

Dietary patterns of Sonoran breastfeeding women are associated to exclusive or partial breastfeeding regimes

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Abstract

Background: During breastfeeding, the maternal diet ensures mothers and infants health. Therefore, it is necessary to update information about the diet of exclusively or partially breastfeeding women in each population. We evaluated the diet of Sonoran breastfeeding women, identified their dietary patterns, and examined their association with the breastfeeding regime. **Methods:** In this cross-sectional study, 62 women breastfeeding exclusively ($n = 43$) or partially ($n = 19$) participated. The diet was assessed using a food frequency questionnaire, and patterns were identified through principal component analysis. **Results:** Overall, fats and sodium intake were higher, while potassium intake was lower than recommended. Two dietary patterns were identified: “regional” ($n = 36$) and “prudent” ($n = 26$). Women following the “prudent” pattern consumed more protein, calcium, and potassium than those following the “regional” pattern ($p < 0.05$). The probability of exclusively breastfeeding women having a “prudent” dietary pattern was higher than that of partially breastfeeding women (adjusted odds ratios = 7.29, $p = 0.019$). **Conclusions:** Exclusive breastfeeding possibly motivated mothers to follow a more prudent diet than those who partially breastfed. Therefore, it is crucial to promote a healthy diet among breastfeeding mothers.

Keywords: Breastfeeding. Sonoran women. Dietary patterns.

Los patrones dietarios de mujeres sonorenses amamantando se asocian con los regímenes de lactancia exclusiva o parcial

Resumen

Introducción: Durante el amamantamiento, la dieta garantiza la salud materno-infantil. Por esto, es necesario contar con información actualizada sobre la dieta de quienes amamantan exclusiva o parcialmente en cada población. El objetivo de este trabajo fue evaluar la dieta de mujeres sonorenses amamantando, identificar sus patrones dietarios y buscar su asociación con el régimen de lactancia. **Métodos:** En este estudio transversal participaron 62 mujeres amamantando de forma exclusiva ($n = 43$) o parcialmente ($n = 19$). Se evaluó la dieta con un cuestionario de frecuencia de consumo de alimentos y los patrones se identificaron a través del análisis de componentes principales. **Resultados:** En general, la ingestión de grasas y sodio fue superior y la de potasio inferior a las cantidades recomendadas. Se identificaron dos patrones dietarios: “regional” ($n = 36$) y “prudente” ($n = 26$). Las mujeres con patrón “prudente” ingirieron más proteína, calcio y potasio que las del patrón “regional” ($p < 0.05$). La probabilidad de que las mujeres que amamantaban en exclusiva siguieran un patrón dietario “prudente” fue mayor que la de aquellas que amamantaban parcialmente (razón de momios ajustada (AOR) = 7.29, $p = 0.019$). **Conclusiones:** La lactancia exclusiva posiblemente motivó a las madres a seguir una dieta más prudente que la de aquellas que amamantaban parcialmente. Es necesario promover una dieta saludable entre las madres amamantando.

Palabras clave: Lactancia materna. Mujeres sonorenses. Patrones dietarios.

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Introduction

During breastfeeding, the mother provides all the nutrients and bioactive compounds required to support optimal infant health and growth, and reduce disease risk¹. The input to sustain this process is the maternal diet, which continues to ensure the infant's health as it did during pregnancy. In parallel to the benefits for the infant, a healthy diet also protects the breastfeeding mother's well-being and helps replenish the maternal nutrient stores used for milk production².

Breastmilk is tailored to meet the complex nutritional requirements of infants, and its composition varies according to the infant's age and physiological needs³. The infant requirements and milk production take priority over the needs of the mother, and even in cases of maternal malnutrition, high-quality milk is produced to meet the nutritional and immunological requirements of the infant⁴. Nevertheless, several authors have found that dietary patterns influence the concentration and composition of different nutrients in breast milk, including fatty acids, Vitamins B1, B2, B6, C, carotenoids, and others⁵⁻⁷.

Changes in breast milk composition may influence the health and development of breastfed infants⁸. As diet and other environmental factors are particular to each population and region, it is important to study specific dietary patterns of breastfeeding mothers to find solutions to address negative outcomes for infants and mothers for future interventions.

The only study about the diet of breastfeeding women in Sonora, Mexico, was conducted two decades ago⁹. It showed that breastfeeding mothers had a high intake of energy-dense foods and low consumption of vegetables and fruits⁹. A more recent study of middle-aged women in the same location coincides with the high intake of energy-dense foods¹⁰.

Although breastfeeding is the gold standard for infant nutrition, in Mexico, only 28.6% of infants under 6 months old are exclusively breastfed, while 22.5% of mothers provide partial breastfeeding in conjunction with formula and other types of milk¹¹. Evidence suggests an association between exclusive breastfeeding and healthy dietary habits¹². Hence, it is possible that dietary patterns differ between mothers providing exclusive or partial breastfeeding to their infants. Therefore, we evaluated the dietary intake of Sonoran breastfeeding women, identified dietary patterns, and examined the association between exclusive or partial breastfeeding regimes and dietary patterns.

Methods

We conducted a cross-sectional study including breastfeeding women. Convenience sampling with the snowball method was conducted in Hermosillo, Sonora, Mexico. Women were invited to participate through breastfeeding support groups on social media platforms and daycare centers. Women who followed a restricted diet or had not lived in Sonora for the past 5 years were excluded. Women following an exclusive breastfeeding regime comprised one group; those who provided infant formula alongside breastfeeding were in the partial breastfeeding group. All the participants signed an informed consent, and the study protocol was approved by the institute's Ethics Committee (CEI/002/2022).

During home visits, sociodemographic and health data were collected using questionnaires. The level of marginalization was assessed through household location according to a social marginalization map of Hermosillo, Sonora¹³. Maternal weight and height were measured using an electronic scale (A&D FG-150KBM) and a portable stadiometer (SECA 213). Body mass index (BMI) was calculated for each participant.

Dietary intake was evaluated using a validated food frequency questionnaire (FFQ) modified for the study¹⁴. The dietary data were coded and analyzed using Ortega et al.¹⁵ and Food Data Central¹⁶ databases. The dietary intake assessment included energy, total protein, total fat, saturated fat, cholesterol, total carbohydrates, fiber, calcium, folate, iron, phosphorus, potassium, sodium, zinc, and Vitamins A, B2, B6, B12, C, and E. The 110 items of the FFQ were assigned to 12 food groups based on their similarity and nutrient content, and the quantity (g) of each food group consumed by each participant was calculated.

Statistical analysis

Data are presented as mean and standard deviation for continuous variables or sums (percentages) for categorical variables. The Kurtosis, Skewness, and Shapiro–Wilk tests were used to verify variable normality. Dietary intake was energy-adjusted using the residual method. Differences in BMI and dietary intake between dietary patterns were evaluated using the t-test for independent variables. Statistical significance was set at $p < 0.05$.

Dietary patterns were identified using principal components analysis (PCA) with orthogonal transformation (varimax rotation). To determine the adequacy of PCA,

we used the Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests; the KMO value was 0.61, and Bartlett's p-value was < 0.001 , which supported the model validity. Before PCA, variables were normalized (mean = 0, standard deviation = 1). The number of patterns included was based on visual interpretation of the scree plot of eigenvalues and the percentage of total variance explained by each pattern. Food groups with a factor loading ≥ 0.19 were included in the dietary pattern. The sum of grams consumed of each food group was pondered by its factor load to assign a dietary pattern to each subject.

A logistic regression analysis was conducted to examine the association between dietary patterns and potential predictors, such as breastfeeding regime, sociodemographic, and health factors. The logistic regression model was fitted using maximum likelihood estimation. A model fit was assessed through the Hosmer–Lemeshow goodness-of-fit test and the Akaike Information Criterion. Confounding and effect modification were assessed through stratified analysis and model comparison, respectively. Variables with a p-value ≤ 0.20 in the bivariate analysis were included in the initial logistic regression model. A backward step-wise elimination approach was used to identify the final model, with variables retained in the model if they were statistically significant or improved the model fit. The results are presented as adjusted odds ratios (AOR) with p-value. All statistical analyses were conducted using the Stata 17 MP edition (Stata Corp, College Station, Texas).

Results

Sixty-four breastfeeding women were interested in participating in the study, and 62 met the eligibility criteria and were included in the study. The mean age of the women was 31.6 years old; 51.6% were overweight or obese, 59.7% had a cesarian section delivery, and 69.3% of the women provided exclusive breastfeeding (Table 1). Given the characteristics of our sampling method, all the women in this study lived in areas of very low marginalization.

Table 2 presents women's energy and selected nutrient daily intake compared to the Dietary Recommended Intakes¹⁷. Women had a high fat intake, accounting for 37.4% of their daily energy consumption, reflecting a high cholesterol intake. Furthermore, women had a high sodium and low potassium consumption, while the rest of their micronutrient intake was adequate. Women who partially breastfed had a higher intake of energy, fiber, folate, iron, sodium, zinc, and Vitamin B2, B6, and B12 than those who exclusively breastfed ($p < 0.05$). In

Table 1. Characteristics of Sonoran breastfeeding women (n = 62)

Characteristics	n (%)	Mean \pm SD
Age (years)		31.63 \pm 4.0
Weight (kg)		68.70 \pm 13.48
Height (m)		1.63 \pm 0.06
BMI (kg/m ²)		25.82 \pm 4.31
Underweight	3 (4.84)	
Normal weight	27 (43.55)	
Overweight	20 (32.26)	
Obese	12 (19.35)	
Parity		
Primiparous	32 (51.61)	
Multiparous	30 (48.32)	
Delivery mode		
Vaginal	25 (40.32)	
Cesarian	37 (59.68)	
Breastfeeding regime		
Exclusive	43 (69.35)	
Partial	19 (30.65)	
Dietary supplement intake	48 (77.42)	

BMI: body mass index; SD: standard deviation.

contrast, women who exclusively breastfed had higher protein intake than women who partially breastfed ($p < 0.05$).

Dietary patterns

Two dietary patterns that explained 43.1% of the data variability were identified. The "prudent" pattern was characterized by consuming vegetables, fruits, fats and oils, rice, oats, potatoes, and corn, and no consumption of sweetened drinks. The "regional" pattern was characterized by consuming meat and deli, wheat-based products, legumes, sugar, candies and pastries, and sweetened drinks (Table 3).

Fifty-eight percent of the women had a "regional" dietary pattern, while 41.9% had a "prudent" pattern (Table 4). Women with the "regional" pattern had a higher BMI than women who followed the "prudent" pattern ($p = 0.026$). In terms of dietary intake, women with the "prudent" pattern had a higher daily intake of protein, calcium, phosphorous, potassium, Vitamin A, and Vitamin C than women in the "regional" pattern ($p < 0.05$).

Odds-ratio for dietary patterns

Table 5 presents a logistic binary regression analysis, and it reveals that women who exclusively breastfed

Table 2. Energy and selected nutrient daily intake of Sonoran breastfeeding women compared to the Dietary Reference Intake (n = 62)

Nutrient*	Daily intake (mean ± SD)			Requirement†
	All women (n = 62)	Exclusive breastfeeding (n = 43)	Partial breastfeeding (n = 19)	
Energy (kcal)	2025.9 ± 560.6	1838.4 ± 463.5	2450.3 ± 538.6	-
Total protein (E%)	19.1 ± 2.5	19.6 ± 2.6	18.0 ± 1.9	10-35
Total fat (E%)	37.5 ± 4.9	31.8 ± 4.8	36.9 ± 5.2	20-35
Saturated fat (E%)	13.6 ± 2.0	13.5 ± 1.9	13.7 ± 2.4	As low as possible
Cholesterol (mg)	359.9 ± 132.2	346.3 ± 103.7	390.8 ± 180.8	As low as possible
Total carbohydrates (E%)	50.8 ± 5.6	50.9 ± 5.36	50.7 ± 0.6.3	45-65
Fiber (g)	29.5 ± 9.7	27.9 ± 8.6	33.3 ± 11.3	29 (AI)
Calcium (mg)	1015.7 ± 361.6	1007.7 ± 384.2	1033.7 ± 313.4	1000
Folate (µg)	491.3 ± 184.8	454.5 ± 157.8	574.5 ± 217.0	500
Iron (mg)	18.3 ± 5.9	16.7 ± 5.1	22.1 ± 6.1	9
Phosphorus (mg)	1032.6 ± 313.3	977.3 ± 272.8	1157.6 ± 367.9	700
Potassium (mg)	3487.6 ± 997.9	3425.1 ± 963.8	3629.1 ± 1084.7	5100
Sodium (mg)	2914.2 ± 1052.3	2538.5 ± 832.4	3764.4 ± 1017.5	2300 (UL)
Vitamin A (µg)	1564.1 ± 878.7	1612.4 ± 730.9	1454.9 ± 1162.6	1300
Vitamin B ₂ (mg)	2.6 ± 0.8	2.4 ± 0.7	2.9 ± 0.9	1.6
Vitamin B ₆ (mg)	3.2 ± 1.1	2.9 ± 0.9	3.9 ± 1.3	2
Vitamin B ₁₂ (µg)	6.4 ± 4.0	5.4 ± 2.03	8.7 ± 5.9	2.8
Vitamin C (mg)	188.6 ± 112,64	199.3 ± 107.4	164.3 ± 123.2	120
Vitamin E (mg)	9.4 ± 3.5	9.1 ± 3.8	10.2 ± 2.8	19 (AI)
Zinc (mg)	12.4 ± 3.3	11.1 ± 2.3	15.1 ± 3.7	12

*Nutrient intake was energy-adjusted using the residual method.

†Recommended Dietary Allowances, unless specified otherwise.

Dietary Reference Intake refers to a set of reference values that represents the approach adopted by the Food and Nutrition Board (2005). AI: adequate intake; E%: percentage of total energy; SD: standard deviation; UL: tolerable upper intake levels.

were 7.3 times more likely to have a “prudent” dietary pattern than women who partially breastfed (AOR, p = 0.019). Maternal BMI was neither associated with the dietary pattern (AOR = 0.96, p = 0.071) nor maternal age (AOR = 0.95, p = 0.462).

Discussion

This study found that the dietary intake of Sonoran breastfeeding women can be grouped into two dietary patterns. Most women (58%) showed a “regional” pattern, which included a higher consumption of ultra-processed foods than the “prudent” pattern. This finding is significant

because an ultra-processed dietary pattern during breastfeeding may be associated with negative outcomes for the mother and infant, such as an increase in weight gain and adiposity measures and early weaning¹⁸.

The dietary patterns of Sonoran breastfeeding women were previously studied. Caire-Juvera et al. (2002) found that the typical dietary pattern was characterized by the consumption of foods of animal origin, wheat-based foods, legumes, and soft drinks⁹. This pattern is similar to the “regional” pattern found in our study. In addition, our study also found a “prudent” pattern characterized by the intake of vegetables and fruits. This discrepancy could be attributed to differences in the level of

Table 3. Dietary patterns of Sonoran breastfeeding women (n = 62)

Food groups	Pattern 1: Regional*	Pattern 2: Prudent*
Fruits	-0.0130	0.4715
Vegetables	0.0197	0.5244
Dairy products	0.0676	0.2752
Rice, oats, potatoes, and corn	0.3042	0.3439
Wheat-based products	0.4761	-0.0036
Poultry, fish, and eggs	0.2359	0.1995
Meat and deli	0.4813	0.0136
Legumes	0.3842	-0.1329
Fats and oils	-0.1543	0.4484
Sugar, candies, and pastries	0.3438	0.0305
Sweetened drinks	0.3087	-0.2174
Chips and snacks	0.0588	-0.0422
Explained variance (%)	24.81	18.34

Values in the table are the factor loadings for each food group in each dietary pattern.

*Food groups with factor loadings > |0.19| were included in each dietary pattern and are highlighted in bold.

marginalization between the two population samples. Most women in the study of Caire-Juvera et al. had a low socioeconomic status and lived in areas with medium and high levels of marginalization^{9,13}. Evidence suggests that socioeconomic status is a key factor in determining diet quality in the Mexican population¹⁹. However, even though mothers in our study lived in areas with very low levels of marginalization, 42% of them had a “prudent” dietary pattern, suggesting that other factors besides socioeconomic status influence the diet quality of participants. In addition, the difference between the two studies, with this study conducted two decades after the study by Caire-Juvera et al.⁹, could also contribute to the observed differences.

Our findings suggest that exclusive breastfeeding may be associated with a healthier dietary pattern among mothers. One possible explanation is that women are more likely to consciously consume healthy foods to provide optimal nutrition for their infants. A study of Spanish women found that concern about promoting infant health during breastfeeding was one of the factors that facilitated the adoption of healthy dietary habits²⁰. In addition, according to a study with Bangladeshi mothers, nutrition counseling during pregnancy was associated with a healthier diet and

exclusive breastfeeding¹², suggesting a link between healthy food choices and exclusive breastfeeding.

In our study, maternal BMI and age were not significant predictors of maternal dietary patterns. In contrast, a study evaluating dietary habits in pregnant women in the United States found that BMI was associated with healthier dietary habits²¹. It is possible that other factors, such as socioeconomic status, education, and culture, may have a stronger influence on maternal dietary patterns than BMI and age¹⁹.

Regarding body composition, three of the women were underweight, while 32.2% and 19.3% were overweight and obese, respectively. These findings are similar to those reported nationally, where 32.3% of Mexican women between 30 and 39 years old were overweight¹¹. Women with the “regional” dietary pattern had a higher BMI than those with the “prudent” pattern. Although there were no significant differences in energy intake between the two groups, it is possible that there were differences in physical activity, which was not assessed in this study. In addition, there is evidence of an association between healthy eating habits and physical activity²².

Regarding dietary intake, the mean fat consumption was higher than recommended (< 35% of total energy intake), which is associated with negative outcomes for mothers and infants¹⁷. High fat intake is associated with the development of non-communicable diseases¹⁸. In addition, fat content in breast milk increases with dietary fat intake, and high-fat content in breast milk may have negative outcomes on the breastfed infant²³. Women had high sodium and a low potassium intake, which is significant because it is associated with hypertension²⁴, a condition present in 26.4% of Mexican women¹¹.

Most of the women in this study (59.7%) had a cesarean section delivery. This characteristic is noteworthy, given that this procedure is associated with a longer recovery after delivery, which could compromise breastfeeding and influence the maternal diet²⁵. The delivery mode was considered a variable that could affect maternal diet in this study. However, it was not a significant predictor of maternal dietary patterns.

Most women in our study provided exclusive breastfeeding (69.3%) since they were recruited through breastfeeding support groups. Therefore, it is important to know that the sample may not be representative of the general population. In Mexico, only 28.6% of mothers breastfeed exclusively in the first 6 months postpartum, and the regional prevalence is even lower¹¹.

This study has some limitations. The representativeness of the study sample was limited due to the sampling method utilized. Including women from areas with

Table 4. Body mass index, energy, and selected nutrient daily intake of Sonoran breastfeeding women by dietary pattern (n = 62)

Variable	Regional pattern* (n = 36)	Prudent pattern* (n = 26)	p-value
BMI (kg/m ²)	26.8 ± 0.7	24.4 ± 0.8	0.026
Energy (kcal)	2099.4 ± 88.6	1924.2 ± 116.4	0.228
Total protein (E%)	18.2 ± 0.4	20.3 ± 0.5	0.001
Total fat (E%)	37.0 ± 0.8	38.2 ± 0.9	0.364
Saturated fat (E%)	13.7 ± 0.3	13.4 ± 0.4	0.623
Cholesterol (mg)	362.6 ± 24.5	356.2 ± 21.8	0.749
Total carbohydrates (E%)	50.1 ± 0.9	51.8 ± 1.1	0.239
Fiber (g)	29.9 ± 1.6	29.0 ± 1.9	0.410
Calcium (mg)	947.0 ± 47.9	1110.8 ± 84.9	< 0.001
Folate (µg)	510.4 ± 30.6	464.8 ± 36.6	0.917
Iron (mg)	18.3 ± 0.8	18.3 ± 1.4	0.974
Phosphorous (mg)	1007.1 ± 46.7	1067.8 ± 69.9	0.031
Potassium (mg)	3305.9 ± 144.7	3739.1 ± 220.2	< 0.001
Sodium (mg)	3084.1 ± 158.2	2678.9 ± 227.0	0.373
Vitamin A (µg)	1325.0 ± 125.6	1895.3 ± 185.3	0.001
Vitamin B ₂ (mg)	2.6 ± 0.1	2.7 ± 0.2	0.798
Vitamin B ₆ (mg)	3.4 ± 0.2	3.1 ± 0.2	0.079
Vitamin B ₁₂ (µg)	6.5 ± 0.7	6.4 ± 0.7	0.802
Vitamin C (mg)	154.6 ± 15.7	235.6 ± 23.7	< 0.001
Vitamin E (mg)	9.1 ± 0.5	9.8 ± 0.8	0.066
Zinc (mg)	12.8 ± 0.6	11.8 ± 0.6	0.841

*Nutrient intake was energy-adjusted using the residual method. Data is presented as mean ± standard error. E%: percentage of total energy; SE: standard error. p ≤ 0.05.

Table 5. Association between breastfeeding regime and the “prudent” dietary pattern

Predictor variable*	Adjusted odds ratio	p-value
Exclusive breastfeeding (yes)	7.29	0.019
Maternal BMI (kg/m ²)	0.96	0.071
Maternal age (age)	0.95	0.462

*The dependent variable is the “prudent” dietary pattern.

medium and high levels of marginalization would enhance the external validity, identify potential disparities in health and nutrition, and help to understand the influence of socioeconomic factors on diet. Furthermore, the principal component analysis would benefit from a

larger sample size, and including women from areas with higher marginalization levels would have increased the represent ability of the data. In addition, the assessment of diet using FFQ may have limitations. Combining FFQ with other methods, such as 24-h recall or food records, would provide more accurate data on nutrient intake.

Despite limitations related to sample size and method, this exploratory research may lead to further studies with larger sample sizes and rigorous methods for dietary assessment of breastfeeding women. Furthermore, we expect that the information presented will motivate the development of future programs and interventions to improve the diet of this population.

In conclusion, the diet of Sonoran breastfeeding women was categorized into two dietary patterns: “regional” and “prudent.” Our study found that women

who exclusively breastfed were more likely to follow a “prudent” dietary pattern than those who partially breastfed. Therefore, promoting healthy dietary patterns among Sonoran breastfeeding women is crucial for improving maternal and infant health outcomes. Further studies are required to confirm our findings and explore the underlying association mechanisms between the breastfeeding regime and maternal dietary patterns.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author has this document.

Conflicts of interest

The authors declare no conflicts of interest.

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