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Maternal Nutrition Status and Human Milk Composition of DHA and AA Fatty Acids in Breastfeeding Honduran Women

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Abstract

Dietary habits and maternal nutrition status are the most important modifiable factors that will determine the concentration of certain essential components and nutrients in Breast Milk (BM).The objectives were to estimate the nutritional status of Breastfeeding (BF) women in rural Honduras, identifying the main food sources that contribute to the consumption of EFA and its content in BM. The Honduran study was part of an international study with a sample (n=25) with children between 26 and 64 days of age. The consumption of food sources of Essential Fatty Acids (EFA) was evaluated with a frequency questionnaire. BMcomposition was analyzed using the dry drop method with Guthrie cards. 56% of mothers provided exclusive BF, 27% of mothers were overweightand 68% had excess body fat. The average monthly consumptionof marine foods was 1.44, 0.60 and 0.68 servings of fish, sardines and tuna, respectively. The average consumption of Docosahexaenoic Acid (DHA) and Arachidonic Acid (AA) was 0.05 g / day. The content of DHA, EPA and AA fatty acids in BM was 0.14, 0.01 and 0.4% respectively. The amount of DHA and AA in the BF women is well below the median values of a global reference distribution.

Keywords: Arachidonic acid;Breastfeeding; Docosahexaenoic acid; Eicosapentaenoic acid; Essential fatty acids; Human milk; Intra-abdominal fat; Obesity

Key Messages

- Tuna is the main food source of DHA (P=0.912) in the diet of our sample of Honduran mothers.
- Eggs were shown to be a major source of AA (P= 0.990) in the participants' diet.
- The predominant EFA in participants' BM was AA (mean of 0.40 wt%), and the lowest percentage was EPA (mean of 0.01 wt%).
- In the BM sample analyzed, an average of 0.14 wt% DHA whereas normative abundance would be at least 0.20 wt% of the total fatty acid content in BM.

Introduction

Breastfeeding (BF) from healthy, well-nourished mothers is the ideal food to meet the nutritional demands of full-term babies[1-4] promoting their growth and the development of their gastrointestinal[5,6], immunological[7] and neurological[8] systems, owing to its unique content of essential nutrients[9,10], hormones, antibodies and biologically-active molecules[11,12]. The World Health Organization (WHO) recommends exclusive BF (EBF) for the first six months of life and continuing it in conjunction with feeding for two years or more [13,4].

Generally, the composition of breastmilk is approximately 87% water, 3.8% fat, 1.0% protein and 7% lactose[14]. It has a dynamic nature[4], both in volume[15] and in the concentration of macro[16] and micronutrients [17], reflecting the changing needs of the baby[18] according to health status and age[6], as well as multiple environmental, cultural, physiological[18], and genetic factors in the mother [4,11,19]. Among them, dietary habits[20] and maternal nutritional status, before, during, and at the end of pregnancy[16], which are the most important modifiable factors, will determine the concentration of certain essential nutrients in breast milk[2,3].

The long chain fatty acids (with more or equal to 18 carbons) of the series n-3 and n-6 are essential (EFA) because they cannot be synthesized by the human body from precursors and must be consumed in the diet, and in the case of babies, through breast milk[21,22]. TheArachidonic Acid (AA, 20: 4 n-6), Docosahexaenoic Acid (DHA, 22: 6 n-3) and eicosapentaenoic acid (EPA, 20: 5 n-3) [21,23]can be formed from their precursors, linoleic acid (LA, 18: 2 n-6) and α-linolenic acid (ALA, 18: 3 n-3); however, conversion rates are insufficient to maintain their biochemical and functional normality [24,25]. Metabolically, these fatty acids play a key role in the development of the central nervous system and retinal function[17,26,27].

EFA consumption in the maternal diet has a direct influence on their concentration in maternal plasma[28], facilitating the uptake and endogenous synthesis of EFA in the mammary glands[27], so the composition of EFA and other fat-soluble nutrients will depend on maternal intake[9,17,29]. ALA is mainly obtained from avocado, flaxseed, soybean and their respective oils. DHA and EPA are found in fatty fish (e.g., sardine) and fish oils [1,23]. LA and AA are obtained

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from foods such as vegetable oils, peanuts, animal fats (milk, cheese, yogurt) and eggs[23].

Nutritional needs during pregnancy and lactation increase in mothers to ensure adequate nutrition for the infant as a continuation of its intrauterine development[30]. In addition, lipids are the group of macronutrients in breast milk with the greatest variation in composition because they are highly sensitive to nutritional status and the maternal diet[27,31]. Lipids are the main source of energy in the infant's diet, providing 45%-55% of the calories consumed during the day[1,32].

The lipid fraction of breast milk is composed mainly of triacylglycerides, diacylglycerides, monoacylglycerides, phospholipids, cholesterol[32] and free fatty acids, especially EFA[4,6], which are critical to the health of the infant because of their involvement in the development of the nervous system[14]. It has been observed that breast milk is generally adequate in quantity and quality, even when the mother's nutritional status is not optimal, due to compensatory physiological mechanisms[15,33] and the use of body reserves[19,30].

Numerous studies have shown that frequent consumption of seafood such as fatty fish and shellfish improves the concentration of EFA and particularly the concentration of DHA[29,34] despite the fact that there is a disparity in access to these foods conditioned by physical accessibility and socioeconomic status[35]. In addition, the increase in the consumption of highly processed foods[21,36,37] made from refined oils[5,27], have displaced the consumption of healthy meats, fish and fats[21], causing an imbalance in the ratio of omega-3 and omega-6 fatty acids in breast milk[5,22].

Evidence on the consumption pattern in Honduras, particularly in the central zone where the largest amount of population is concentrated, and that of the present study, indicates that a diet made up of eight foods (corn, rice, beans, sweet bread, eggs, fats, sugar and sweetened coffee). This is traditional and provides a large amount of energy and few proteins, vitamins and minerals. These foods belong to six groups of the 12 considered necessary for a diverse and acceptable diet, lacking other food groups that are sources of good quality protein and micronutrients, indispensable in the growth of children and health in general[38].

Information about the nutritional status and pattern of food consumption in pregnant or postpartum women in Honduras is very limited, poorly socialized and published, so dietary advice during pregnancy and breastfeeding is of vital importance to improve their nutrition and prevent deficiencies in neurological development[20, 39], as well as contributing to access to a varied diet. The objectives of this study were to estimate the nutritional status of breastfeeding women in rural Honduras, to identify the main food sources that contribute to the consumption of EFA and its content in the breast milk of these mothers.

Methods

An exploratory analytical cross-sectional study was carried out, which was part of an international study, and which included analysis of the content of the lipid profile of BM samples, to carry out a comparative analysis between countries and generate an international standard, led by the Ibero-American Foundation of Nutrition (FINUT).

The study was conducted by Zamorano University's human nutrition laboratory, with trained nutritionists for the using of the different data collection instruments and was carried out in the municipality of San Antonio de Oriente (SAO) in central-eastern Honduras. According to data from the National Institute of Statistics[40], in 2013, SAO had a population of 15,005 inhabitants. The call for participants was made with the collaboration of several health centers in four villages of the municipality: El Jicarito, Villa de San Francisco, Valle de San Francisco and La Cienega, which provided the space for data collection and sampling.

Participants and ethical approval

According to the international study convened by FINUT, the inclusion criteria were having children between 26 and 64 days of age; born full term; and receiving exclusive or predominant BF. Last one was defined if the mothers answered that the predominant source of feeding for their infant was breastfeeding. The child could also receive fluids (water and water-based drinks, fruit juices), and oral rehydration salts, drops or syrups (vitamins, minerals and medications)[41].

Mothers were excluded if: they were not breastfeeding; they were taking supplements that included essential fatty acids; and/or they or their babies were sick that made it difficult for them to breastfeed their babies at the time of sample collection.

Data collection was conducted from February to April 2019.To establish the scope, the monthly outpatient care reports of the health center in each of the participating communities were reviewed to identify mothers who met the inclusion criteria and could be invited to each of the health centers. After this search, the pool was made up of 50 women in the postpartum period, between 26 and 64 days after the birth of their baby.

All identified mothers were contacted by phone. The sample was for convenience, with the mothers who attended the call at each health center and who met all the inclusion criteria. The purpose of the study was explained to each participant and they were interviewed individually, and it was possible to include 25 participants, which made up the sample in each of the countries participating in the international study.

The Human Research Ethics Committee (HREC #00003079) of the National Autonomous University of Honduras approved the research protocol. All participantsprovided a written informed consent.

Dietary intake instruments

A socioeconomic questionnaire during an interview was applied with variables for age, baby's sex, type of BF provided, mother's age, marital status, academic degree, and place of origin. In the same interview, the consumption of EFA source foods was recorded using amonthly consumption frequency tool where foods considered physically and economically accessible to the population were included: fish, linseed, soybean, avocado, tuna, sardines, sunflower or sesame seeds; peanuts, eggs, cow's milk, cheese, yogurt, corn, sunflower, or soybean oil. The average monthly consumption was calculated for each of the foods. The Food Processor™ software was used to estimate the fatty acid content of each food, and the USDA food composition database included therein.

The monthly consumption of portions of each of the foods was standardized as part of the consumption frequency questionnaire and the content in grams of Monounsaturated Fatty Acids (MUFA), polyunsaturated fatty acids of the series n-3 and n-6 (PUFA): ALA, AA, EPAand DHA in one serving of food. The number of servings consumed in the month was multiplied by this value; to estimate the daily consumption the result was divided by thirty.

The questionnaire also collected information on some main reasons for not consuming the foods mentioned, such as 1) cultural traditions, 2) because they do not like the taste or 3) they are very expensive.

Anthropometric Measurements

Anthropometric data collection was performed using the OmronTM Full Body Sensor portable equipment, model HBF-5168 (Omron Healthcare Inc, Lake Forest, IL, USA). All this data were collected due to interviews applied to the mothers. The parameters included were weight, height, Body Mass Index (BMI), body fat, skeletal muscle and visceral fat. The BMI (kg/m^2) was classify with the WHO criteria: <18.5 underweight, 18.5-24.9 normal weight, 25-29.9 overweight and >30 obesity [42]. To classify the other parameters, the criteria of the OmronTM balance were used. Normal percentage of body fat was analyzed as follows: 21.0 - 32.9% for 20–39 years old, 23.0 - 33.9% for 20 – 39 years old[43]. Normal percentage of skeletal muscle was analyzed with the next criteria: 24.3-30.3 % for 18–39 years old and 24.1 - 30.1% for 40–59 years old[43]. Normal level of visceral fat, indicates that the normal range is when a value of less than 9 cm^2 is estimated [43].

Collection and Analysis of Breast Milk Samples

The collection of BM was carried out with the 25 participating women during the same interview, who before performing the milk extraction, were asked to sanitize their hands and the breast from which the sample would be obtained. The extraction of BM was done in the morning, between 10:00 and 12:00 am, 1–2 h after the last feeding, from the breast the infant had not yet fed.

All were hand expressed until at least 1 mL of milk was obtained. The samples were stored in special BM Medela™ pre-sterilized containers. Immediately after milk extraction, all samples were refrigerated and transported to the food microbiology laboratory at Zamorano University, within a period of no more than three hours.

The breast milk dried-drop method was used, using PerkinElmer 226 Bioanalysis RUO cards (PerkinElmer, Waltham, MA, USA) with each participant's data. Two to three drops were placed in each circle on the card. Each card was air-dried in a closed environment and then stored individually in a Ziploc™ bag (SC Johnson, Racine, WI, USA) in a freezer at -20°C, prior to shipment to the laboratory for analysis by Gas Chromatography -Mass Spectrometry system, where the concentration of the main fatty acid (% of total) of the samples was determined. The analysis of the BM was carried out in the Lipid Technologies Laboratory, LLC in Austin, Minnesota, United States. The costs of the analysis were covered directly by FINUT.

Data Analysis

Frequency and dispersion measures were used to describe population characteristics and fatty acid concentrations in breast milk. Normality tests were performed; those variables related to the participants and their infants, with non-parametric distribution, were presented through medians; while variables with parametric distribution were described through means, standard deviation, ranges and variation coefficients. Population characteristics were correlated using Pearson's Wilcoxon Rank-sum and Chi^2 test. The contribution of each fatty acid in each food source was correlated with the monthly contribution of fatty acids, using Pearson's correlation coefficient.

Results

Ninety-two percent (n=23) of the mothers were married or in a relationship and 8 percent (n=2) were single mothers. Sixty percent (n=14) attended high school, 36% (n=9) attended elementary school, and 4% (n=1) had no schooling at all. Fifty-six percent (n=14) of mothers provided EBF and the remaining 44% (n=11) provided predominant BF. No correlation was found between schooling and type of breastfeeding. The median age of the infants was 41 days, with a range of 26-64 days. The median age of the 25 mothers was 25 years, ranging from 16 to 41 years (Table 1).

The median BMI (kg/m^2) was in the normal range, however, the median body fat percentage was 5.4% above the normal range. Using the WHO criteria for the normal adult population, 36% (n=9) were found to be overweight, 56% (n=14) normal weight, 4% (n=1) underweight, and 4% (n=1) obesity. The mean percentage of visceral fat was found to be within the normal level. 68% (n=17) of the mothers presented an excess of body fat and 32% (n=8) presented a percentage of body fat within the range of normality. The average percentage of skeletal muscle was within the normal range.

A high positive correlation was established between BMI and percentage of body fat, weight and visceral fat ($p<0.001$), whereas for the percentage of muscular fat, a negative average correlation was obtained.

None of the mothers had consumed omega-3 supplements during breastfeeding or pregnancy. Seafood consumption was very low (Table 2), with an average of 1.44 servings of fresh fish (90 g/ portion of tilapia), 0.60 servings of tuna (90 g/portion), and 0.68

Table 1: Characteristics of participating infants and mothers (n=25).

Variable	Median	Range
Baby Characteristics		
Age (days)	41	26-64
Mother Characteristics		
Age (years)	25	16-41
Weight (kg)	61.3	44.3-95
BMI (kg/m^2)	23.9	16.7-38.1
Body fat (%)	39.3	17-52
Skeletal muscle (%)	26.2	21.3-41
Visceral fat (cm^2)	25	3–9

Table 2: Distribution of food source consumption and Pearson's correlation r-value for each fatty acid.

Food source and portion size	Mean ± SD portions (per month)	Range	Values of Pearson correlation r value						
			MUFA	PUFA	w-3	w-6	*C22:6n3*	*C20:5n3*	*C20:4n6*
Cheese (30 g)	19.36 ± 10.72	0 - 30	0.45	0.35	0.33	0.36	-	0.29	-
Cow Milk (240 g)	15.28 ± 13.88	0 - 30	0.11	0.05	0.05	0.06	-	-	0.11
Eggs (63 g)	12.68 ± 10.87	0 - 40	0.14	0.06	0	0.05	-0.3	-0.1	0.99
Vegetable oil (45 g)	10.88 ± 14.07	0 - 30	0.87	0.99	1	0.98	-	-	-
Avocado (50 g)	4.64 ± 9.84	0 - 30	0.48	0.25	0.2	0.28	-	-	-
Yogurt (240 g)	2.44 ± 8.30	0 - 30	0.04	0.08	0.12	0.09	-	-	-
Peanuts (60 g)	2.28 ± 6.13	0 - 30	0.69	0.41	0.31	0.46	-	-0.1	-
Soy milk (240 g)	1.68 ± 6.16	0 - 30	-0.1	-0.1	-0.1	-0.1	-	-	-
Fish-tilapia (90 g)	1.44 ± 2.47	0 - 8	-0.1	-0.1	-0.1	0.26	-	-0.1	-0.3
Sardine (90 g)	0.68 ± 1.03	0 - 4	-0.2	-0.2	-0.1	-0.2	0.3	0.42	-
Tuna (90 g)	0.60 ± 2.41	0 - 12	0.18	0.28	0.32	0.27	0.91	0.86	-

Table 3: Daily intake of fatty acids in the maternal diet and percentage of fatty acids in breast milk (n=25).

Nutrient	Fatty acids Daily Consumption (g)		Fatty acids Content in Breast Milk (wt%)	
	Mean ± SD	Range	Mean ± SD	Range
Monounsaturated fatty acids	10.09 ± 9.44	0.69 - 40.4	42.72 ± 3.25	34.79-48.32
Polyunsaturated fatty acids	9.90 ± 11.46	0.18 - 31.4	13.92 ± 1.92	8.24-17.24
Omega-3 fatty acids	0.77 ± 0.85	0.03 - 1.97	0.82 ± 0.15	0.55-1.15
Omega-6 fatty acids	6.72 ± 7.65	0.14 - 22.99	13.10 ± 1.91	7.37-16.41
Docosahexaenoic acid *C22:6n3*	0.05 ± 0.07	0 – 0.32	0.14 ± 0.04	0.06 – 0.23
Eicosapentaenoic acid *C20:5n3*	0.02 ± 0.03	0 – 0.13	0.01 ± 0.02	0.00 – 0.09
Arachidonic acid *C20:4n6*	0.05 ± 0.04	0 – 0.15	0.40 ± 0.10	0.21 – 0.66
Linolenic acid *C18:3n3*	1.24 ± 1.52	0.01 – 4.7	0.54 ± 0.11	0.30-0.75

servings of sardines (90 g/portion) consumed during the month. The most consumed foods were cheese (30 g/portion), milk (250 ml/portion) and eggs (63 g/portion), with averages of 19.36, 15.28 and 12.68 portions during the month, respectively.

Ninety-two percent (n=23) of mothers indicated that they limited the consumption of some of these foods because of cultural traditions (40%), because they do not like the taste (28%) or because they are very expensive (16%), while the remaining 8% (n=2) consumed them as part of their usual diet. The flaxseeds, sunflower seeds and sesame seeds included in the consumption frequency questionnaire were not consumed by any of the participants and therefore were not included in the results table.

Table 2 illustrates the degree of correlation between each fatty acid and its respective food source. Dairy products (cheese, cow's milk, and yogurt) did not represent a significant source for any fatty acid, whereas eggs were shown to be a major source of AA (r = 0.990) in the participants' diet. Vegetable oil represented the food source with the highest contribution to the highest amount of fatty acids, showing a strong correlation to MUFA, PUFA, omega-3 and omega-6. Avocado and nuts correlated mostly to MUFA, while soymilk showed no correlation to any fatty acid. Tilapia showed a slight correlation to omega-3. Sardines were slightly correlated to DHA and EPA, whereas tuna showed a strong correlation to these same fatty acids, particularly DHA (r=0.912). This suggest that tuna was the mayor source of DHA in our sample of Honduran mothers.

The upcoming data from table 3,shows only the data when a correlation exist between different consumption of certain foods through the fatty acids.There was significant correlation for consumption of sardines and EPA (p=0.041), contrary to consumption of sardines and DHA that did not present correlation (p= 0.140). Average AA consumption was 0.05 g/day, with eggs as the main source providing 0.046 g AA/day per 63 g/portion. No significant correlation was found between EFA consumption and BMI or body fat percentage.

Saturated fatty acids represented the highest proportion of fatty acids in breast milk (42.72 wt%), followed by PUFA (13.92 wt%). The average content of omega 3 was 0.82 wt% whereas the omega 6 was 13.1 wt%. The predominant EFA was AA, with an average of 0.40 wt%, followed by DHA (0.14 wt%) and finally EPA (0.01wt%).

MUFA were the most consumed fatty acids(Table 3), with an average daily consumption of 10.09 g, followed by PUFA with an average daily consumption of 9.90 g. Linear regression analysis shows a statistically significant relationship of 9 g of omega-6 fatty acid for each gram of omega-3 consumed. The average consumption of DHA and EPA was 0.05 g/day and 0.02 g/day, coming mainly from sardines, providing 0.017 g/day of DHA and 0.096 g/day of EPA per 90 g portion.

By correlating the EFA of breast milk with the age of the mothers, a mean correlation was found (r=0.53; P=0.01) for omega-3 only. The EFA correlation of breast milk for the different food groups was low negative (r=-0.42; P=0.03) on AA with avocado, and with tuna (r=-0.44; P=0.03) on MUFA. For eggs, the correlation was low negative for omega-3 (r=-0.42; P=0.04), and for ALA (r=-0.43; P=0.03). On the other hand, the BMI, type of BF given, fish, soy, sardine, dairy products (cow's milk, yogurt and cheese), vegetable oil and peanuts did not show significant correlations on the EFA in BM (P>0.05).

Discussion

This study is an exploration of the nutritional situation of breastfeeding Honduran women from like around one month postpartum, as well as the concentration of DHA and AA in the breast milk of these mothers. Although similar studies have been conducted in different parts of America, Asia, and Europe [44], this is the first one to be conducted in Honduras. Moreover, in a systematic review of 65 studies worldwide [44], the average participation number per study was 38 mothers, in a range of 5 mothers in countries such as Canada, United States and Germany (between 1996 and 2000), and up to 198 mothers in Canada in 1996, so the sample in this study was slightly below this average.

The mothers participating in the study were young with an average of 25 years.Although it is a young population, one third of the mothers were overweight, as a reflect of the current national situation, where 29% of women between the ages of 14 and 49 are overweight whereas 22% are obese [45], in a worldwide context of the increasing prevalence of overweight and obesity in women of reproductive age[46].

The nutritional status of mothers is important for the adequate feeding of their child through breastfeeding. The breast milk of all mothers has excellent nutritional and immunological value in addition to certain biological benefits unique to the babies[12,14,30]. Multiple studies show that BF has a metabolic programming effect that decreases the risk of developing noncommunicable and inflammatory diseases[10,47,48] such as obesity, diabetes, and high blood pressure in adulthood, due to their content of hormones involved in the regulation of energy balance and appetite[31,33,49,50].Despite these and other benefits that justify the protection and promotion of BF [30,37], 44% of the mothers from the current study were not practicing EBF, and their babies were not more than two months old (average 41 days).

Currently, 38% of babies worldwide are exclusively breastfed up to 6 months of age[13,14]. In Honduras, 96% of babies have been breastfed at some point, 64% begin to breastfeed from the first day of birth[51], and the average duration of the EBF is 2.5 months; in high-income countries such as the United States, the average duration is 3 months[14]. Within the WHO global nutrition goals for 2025, it is to increase the EBF by at least 50% during the first 6 months of life[13]. Situation that in Honduras is pressing to facilitate optimal feeding for babies.

This is a highly importance situation in terms of public health, becausemothers of this study who do not provide EBF would be at risk (68% excess body fat, 40% overweight and/or obese), due to during pregnancy, 2-5 kg of fat is accumulated as energy reserves to be used during BF[30,52]. This fat accumulates mainly in the torso and thighs, these being the areas that present the greatest fat mobilization [15].

Moreover, the short duration of EBF (56%) puts at risk also the nutritional and health status of the babies. Studies show that children who receive BF for more than 6 months have a 51% reduction in the risk of developing obesity[12,53]. In addition, they tend to develop better eating habits, such as increased consumption of vegetables, as a result of flavor transmission in BM[50].

Children of overweight mothers are more likely to develop overweight or obesity before the age of two, due to changes in their breast milk composition, among other factors[54]. Breast milk transmits hormones involved in the regulation of appetite and growth in children, such as leptin, adipopetin and ghrelin. However, the concentration of these hormones in this milk, is affected by a high BMI and excess body fat, inducing hyperphagia and increased fat deposition in infants[12,47,48,53]. Studies have shown that the lipid composition of breast milk in overweight or obese mothers differs from that of normal-weight mothers because it has a higher content of long-chain fatty acids that are difficult for newborns to digest[55].

A meta-analysis with worldwide data estimated that in human milk the global average concentrations of DHA are 0.32 +- 0.22% and AA are 0.47 +- 0.13%[44]. In the evaluated sample, despite a low intake of DHA and AA in the maternal diet, averaging 0.05g per day in both cases, the average maternal milk sample was higher than the intake, 0.14 +- 0.04% in DHA and 0.40 +- 0.10% in AA. However, both are far from the world average, it is even more so the content of DHA, which could be because the sample of mothers are located in the interior of the country, not on the coasts. Other studies have shown that communities on the coasts, the content of DHA is higher, particularly due to the fish consumption [56].

Honduras has extensive coastlines in the Atlantic and Pacific oceans, but fish consumption (which is not from sea origin) is very low, as shown in the results of the study. The AA content in BM is usually stable[3], fluctuating slightly around 0.5% of total fatty acids as it is mostly derived from maternal reserves[29]; however, the DHA concentration is much more variable, constituting 0.1% to 1.0% of total fatty acids[5]. To maintain an adequate concentration of AA and DHA, it is recommended that at least 200 mg/day of preformed DHA be consumed daily [2,57], however, consumption in our sample was found to be well below the recommendation (40 mg/day). DHA must make up at least 0.20% of the total fatty acids content in BM to meet the needs of the newborn up to 6 months, while from this age to 24 months, their needs increase to 10-12 mg DHA/kg/day[23].

The DHA in the analyzed samples, it is as low as it was in the studies carried out in 2006 in Canada and the United States, with 48 and 49 mothers, respectively, with a concentration of 0.17%. While the AA was similar to the results carried out in the same year in Philippines and Japan, with 54 and 51 sample of mothers, respectively, with a concentration of 0.39 and 0.4% respectively [56].

The 200 mg/day DHA recommendation can be met by consuming 1-2 servings per week of fatty fish[11] or shellfish[6,34,57]. However, in Honduras only 34% of the national population consumes fish or shellfish[58], and not specifically the fatty type. In the sample for this study, average consumption of tuna and sardines was 0.60 and

0.68 portions per month, respectively, considering that the sample is located in the central-eastern region of the country, without nearby aquifers. In situations where it is difficult to comply with the DHA recommendation through food consumption, daily supplementation of 200 mg/DHA is recommended[2,21]. Studies show an increase of up to 75% of DHA in BM in supplemented mothers compared to non-supplemented mothers[6]. In the sample evaluated, no mothers had taken DHA supplements, as this was one of the inclusion criteria.

Dietary DHA deficiencies have been reported to be due to, among other factors, high consumption of vegetable oils[5] that displace traditional sources of omega-3 family fatty acids[4], seeds, and nuts. This was reflected in our results where the average consumption of vegetable oils was seven times higher than fish (tilapia) and almost five times higher than peanuts. These vegetable oils come largely from processed and prepared foods that are increasingly consumed[28], generating imbalance in the proportion of omega-6 and omega-3 fatty acids consumed. Previously this ratio was approximately 1:1, however, it is now estimated to be between 15:1 and 20:1. The results of this study are consistent with these findings, with a ratio of 9:1and in the breast milk the relation is even higher (16:1). This imbalance is associated with inflammatory conditions and diseases[28], dangerous for both mothers and their babies.

Mothers identified eggs as the third most consumed food. The lack of omega-3 in eggs shown in the inverse correlation (-0.42; p=0.04), evidences that the consumption of eggs enriched with omega-3 could be a way to improve the EFA in breast milk. In this sense, eggs enriched with omega-3 are a potential functional food for health[59], being also economically viable. Furthermore, improved eggs provide safe and immunological foods that may have improved vitamins and minerals, as well as a balanced ratio of omega-6:omega-3 fatty acids, reduced total cholesterol, additional antibody reinforcement, and essential pigments such as carotenoids[60].

The authors acknowledge as limitations, the size and origin of the sample, which only represents the geographical area of study, not the country. This will require a larger sample and from different regions. As for strengths, they highlight the importance of having carried out a first exploratory study that highlights the importance of maternal nutrition and breastfeeding. As future work, it is also suggested to include more information from both the mother and her child, which helps to estimate the nutritional status, beyond the BMI, to promote better feeding and nutrition of lactating mothers, taking advantage of maritime resources, and elaborate proposals of DHA-fortified foods accessible to nursing mothers.

Conclusion

In this small convenience sample of 25 breastfeeding mothers from the central-eastern region of Honduras, there appears to be a shift to the left in the distribution of BMI, especially that which is close to obesity. Despite the small sample size, there are several significant associations between consumption of fatty acids or their food sources and the abundance of fatty acids in the breast milk, which attests to the validity of the food frequency instrument used. From a global context, both the abundance of DHA and AA in the breast milk of non-supplemented women in the area are well below the median values of a global reference distribution [52]becoming a potential concern for the nutrition of infants in the region. Nutritional counseling and facilitating access to EFA- and DHA rich foods during these stages are indispensable for optimizing child development.

Author Statement

AHS and SRMM conceived and designed the study; SRMM and JPE performed data analysis; and AHS, SRMM, JPE and SBLA wrote the paper. All the authors provided a critical review of the manuscript.

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