05$) by Chi-square test. FI: food insecurity.*

DISCUSSION

Food insecurity was associated with low quality diet and low levels of HDL cholesterol in mothers of Northwest Mexico relying on fisheries for livelihood. Food insecurity was associated with a lower consumption of fruits and vegetables and a higher consumption of sweetened non-dairy drinks. Mothers from food-insecure homes had less frequent consumption of food groups rich in micronutrients (19-21).

Our findings are consistent with the low consumption of fruits and vegetables presented by the Mexican population. The most recent results of the National Health and Nutrition Survey of the Mexican population (ENSANUT, 2016) reported that only 42.3% of the adult population of the country consume fruits and vegetables. In addition, the consumption is below the average in rural locations and in the northern region of the country (including the Northwest of Mexico), being consumed by 35.8% and 34.6% of the population, respectively. Additionally, fruits were consumed by half of the Mexican adult population (51.4%), being higher in urban (53.5%) than rural (45.3%) locations (17). Other studies reported for the Northwest region of Mexico, especially in Sonora, have documented low consumption of fruits and vegetables. In 1997, a basket of food consumption for Sonora and its contribution of nutrients was determined. It was found that fruits and vegetables, except for those used as seasonings in stews (tomatoes, chili and onion), are not part of the usual meals and are of secondary importance for the Sonoran population (22).

In 2009, the causes, strategies, and consequences of food insecurity in families from urban, rural, border, and coastal areas of Northwest Mexico were analyzed. In that study, diets were high in total energy, saturated fat and sodium, as well as low in iron and vitamin A among the participants. This reflected a low consumption of fruits and vegetables and high food with high energy density, which satisfies the appetite, but not necessarily nourishes adequately (23). In 2013, the conceptions and experiences of food insecurity of women who represent low-income households in Northwest Mexico were studied. Participants recognized that fruits and vegetables were important for a healthy life, but could not acquire them due to their economic limitation (3). This same barrier for the consumption of fruits and vegetables was found in the ENSANUT 2016, in which it was observed that the main obstacle for eating healthy was the lack of money to buy fruits and vegetables (17). Other studies have also documented that the purchase of fruits and vegetables is lower as food insecurity is greater (24).

On the other hand, in Mexico, average individual consumption of sugar-sweetened beverages increased 60% between 1989 and 2006. In 2011, Mexico had the largest *per capita* consumption of soft drinks worldwide, estimated at 163 liters *per capita* per year (25). In 2012, the mean *per-capita* consumption of beverages was 382 kcal/d among adults aged ≥ 20 y. All beverages represent 19% of the total daily energy intake *per capita.* Caloric soda, caloric coffee/tea, and fresh water (natural fruit water sweetened with sugar) were the top three major contributors to the total daily energy intake *per capita* (26).

Table III. Intake of energy, macro and micronutrients according to the level of food insecurity in mothers of the Northwest coast of Mexico (n = 116)*

Nutrient	Food security	Mild FI	Moderate FI	Severe FI	p
Energy, kcal	1,897 ± 610.9	1,926.4 ± 721.5	1,956.6 ± 823.1	1,534.7 ± 590.3	0.31
Protein, %	15.8	13.2	14.5	15.3	0.04
Fiber, g	20.2 ± 8.8	20 ± 7.1	21.7 ± 11.1	16.2 ± 7.5	0.41
Carbohydrates, %	49.8	53.3	51.4	45.8	0.11
Added sugars, g	79.8 ± 46.5	94.1 ± 59	74.2 ± 48.5	70 ± 44.3	0.02
Total fat†, %	36.1	35.3	38.9	38.4	0.20
Saturated‡	24.5	20.8	25.7	16.6	0.08
Cholesterol, mg	416.5 ± 190.5	350.5 ± 212.4	382.7 ± 178.5	429.1 ± 176.1	0.46
Calcium, mg	845.4 ± 459.6	656.5 ± 232.7	722.7 ± 396.2	616.1 ± 277.4	0.25
Iron, mg	13.5 ± 4.8	13.7 ± 7.2	13.3 ± 6.6	10.3 ± 4.9	0.20
Potassium, mg	2,158.4 ± 933.4	1,954.2 ± 1,049.9	2,213.8 ± 1,139.9	1,398.8 ± 485.1	0.04
Sodium, mg	2,590.7 ± 1,105.7	2,023.6 ± 783.2	1,831.7 ± 947.9	1,862 ± 845.5	0.01
Vitamin A, µGer	1,240.6 ± 1,904.4	618.6 ± 617.9	965.6 ± 1,767.4	334 ± 94.2	0.01
Vitamin C, mg	129.2 ± 143.9	100.2 ± 120.5	133.8 ± 170.6	36.5 ± 33.6	0.06
Folate, µGef	443.6 ± 230.1	404 ± 196	472.5 ± 331.2	348 ± 153.7	0.61
Zinc, mg	11.3 ± 5.5	10 ± 6.9	10.7 ± 4.3	7.8 ± 3	0.02
Iodine, µg	35.8 ± 37.3	31.8 ± 20.2	31.3 ± 22.4	17 ± 14.5	0.07

**Values are mean ± SD or percentages; significant difference ($p \leq 0.05$) by Kruskal-Wallis test. FI: food insecurity. †From total energy. ‡From total fat.*

Table IV. Logistic regression analysis between food insecurity and the consumption of food groups in mothers of the Northwest coast of Mexico (n = 116)*

	Not consuming fruits		Not consuming vegetables		Consuming sweetened non-dairy drinks	
Level of food (in)security	**AOR**	**p**	**AOR**	**p**	**AOR**	**p**
Food security (reference)	1.0	-	1.0	-	1.0	-
Mild food insecurity	3.68	0.04	3.22	0.04	4.87	0.05
Moderate food insecurity	3.45	0.09	2.30	0.22	2.08	0.37
Severe food insecurity	1.66	0.56	7.95	0.01	3.20	0.24

*Significant association $p \leq 0.05$. *Adjusted for head of household, household size, number of children, marital and employment status and education level.*

Table V. Linear regression analysis between food insecurity and consumption of protein, carbohydrates, and iodine in mothers of the Northwest coast of Mexico (n = 116)*

	Nutrients					
	Protein (%)		Carbohydrates (%)		Iodine (µg)	
Level of food (in)security	β	**p**	β	**p**	β	**p**
Food security (reference)	-	-	-	-	-	-
Mild food insecurity	-3.22	0.01	6.04	0.02	-10.50	0.18
Moderate food insecurity	-2.37	0.03	-0.04	0.99	1.23	0.89
Severe food insecurity	-1.61	0.23	0.46	0.90	-24.41	0.03

*Significant association $p \leq 0.05$. *Adjusted for head of household, household size, number of children, marital and employment status and education level.*

Table VI. Linear regression analysis between food insecurity and biochemical measures in mothers of the Northwest coast of Mexico (n = 60)*

	Total cholesterol (mg/dl)		HDL cholesterol (mg/dl)	
Level of food (in)security	β	**p**	β	**p**
Food security (reference)	-	-	-	-
Mild food insecurity	2.26	0.83	4.16	0.19
Moderate food insecurity	8.29	0.48	3.44	0.34
Severe food insecurity	-51.18	0.01	-12.01	0.03

*Significant association $p \leq 0.05$. *Adjusted for age, head of household, household size, number of children, marital and employment status and education level.*

In 2016, the ENSANUT highlighted the high frequency of consumption of sugar sweetened beverages by a considerable part of the Mexican population. This survey found that 86% of the population regularly consumed sugary drinks, and of this, 39% reported consuming them daily, while 33% consumed them several times a week (17). Everyday knowledge and socialization practices have been described as determinants of sweetened beverages consumption in Mexican adults, particularly in those with low socioeconomic status. In this regard, several studies have established that integrating educational campaigns promoting the consumption of pure water and emphasizing the unhealthiness of sugar sweetened beverages can decrease the energy intake from beverages (27). In the ENSANUT 2016, despite the high frequency of consumption of sugary drinks, 92% of the Mexican population knows that their excess consumption is not healthy and knows the negative consequences of high consumption. This knowledge may be the result of exposure to health campaigns that expose the damage caused by high consumption of sugary drinks (17). These educational campaigns have been included within initiatives proposed by the federal government of Mexico, which seek to reduce the consumption of these beverages through changes in taxes that make pure water more accessible and the sugar-sweetened beverages less accessible (25,26). After Mexico implemented a 1 peso per liter excise tax on sugar-sweetened beverages on January 1st, 2014, purchase of sugary drinks decreased by 7.6% in the 2014-2015 period. Households at the lowest socioeconomic level had the largest decreases in purchases of taxed beverages (28). Additionally, a price increase in soft drinks has been associated with a larger quantity consumed of water and milk and a decrease in the consumption of other sugar sweetened beverages, snacks, and candies. Higher elasticities have been found among households living in rural areas, in more marginalized areas, and with lower income. Fiscal approaches such as taxation continue to be recommended as a public health policy to reduce sugar-sweetened beverages consumption (25).

Worldwide, food insecurity has been associated with higher intakes of fruit juice and other sugar-sweetened beverages (e.g., lemonade, sweetened tea, fruit punch, Kool-Aid®) (29). In this regard, in our analysis of dietary intake, higher intake of food products containing carbohydrates and added sugar occurred among mothers with mild food security.

The preference for consuming sugary drinks and junk food and the distaste for the taste of vegetables are other perceived barriers to healthy eating (17). Food-insecure people are more likely to report cost and taste as barriers to healthy food consumption than food-secure people (30). In this regard, the association between food insecurity and the lower consumption of healthy food groups and poor diet quality may be mediated, in part, by the low cost of energy-dense foods and may be reinforced by the high palatability of sugar and fat (31). Household food insecurity has been previously hypothesized to promote dependence on inexpensive, highly palatable foods that are energy dense (21).

Food-insecure families often consume foods with high energy density such as refined carbohydrates, added sugars and fats which only provide "empty calories" and, therefore, do not provide vitamins, minerals or other nutrients associated with the health and well-being of people (6,32,33). Therefore, it is expected that the consumption of proteins is significantly lower in mothers with slight insecurity since they substitute the consumption of high protein foods for foods and drinks high in carbohydrates and added sugars.

Previous studies have found that in households experiencing food insecurity, there is less availability and low intakes of animal products, fruits, vegetables, milk and lean meats (6,19). Particularly in studies with women living in food insecure homes, a lower weekly average consumption of fruits, vegetables, meats, fish, seafood, milk and milk products has been reported compared to food secure homes (20); this can explain the low intake of micronutrients. In our study, the consumption of potassium and vitamin A (micronutrients contained in fruits and vegetables) and iodine and iron (contained in meats) was significantly lower as food insecurity was higher. That reflects not only restrictions on quality or variety of diet, but on economic and social access to a greater variety of foods. Other studies have shown significantly lower levels of potassium and fiber intake among food-insecure groups (21). In addition, women from food-insecure households had inadequate intakes of vitamin A, E, C and pyridoxine, as well of folate, thiamin, niacin, iron and magnesium (21,34). Compromising dietary intakes in the context of household food insecurity heightens the vulnerability for nutrient inadequacies (35).

Households with food insecurity not only guide their decisions for the acquisition of food because of the price, but for other issues such as the perception they have on the ability of the kind

of food to generate satiety. Although the economic resources is the main criterion that families use to acquire food, the experience of food insecurity has other cultural or symbolic dimensions that are not exhausted in their economic dimension (6).

Mothers with food security in our study had a significant higher sodium intake compared to those in food insecurity. This may be because in food security households there was a higher consumption of food with high sodium content such as processed meats; we found that they had a greater intake of food from this group. Thus, living in a food-secure household did not guarantee optimal dietary intake.

Mothers with food security had a significantly higher HDL cholesterol level than mothers with severe food insecurity. In studies with young and old adults, those from food-insecure families had lower serum concentrations of HDL cholesterol, albumin, vitamin A, and vitamin E (21). People with food security were more likely to have lower fasting serum glucose, total cholesterol, LDL cholesterol and triglycerides and lower hemoglobin levels than those with food insecurity (7-11,36,37). Previous research studies have demonstrated that household food insecurity is associated with dietary compromise and are corroborated by studies documenting lower serum nutrient concentrations among adults in households characterized by food insecurity (35).

The finding that mothers from Kino Bay, especially those living in food-insecure homes, have lower quality and less diverse diets is of particular concern. It is widely known that the consumption of a variety of good quality foods is important for preconception, prenatal, and postnatal nutrition as well as overall health. Eating a diverse diet also ensures the presence of beneficial phytochemicals, promotes balance among nutrients that influence micronutrient absorption and utilization, and moreover, reduces the risk for multiple micronutrient deficiencies (20).

Some coastal communities, such as Kino Bay, have been experiencing complications in fishery, the main economic activity in these regions, due to environmental problems and lack of control of human activities (e.g., the introduction of exotic species deliberately or accidentally impacting native species, the disturbance of the fauna, clandestine hunting, contamination of the coastal zone, alteration of habitats, and the increase in population). Such phenomena impact on families who depend on this activity, increasing the risk of food insecurity, where mothers are one of the most affected (12). Food insecurity had been identified long ago as one of the main problems affecting fishing communities. The Food and Agriculture Organization (FAO) observed that the people engaged in these activities and their families continue, with few exceptions, to live at the margin of subsistence and human dignity. In addition, it was showed that food insecurity is endemic among artisanal fishers in terms of availability and quality of food, and diversification of diets (38).

In many societies, women add substantial economic value to fish caught and landed by men through their control of processing and marketing activities. Recognizing this contribution will promote the empowerment of women, increase their participation in management and stewardship, and address issues of food security and development (39).

Therefore, policy makers should focus on interventions that help prevent and reduce poverty, as well as improve the food security of fishing families, in order to protect their food consumption and livelihoods. Making the link between women's contributions to fisheries, and development on a broader scale as women play a key role in health, nutrition, and poverty reduction (38,39).

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REFERENCES

1. Leroy JL, Ruel M, Frongillo EA, Harris J, Ballard TJ. Measuring the food access dimension of food security: a critical review and mapping of indicators. Food Nutr Bull 2015;36:167-95. DOI: 10.1177/0379572115587274
2. Encuesta Nacional de Salud y Nutrición 2012 (ENSANUT). Distribución de la inseguridad alimentaria: evidencia para intervenciones diferenciadas. México: INSP; 2012. Disponible en: http://ensanut.insp.mx/doctos/analiticos/InseguridadAlim.pdf
3. Quizán T, Castro ML, Contreras AD, Saucedo S, Ortega MI. Inseguridad alimentaria: experiencias en familias de bajos recursos del noroeste de México. Biotecnia 2013;15:3-9. Disponible en: https://biotecnia.uson.mx/index.php/biotecnia/article/view/142
4. Hernández E, Pérez D, Ortiz L. Consecuencias alimentarias y nutricionales de la inseguridad alimentaria: la perspectiva de madres solteras. Rev Chil Nutr 2013;40:351-6. DOI: 10.4067/S0717-75182013000400004
5. Mundo V, Shamah T, Rivera J. Epidemiología de la inseguridad alimentaria en México. Salud Públca Mex 2013;55:206-13.
6. Valencia-Valero RG, Ortiz-Hernández L. Disponibilidad de alimentos en los hogares mexicanos de acuerdo con el grado de inseguridad alimentaria. Salud Pública Mex 2014;56:154-64.
7. Shin JI, Bautista LE, Walsh MC, Malecki KC, Nieto FJ. Food insecurity and dyslipidemia in a representative population-based sample in the US. Prev Med 2015;77:186-90. DOI: 10.1016/j.ypmed.2015.05. 009
8. Tayie FA, Zizza CA. Food insecurity and dyslipidemia among adults in the United States. Prev Med 2009:48:480-5. DOI: 10.1016/j. ypmed.2009.03.003
9. Parker ED, Widome R, Nettleton JA, Pereira MA. Food security and metabolic syndrome in U.S. Adults and adolescents: findings from the National Health and Nutrition Examination Survey, 1999-2006. Ann Epidemiol 2010;20:364-70. DOI: 10.1016/j.annepidem.2010.02.009
10. Holben DH, Taylor CA. Food insecurity and its association with central obesity and other markers of metabolic syndrome among persons aged 12 to 18 years in the United States. J Am Osteopath Assoc 2015;115:536-43. DOI: 10.7556/jaoa.2015.111
11. Egeland GM, Johnson-Down L, Cao ZR, Sheikh N, Weiler H. Food insecurity and nutrition transition combine to affect nutrient intakes in Canadian Arctic communities. J Nutr 2011;141:1746-53. DOI: 10.3945/jn.111.139006
12. Moreno C, Weaver A, Bourillón L, Torre J, Égido J, Rojo M. Diagnóstico ambiental y socioeconómico de la región marina-costera de Bahía de Kino, Isla Tiburón, Sonora México: Documento de trabajo y discusión para promover un desarrollo sustentable. México: Comunidad y Biodiversidad, Asociación Civil; 2005. Disponible en: http://cobi.org.mx/wp-content/uploads/2012/08/2005-t-cobi_rep_diagn_bahia_kino_051116.pdf
13. Willet W. Nutritional epidemiology. 2nd ed. Nueva York: Oxford University Press; 1998.
14. Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL). Dimensiones de la seguridad alimentaria: evaluación estratégica de nutrición y abasto. México: CONEVAL; 2010. Disponible en: https://www.coneval.org.mx/rw/resource/coneva/info_public/PDF_PUBLICACIONES/Dimensiones_seguridad_alimentaria_FINAL_web.pdf

15. Ortega MI, Quizán T, Morales GG. Cálculo de ingestión dietaria y coeficientes de adecuación a partir de: registro de 24 horas y frecuencia de consumo de alimentos. Cuadernos de trabajo nº 1. Estimación del consumo de alimentos. Hermosillo, Sonora: Centro de Investigación en Alimentación y Desarrollo, A.C. Dirección de Nutrición; 1999.
16. Suverza A, Haua K. El ABCD de la evaluación del estado de nutrición. 1ª ed. Ciudad de México: McGraw-Hill; 2010.
17. Encuesta Nacional de Salud y Nutrición de Medio Camino 2016 (ENSANUT). México: INSP; 2016. Disponible en: http://promocion.salud.gob.mx/dgps/descargs1/doctos_2016/ensanut_mc_2016-310oct.pdf
18. World Health Organization (WHO). Physical status: the use and interpretation of anthropometry. Geneva, Switzerland: WHO Expert Committee; 1995. DOI: 10.1002/(SICI)1520-6300(1996)8:6<786::AID-AJHB11>3.0.CO;2-1
19. Leyna GH, Mmbaga EJ, Mnyika KS, Hussain A, Klepp KI. Food insecurity is associated with food consumption patterns and anthropometric measures but not serum micronutrient levels in adults in rural Tanzania. Public Health Nutr 2010;13(9):1438-44. DOI: 10.1017/S1368980010000327
20. Weigel MM, Armijos RX, Racines M, Cevallos W. Food insecurity is associated with undernutrition but not overnutrition in Ecuadorian women from low-income urban neighborhoods. J Environ Public Health 2016;2016:8149459. DOI: 10.1155/2016/8149459
21. Laraia BA. Food insecurity and chronic disease. Adv Nutr 2013;4(2):203-12. DOI: 10.3945/an.112.003277
22. Valencia ME, Hoyos LC, Ballesteros MN, Ortega MI, Palacios MR, Atondo JL. Canasta de consumo de alimentos en el estado de Sonora. Rev Estud Soc 1997;8(15):12-33. Disponible en: https://www.researchgate.net/publication/267393961_Canasta_de_Consumo_de_Alimentos_en_el_Estado_de_Sonora
23. Quizán-Plata T, Castro-Acosta M, Paniagua C, Alma D, Saucedo S, Ortega MI. Inseguridad alimentaria en familias del noroeste de México: causas, estrategias y consecuencias sociales y nutricionales. Epistemus 2009;(7):23-8. Disponible en: http://www.epistemus.uson.mx/revistas/pdf/numero7.pdf
24. Kendall A, Olson CM, Frongillo EA. Relationship of hunger and food insecurity to food availability and consumption. J Am Diet Assoc 1996;96(10):1019-24. DOI: 10.1016/S0002-8223(96)00271-4
25. Colchero MA, Salgado JC, Unar-Munguia M, Hernández-Ávila M, Rivera-Dommarco JA. Price elasticity of the demand for sugar sweetened beverages and soft drinks in Mexico. Econ Hum Biol 2015;19:129-37. DOI: 10.1016/j.ehb.2015.08.007
26. Stern D, Piernas C, Barquera S, Rivera JA, Popkin BM. Caloric beverages were major sources of energy among children and adults in Mexico, 1999-2012-3. J Nutr 2014;144(6):949-56. DOI: 10.3945/jn.114.190652
27. Illescas-Zarate D, Espinosa-Montero J, Flores M, Barquera S. Plain water consumption is associated with lower intake of caloric beverage: cross-sectional study in Mexican adults with low socioeconomic status. BMC Public Health 2015;15(1):405. DOI: 10.1186/s12889-015-1699-0
28. Colchero MA, Rivera-Dommarco J, Popkin BM, Ng SW. In Mexico, evidence of sustained consumer response two years after implementing a sugar-sweetened beverage tax. Health Aff 2017;36(3):564-71. DOI: 10.1377/hlthaff.2016.1231
29. Leung CW, Epel ES, Ritchie LD, Crawford PB, Laraia BA. Food insecurity is inversely associated with diet quality of lower-income adults. J Acad Nutr Diet 2014;114:1943-53. DOI: 10.1016/j.jand.2014.06.353
30. Mook K, Laraia BA, Oddo VM, Jones-Smith JC. Food security status and barriers to fruit and vegetable consumption in two economically deprived communities of Oakland, California, 2013-2014. Prev Chronic Dis 2016;13. DOI: 10.5888/pcd13.150402
31. Drewnowski A, Specter SE. Poverty and obesity: the role of energy density and energy costs. Am J Clin Nutr 2004;79(1):6-16. DOI: 10.1093/ajcn/79.1.6
32. Seligman HK, Laraia BA, Kushel MB. Food insecurity is associated with chronic disease among low-income NHANES participants. J Nutr 2010;140:304-10. DOI: 10.3945/jn.109.112573
33. 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;22:1018-23. DOI: 10.1007/s11606-007-0192-6
34. Rose D. Economic determinants and dietary consequences of food insecurity in the United States. J Nutr 1999;129(2):517S-20S. DOI: 10.1093/jn/129.2.517S
35. Kirkpatrick SI, Tarasuk V. Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. J Nutr 2008;138(3):604-12. DOI: 10.1093/jn/138.3.604
36. Vega-Macedo M, Shamah-Levy T, Peinador-Roldán R, Méndez-Gómez Humarán I, Melgar-Quiñónez H. Inseguridad alimentaria y variedad de la alimentación en hogares mexicanos con niños menores de cinco años. Salud Pública Mex 2014;56:21-30.
37. Lyles CR, Wolf MS, Schillinger D, Davis TC, DeWalt D, Dahlke AR. Food insecurity in relation to changes in hemoglobin A1c, self-efficacy, and fruit/vegetable intake during a diabetes educational intervention. Diabetes Care 2013;36:1448-53. DOI: 10.2337/dc12-1961
38. Bené C, Macfadyen G, Alisson EH. Increasing the contribution of small-scale fisheries to poverty alleviation and food security. FAO Fisheries Technical Paper. Rome: FAO; 2007. Disponible en: http://www.fao.org/docrep/009/a0237e/a0237e00.htm
39. Harper S, Zeller D, Hauzer M, Pauly D, Sumaila UR. Women and fisheries: Contribution to food security and local economies. Mar Policy 2013;39:56-63. DOI: 10.1016/j.marpol.2012.10.018