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Low docosahexaenoic acid in the diet and milk of American Indian women in New Mexico

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Abstract

A recent finding of low levels of docosahexaenoic acid (DHA) in the milk of lactating Hispanic and non-Hispanic white women in New Mexico prompted a study of the DHA content of the breast milk and diets of American Indian (AI) women in the state. Nineteen urban AI women (18–40 years) who had been lactating for one to six months and who were attending clinics at the University of New Mexico Hospital were enrolled in a cross-sectional study that was conducted between June, 2005 and February, 2009. Descriptive statistics and correlations were performed. The mean fat content of the breast milk was 4.67 ± 1.9 g/dL and the mean DHA proportion of the milk fat was 0.097 ± 0.035%, which is a low value relative to international norms. The low DHA content of the milk could be accounted for by the women's low dietary intake of DHA (median, 30 mg). The DHA percentage in the women's milk fat was positively correlated with dietary intake of DHA ($r = + 0.67$, $p<0.001$). This study shows that the DHA content of the breast milk of urban AI women attending clinics at a university hospital in New Mexico is well below levels widely acknowledged as being healthful for infants who rely mainly on breast milk for their supply of DHA.

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Keywords

breast milk; lactation; milk fat; fatty acids; American Indian; diet; docosahexaenoic acid; arachidonic acid; DHA in American Indian milk; DHA intake by lactating American Indian women

INTRODUCTION

Breast milk is the preferred form of nourishment for infants during the first six months of life and a mother's DHA status plays an important role in determining the DHA status of her offspring (1) and the growth and neurocognitive development of infants through the first 12 months of life (2–9). Although newborns can synthesize DHA from α-linolenic acid, this capacity is insufficient to meet the demands of growth and development (10,11).

The proportion of DHA in human milk fat is highly variable both within and among cultures (12–15), ranging from 0.05–0.10% in women whose diets do not habitually include foods or supplements that provide relatively large amounts of DHA (16), to proportions >1.0% in women who consume salmon or other ocean fish at least once a week (7,17,18).

The DHA content of the serum or red-cell phospholipids of a lactating woman and the breast milk triglycerides she produces are positively correlated with the amount of DHA she consumes (19–21). Bergmann and coworkers (20) estimate that intake of 200 mg per day of DHA from mid-pregnancy through lactation is sufficient to support normal neurodevelopment. In a recent study of the diets and milk fat of breastfeeding Hispanic and non-Hispanic white women in New Mexico (22), it was found that their mean DHA intake was only 47 mg and DHA accounted for just 0.11% of the fatty acids in their milk fat.

In light of the previous finding that the milk fat of women representing the two other major ethnic groups in New Mexico – namely Hispanics and non-Hispanic whites – contained low amounts of DHA (22), and that diets of indigenous people in the US Southwest tend to contain little in the way of seafood or other DHA-rich foods, it was expected that DHA would be an inadequate fatty acid in the diets and milk fat of lactating American Indian women in New Mexico. The main aim of the present study was to determine the DHA content of the diets and breast milk of American Indians inhabiting New Mexico.

METHODS

Participants

Women between 18 and 40 years of age who had been lactating for one to six months were recruited into a cross-sectional study while they were visiting clinics at the University of New Mexico Hospital. From June 2005 to February 2009, of the 789 mothers who were screened for eligibility, 304 were American Indian. Two-hundred-nineteen American Indian women who were determined to be eligible were invited to participate in the study. Of these, 199 were no longer breastfeeding, could not be reached, or were not interested in participating. Nineteen of the remaining 20 women women enrolled in and completed the study. The socioeconomic status (SES) of the subjects was assessed by financial class based on Medicaid eligibility.

Exclusion criteria were maternal use of tobacco, use of immunosuppressive drugs, pregnancy or diabetes mellitus. Informed consent was obtained from each subject and the study was approved by the Human Research Review Committee of the University of New Mexico Health Sciences Center.

Breast milk

Milk was collected and processed as described elsewhere (27–29), between 8:30 and 10:30 a.m. following an overnight fast.

Diet records and dietary supplements

Collection of information regarding diet and dietary supplements is described elsewhere (22). Participants completed a single written diet record of food and drinks consumed in the three days immediately preceding the clinic visit when blood and breast-milk samples were obtained. A registered dietitian (RD) probed for any additional consumption of foods, drinks or dietary supplements. The three-day diet records were coded, analyzed, and reviewed by RDs using the Food Intake Analysis System (version Millennium 1.0, 2005, The University of Texas School of Public Health, Houston, TX). The software database included American Indian foods.

Participant education

After data collection, a RD counseled each participant about increasing fish consumption in accordance with US Environmental Protection Agency Guidelines (EPA) (23).

Body composition analysis

Two measurements of each participant's height and weight were obtained using methods described elsewhere (24). Body composition was assessed in the fasted state according to the method of Heyward (25) using a Quantum II Bioelectrical Impedance Analyzer (RJL Systems, Clinton Township, MI). Duplicate measurements of resistance (R) and reactance (Xc) were used to determine percentage body fat using validated formulas for American Indian women (26).

Fatty acid analysis

Breast milk lipids were extracted as described elsewhere (22). The extracted lipid residue was weighed after drying at 40°C under a stream of nitrogen to calculate milk fat content. Fatty acid methyl esters were prepared, separated and quantified using methods described elsewhere (27). Fatty acid methyl esters were identified using pure methyl ester standards (Nu-Chek Prep, Elysian, MN).

Statistical analyses

Descriptive statistics and correlations were made using the Number Cruncher Statistical Software (NCSS, version 6, 2004, Kaysville, UT, U.S.A.). Data are presented as means plus or minus one standard deviation. Relations between parameters were tested using the Pearson correlation coefficient. A p value ≤ 0.05 was considered statistically significant.

RESULTS and DISCUSSION

Participants ranged in age from 19–34 years (mean 23.9) (Table 1). The average time of lactation when milk was obtained was 2.3 ± 1.8 months. Seventeen women were assessed to be low SES. Sixteen women resided in the Albuquerque area and three in small towns; none resided on an Indian reservation. The mean percent body fat of the subjects was 46.4 ± 4.3%. Three low SES participants reported consuming seafood (tuna, salmon, shrimp, catfish). Nine women reported taking dietary supplements. Seven of the eight participants took a prenatal vitamin/mineral supplement daily. One low-SES participant reported taking a DHA supplement three times weekly. The main finding of this study was that the DHA intake of a sample of urban American Indian women in the US Southwest is suboptimal and may not be sufficient to support the level of DHA in their milk that is required for the

optimum health and development of their infants, especially during the first year of life. The mean percentage of DHA in the milk of the American Indian women in the present study was only 0.097%, a value which is well below the recommended proportion of 0.20–0.40% (28,29) (Table 2). Brenna and coworkers (13) performed a meta-analysis of human milk fat from numerous countries worldwide and found the mean DHA percentage to be 0.32%. The average DHA percentage in the milk of the American Indian participants in this study is slightly lower than the value of 0.11% reported recently for both Hispanic and non-Hispanic white women in New Mexico (22) and 0.20% for women elsewhere in the US (30).

The low level of DHA in the breast milk of most of the participants in the present study can be attributed to their low intake of DHA-containing foods, seafood in particular. The median DHA intake of the 19 participants was only 30 mg/day, which is far below the recommended nutrient intake for DHA of 200 mg/day for lactating women (20,31). A statistically significant relation between the dietary intake of DHA and the percentage of DHA in the milk fat of the American Indian subjects ($r=+0.67$, $p=0.001$) was found. Published reports suggest that DHA may be a conditionally-essential nutrient for optimal infant growth and development, especially for those whose mothers' milk is low in DHA (32). Compared to the intake of 100 mg of DHA per day recommended by FAO/WHO for a 5 kg nursing infant (33), the American Indian infants who were being breast fed by the women who participated in this study were receiving an average of only 46 mg of DHA per day (assuming an infant consumes 750 ml of breast milk per day).

A second concern is the low AA content of the milk of the American Indian women (Table 2). The arachidonic acid (AA) proportion ($0.29 \pm 0.08\%$) was below the percentage considered ideal for human milk fat (30). Arachidonic acid is a major fatty acid in the central nervous system and is important for the growth and development of the brain during the perinatal period. The percentage of AA in human milk fat is remarkably constant across populations globally (13,30). In their meta-analysis of 65 reports of the fatty acid content of human milk, Brenna and colleagues (13) found that the AA content averaged 0.47%. Thus, the AA content of the milk of most of the American Indian women in this study was well below that for the milk of women in many other countries, including some developing countries.

The AA content of the milk of non-Hispanic white and Hispanic women in New Mexico was much higher than that of the American Indian women in the present study (0.44 versus 0.29%)(22). Expert panels worldwide recommend that the AA proportion in breast milk lipids should be between 0.35 and 1.00% (30). The low AA content of the milk of the American Indian women in the present study could be due to at least two factors: a low AA intake and a low ability to metabolize linoleic acid to AA (10). In the present study, however, a statistically significant relationship between the AA content of the milk and AA intake was not found.

The relations between the dietary intake of particular fatty acids of the lactating women in the present study and the weight percentages of those same fatty acids in their milk fat (Table 2) were investigated. The only statistically significant correlation found was between the women's daily intake of DHA and the percentage of DHA in their milk fat ($r =+ 0.67$, $p = 0.001$).

Calories from added sugars and discretionary fat contributed nearly 40% of the average total caloric intake (data not shown), which could contribute to the high percent body fat of these urbanized study participants who were eating a "Western-style diet". The main energy contributor was grain and cereal products which provided 37.7% of total calories, of which 6.5% was provided by tortillas. The meat, poultry and fish group provided 22.1% of total

energy with processed meat products providing 15.3% of the meat contribution to energy. Sweets and beverages contributed 14% of total energy with sweetened beverages accounting for 71.8% of that contribution. Since cold water fish was not a common component of the traditional native American diet in the southwest, it would not be likely that adherence to a traditional diet would be effective in meeting current dietary DHA recommendations.

These results have several practical implications relative to the dietary habits of lactating women in New Mexico. In a recent literature review (18), Innis concluded that maternal intakes of 80 mg DHA per day and levels below 0.2% of total breast-milk fatty acids increase the risk of sub-optimal infant development. Furthermore, the median daily intake of DHA in these women was only 30 mg (Table 1). Even in the four women with the highest DHA intakes (120 – 540 mg/day range), the percentage of DHA in their milk fat was <0.11%.

Jensen and coworkers (28) and others (29,34–36) have shown that increasing the maternal intake of DHA can increase the DHA content of the milk fat. While recognizing that food selection is subject to economic constraints, food availability and cultural factors, it is nevertheless advisable for lactating American Indian women in the US Southwest to increase their intake of DHA. This could be accomplished by incorporating the following into the diet: seafood such as canned tuna (within EPA guidelines) or canned salmon, both of which are reasonably priced and readily available in New Mexico; eggs from free-range chickens ; or through use of fish oil supplements or DHA-fortified foods. Although increasing the DHA intake of a particular population is certainly a formidable challenge, it would be a safe and reliable way of ensuring that lactating American Indian women in the US Southwest produce breast milk that provides their offspring with adequate DHA.

The present study has several limitations. Nineteen participants constitutes a small sample that may not be fully representative of the diets of lactating American Indians in New Mexico and the Southwest as a whole. Second, since all but three of the participants were residing in or near Albuquerque, future studies should include women living in rural areas of New Mexico, including reservations.

Conclusions

The present study adds support to the contention that DHA intake and status of lactating women in New Mexico and the DHA content of their breast milk are substandard and thus, potentially having adverse effects on growth and neurodevelopment of their breast-fed infants. While current efforts to promote breastfeeding in the community should be encouraged, public health officials ought to consider implementing programs aimed at markedly improving the DHA nutrition of pregnant and lactating women in New Mexico and educating them about the importance of consuming adequate quantities of DHA-containing foods.

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Table 1

Summary of the anthropometric characteristics of lactating American Indian women in New Mexico (n=19)

Parameter	Mean ± SD
Age (yrs)	23.9 ± 4.4
Height (cm)	160 ± 6
Weight (kg)	76.5 ± 15.0
Triceps skin fold (mm)	26 ± 6
Mid-upper arm circumference (cm)	32.5 ± 4.3
Body fat (%)	46.4 ± 4.3

Table 2

Weight percentages of fatty acids in the milk of lactating American Indian women in New Mexico (n =19)

Fatty Acid	Weight percentage(mean ± S.D)
4:0	0.009 (0.006)
6:0	0.023 (0.012)
8:0	0.078 (0.044)
10:0	1.16 (0.31)
12:0	5.35 (2.41)
14:0	6.11 (2.49)
Total ICLFA	12.7
15:0	0.24 (0.07)
16:0	21.5 (2.24)
17:0	0.32 (0.10)
18:0	7.27 (0.92)
20:0	0.20 (0.04)
22:0	0.20 (0.04)
24:0	0.044 (0.36)
Monoenoic	
Oleic acid, 18:1 n-9	28.8 (3.48)
c10, 18:1	0.050 (0.063)
c11, 18:1	1.76 (0.24)
c12, 18:1	0.49 (0.20)
Trans isomers	
tT9, 16:1	0.072 (0.031)
t11, 16:1	0.34 (0.077)
t4, 18:1	1.49 (0.052)
t5, 18:1	0.026 (0.062)
t6, plus t7 plus t8, 18:1	0.44 (0.36)
t9, 18:1	0.50 (0.22)
t10, 18:1	0.91 (0.38)
t11, 18:1	0.55 (0.29)
t12, 18:1	0.42 (0.24)
t11, 18:1	0.42 (0.24)
Conjugated dienes	
c9, t11, 18:2	0.29 (0.10)
t10, c12, 18:2	0.052 (0.022)
Nonconjugated dienes	
c9, c12, 18:2 n-6 (LA) *	**17.5 (3.23)**
c11, c14, 20:2 n-6	0.36 (0.051)
Trienoic	
c6, c9, c12, 18:3 n-6	0.093 (0.024)
c9, c12, c15, 18:3 n-3 (α-LNA) *	**1.21 (0.51)**

Fatty Acid	Weight percentage(mean ± S.D)
c8, c11, c14, 20:3 n-6	0.35 (0.35)
C11, c14, c17, 20:3 n-3	0.057 (0.035)
Other	
C13, 22:1	0.055 (0.055)
C5, c8, c11, c14, 20:4 n-6 (AA) *	**0.30 (0.076)**
C5, c8, c11, c14, c17, 20:5	0.033 (0.079)
C15, 24:1	0.037 (0.043)
C7, c10, c13, c16, 22:4 n-6	0.082 (0.037)
C7, c10, c13, c16, c19, 22:5 n-3	0.073 (0.025)
C4, c7, c10, c13, c16, c19, 22:6 (DHA) *	**0.097 (0.035)**

* LA, linoleic acid; α-LNA, α-linolenic acid; AA, arachidonic acid; DHA, docosahexaenoic acid; ICLFA, C4–C14.