Changes in the maternal essential fatty acid profile during early pregnancy and the relation of the profile to diet[1,2]

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ABSTRACT

Background: Although the pattern of the essential fatty acids (EFAs) changes considerably from week 10 of pregnancy to term, no information is available on changes in EFA concentrations in the early stages of pregnancy.

Objective: The main objectives were to assess the EFA status, particularly that of 22:6n−3, in women during the first 10 wk of pregnancy and to investigate the relation of EFA status to dietary EFA intake during this period.

Design: Healthy women (n = 24) planning to become pregnant were recruited. The fatty acid composition of plasma and erythrocyte phospholipids was determined before and at weeks 4, 6, 8, and 10 of pregnancy. Food intake was assessed at entry into the study and at week 10 of pregnancy by using food-frequency questionnaires.

Results: A small but nonsignificant increase in dietary intake of 22:6n−3 was found. The plasma phospholipid content of 22:6n−3 (% by wt) increased continuously during the first 10 wk of pregnancy. At week 10 of pregnancy, the plasma percentages of 16:0, 20:3n−6, and 20:4n−6 had increased significantly, whereas the percentages of the 18–24-carbon saturated fatty acids, 18:2n−6, and the ratio of n−6 to n−3 fatty acids had dropped significantly. The composition of erythrocyte phospholipids showed changes similar to those observed in plasma.

Conclusions: Maternal plasma and erythrocyte phospholipid 22:6n−3 concentrations start to increase in very early pregnancy, which cannot be explained by changes in dietary intake alone. This rise probably represents early maternal adaptations to meet the requirements of highly proliferating and differentiating tissues at this stage of fetal development. *Am J Clin Nutr* 2001;73:302–7.

KEY WORDS Early pregnancy, phospholipids, essential fatty acids, docosahexaenoic acid, dietary intake, food-frequency questionnaire, women

INTRODUCTION

The n−6 and n−3 long-chain polyenes (LCPs) are important structural components of cell membrane phospholipids. During pregnancy, an adequate LCP supply is required to sustain proper fetal growth and development. In recent years, extensive research has been performed on these LCPs in early human development, with emphasis on docosahexaenoic acid (22:6n−3), which is the predominant fatty acid in the central nervous system (1, 2) and the retina (3). The functional significance of 22:6n−3 as a structural constituent of the phospholipids in nervous and retinal tissues is illustrated by the irreversible impairment of neural and visual function in animals exposed to diets deficient in n−3 fatty acids throughout the prenatal and postnatal periods (4).

Longitudinal data on fatty acid concentrations in pregnant women indicate that the amounts (mg/L) of saturated, monounsaturated, and polyunsaturated fatty acids in the maternal plasma phospholipids increase from week 10 of pregnancy until delivery (5). However, a continuous decline was observed in the overall functional essential fatty acid (EFA) status of the women, reflected by the ratio between the essential n−3 plus n−6 and the nonessential n−7 plus n−9 unsaturated fatty acids. Because no information is available from the first 10 wk of gestation, it is not clear when the fatty acids concentrations start to change. This period of early pregnancy is important considering the findings of Wynn and Wynn (6) and Wynn et al (7) that the nutritional status of women is important not only during pregnancy but around the time of conception as well. Surprisingly, little is known about maternal dietary fat intake, particularly EFA consumption, around conception and during early pregnancy. Therefore, we decided to study the EFA status in plasma and erythrocyte phospholipids in women before conception and during the first 10 wk of pregnancy, and to assess the women's dietary EFA intake in this period.

SUBJECTS AND METHODS

Subjects and study design

Women planning to soon become pregnant were recruited through advertisements in local newspapers. Only healthy women without metabolic, cardiovascular, neurologic, or renal disorders were included. From all eligible respondents, 67 women agreed to participate in the study. Before the initial blood sample collec-

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TABLE 1
Characteristics of the subjects[1]

Age (y)	30.7 ± 0.6[2]
Height (m)	1.70 ± 0.01
Length of last menstrual cycle (d)	30.1 ± 0.9
Parity (*n*)	
0	10
1	12
2	1
3	1
Prepregnancy characteristics	
Weight (kg)	67.1 ± 2.8
BMI (kg/m^2)	23.1 ± 0.91
Smoking (*n*)	1
Use of alcohol (*n*)	14
Characteristics at week 10 of pregnancy	
Weight (kg)	68.7 ± 2.8[3]
BMI (kg/m^2)	23.8 ± 0.94[3]
Smoking (*n*)	1
Use of alcohol (*n*)	3

[1] $n = 24$.
[2] $\bar{x}$ ± SEM.
[3] Significantly different from prepregnancy value, $P < 0.01$.

tion, 6 women were pregnant already and 11 decided not to participate. Of those who started the study, 20 dropped out for different reasons, such as lack of motivation or miscarriage before reaching week 10 of pregnancy. Another 6 women failed to conceive within the study period. Thus, 24 subjects completed the study. Subject characteristics are presented in **Table 1**. The research protocol was approved by the Medical Ethics Committee of the University Hospital Maastricht. Signed informed consent was obtained from each participant.

Every month, on the first or second day of the menstrual cycle, a venous blood sample was collected into EDTA-containing tubes. When menstruation did not occur at the expected time, the women were instructed to have another blood sample taken. When pregnancy was confirmed (often already at week 4–5 of pregnancy), further samples were collected at weeks 6, 8, and 10 of pregnancy. Pregnancy duration was calculated from the first day of the last menstrual cycle. After blood collection, plasma was separated from the erythrocytes by centrifugation for 10 min at 1000 × *g* and 4°C. The erythrocytes were washed twice with an EDTA-containing saline solution. The plasma and erythrocyte samples were divided between 2 storage tubes, closed tightly under nitrogen, and stored at −80°C until analyzed for fatty acids. Butylated hydroxytoluene was added to all erythrocyte samples before storage. These procedures were described in detail elsewhere (8).

Fatty acid analysis

The fatty acid composition of plasma and erythrocyte phospholipids was analyzed in the blood samples as described previously (8). The fatty acids were determined by capillary gas chromatography with a polar capillary column (50 m × 0.25 mm CPSil 88; Chrompack, Middelburg, Netherlands) and helium as the carrier gas. The amount of each fatty acid was quantified by the amount of the internal standard [dinonadecanoyl (19:0)-phosphatidylcholine] added to each sample that was recovered. The fatty acids are expressed as mg/L plasma or erythrocyte suspension and as a percentage by weight of total fatty acids (% by wt). The sum of the saturated, monounsaturated, and polyunsaturated fatty acids; the sum of the n−6 LCPs (20:3n−6, 20:4n−6, 22:4n−6, and 22:5n−6); and the n−3 LCPs (20:5n−3, 22:5n−3, and 22:6n−3) and the ratio of the n−6 to n−3 fatty acids are also presented. In addition, the EFA index (sum of n−3 and n−6 fatty acids)/(sum of n−7 and n−9 fatty acids), which reflects the overall EFA status, was calculated.

Assessment of the dietary fatty acid intake

The subjects' food intake in the period before pregnancy and during the first 10 wk of gestation was assessed by using a food-frequency questionnaire (FFQ). This questionnaire was used previously and validated in the longitudinal study of Al et al (9). The FFQ was sent to the subjects for the first time at entry and the second time at week 10 of pregnancy. The food consumption data were encoded according to the system of the Dutch nutrient data bank (NEVO; 10) and converted into dietary intake data by using the extended computerized version of the Dutch food-composition table (version 1996.I; 11). Intakes of total fat; total saturated, monounsaturated, and polyunsaturated fatty acids; and linoleic acid (18:2n−6) were calculated. In addition, with data provided by the Dutch food-composition table, version 1996.II (11), the intakes of palmitic acid (16:0), stearic acid (18:0), oleic acid (18:1n−9), γ-linolenic acid (18:3n−6), arachidonic acid (20:4n−6), α-linolenic acid (18:3n−3), eicosapentaenoic acid (20:5n−3), docosapentaenoic acid (22:5n−3), and 22:6n−3 were assessed.

Statistical analysis

Data are presented as means ± SEMs. In 8 subjects, fatty acid data for one sampling point were missing because an occasional blood sample was not collected at the intended sampling time. A paired *t* test was used to examine whether the fatty acid values measured at weeks 4, 6, 8, and 10 changed significantly from baseline (prepregnant values).

Differences between the dietary intake data of the 2 assessment periods were assessed by using Wilcoxon's signed-rank test. The relations between maternal dietary fatty acid intake (% by wt of total fat intake) and maternal plasma and erythrocyte phospholipid fatty acid concentrations (% by wt of total fatty acids) were evaluated by using Spearman's rank-order correlation coefficients. In addition, the relation between the change in maternal dietary fatty acid intake and the changes in maternal plasma and erythrocyte fatty acid concentrations was evaluated. Nonparametric tests were used because the data were not normally distributed.

Because of multiple testing, $P < 0.01$ was considered significant. All statistical analyses were performed by using STATVIEW (version 5.0 for Macintosh PPC; SAS Institute Inc, Cary, NC).

RESULTS

Subject characteristics

There was a significant weight gain of 1.6 ± 0.5 kg during the first 10 wk of pregnancy. Of the 14 women who reported consuming alcoholic beverages before conception, only 3 continued to do so in the first 10 wk of pregnancy. The one subject who reported smoking did not quit this habit during the study period.

Fatty acids

Comparison of the baseline fatty acid values with those obtained at the first blood sampling in the pregnant state did not

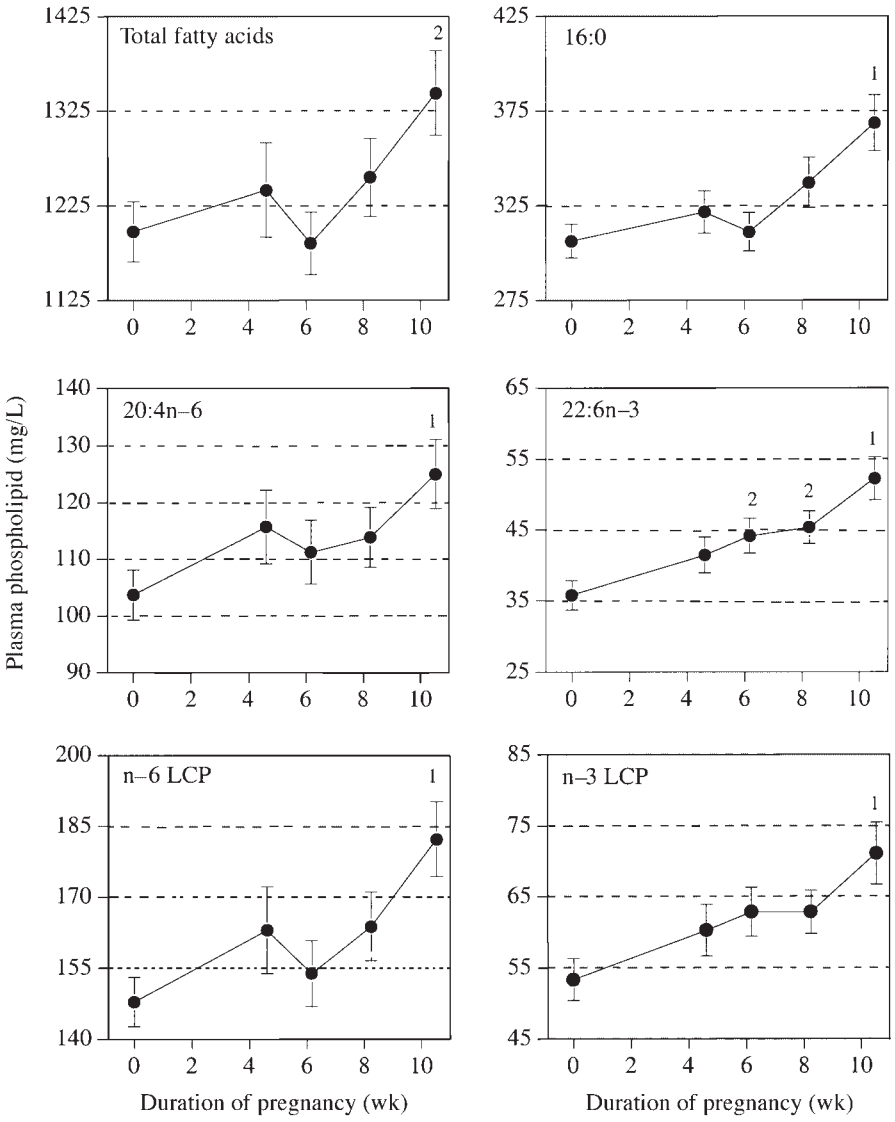

FIGURE 1. Mean (±SEM) plasma phospholipid concentrations of total fatty acids, 16:0, 20:4n−6, 22:6n−3, and n−6 and n−3 long-chain polyenes (LCP) in the first weeks of pregnancy, ie, baseline (prepregnant, $n = 23$), 4.6 wk ($n = 21$), 6.2 wk ($n = 21$), 8.2 wk ($n = 24$), and 10.5 wk ($n = 23$). [1,2] Significantly different from prepregnant value (paired t test): [1]$P < 0.0001$, [2]$P < 0.01$.

show significant differences in either plasma or erythrocyte phospholipids. A tendency toward a significant increase was observed, however, for plasma 22:6n−3 ($P = 0.013$ for the absolute amount and $P = 0.026$ for the percentage). Changes in other fatty acids and fatty acid combinations were not significant.

From prepregnancy through week 10 of pregnancy, significant increases were observed in the amounts of plasma phospholipid total fatty acids and in most of the individual fatty acids. The results for total fatty acids, 16:0, 20:4n−6, n−6 LCPs, 22:6n−3, and n−3 LCPs are presented in **Figure 1**.

In erythrocyte phospholipids, the total fatty acid amounts and most individual fatty acids measured did not change significantly during the first 10 wk of pregnancy. However, the amounts of 18:0 and 18:2n−6 declined significantly during this period (from 86.69 ± 9.71 to 78.23 ± 11.50 mg/L, and from 119.77 ± 15.75 to 106.19 ± 15.79 mg/L, respectively). The 22:6n−3 concentrations of erythrocyte phospholipids rose from 30.78 ± 6.68 to 35.60 ± 9.66 mg/L, but the P value was not significant (prepregnant compared with week 10: $P = 0.011$).

The percentages of fatty acids in plasma and erythrocyte phospholipids are shown in **Tables 2** and **3**, respectively (data not shown are available from the authors on request). Although the percentages of the plasma phospholipid total saturated fatty acids did not change significantly over time, the percentages of the individual saturated fatty acids did. A significant decrease was observed in the percentages of plasma 18:0, arachidic acid (20:0), behenic acid (22:0), and lignoceric acid (24:0) at week 10 of pregnancy, whereas the percentages of 16:0 increased significantly (data not shown). In erythrocyte phospholipids, the percentages of 18:0 decreased significantly by week 10 of gestation; no significant changes were observed for the total or for the other individual saturated fatty acids (data not shown).

A small but significant increase was observed for the percentages of 18:1n−7 in plasma and erythrocyte phospholipids; for

TABLE 2
Plasma phospholipid fatty acid composition in early pregnancy[1]

Fatty acid	Prepregnant (n = 23)	Week of pregnancy: 4.6 ± 0.1, 32.2 d (n = 21)	6.2 ± 0.1, 43.2 d (n = 21)	8.2 ± 0.1, 57.6 d (n = 24)	10.5 ± 0.1, 73.7 d (n = 23)
			% by wt of total fatty acids		
SFA	44.64 ± 0.41	44.61 ± 0.65	44.10 ± 0.35	44.58 ± 0.40	44.14 ± 0.46
MUFA	11.94 ± 0.29	11.61 ± 0.28	11.78 ± 0.31	11.74 ± 0.33	12.05 ± 0.25
18:2n−6	22.32 ± 0.36	21.73 ± 0.68	21.92 ± 0.48	21.56 ± 0.54	20.48 ± 0.48[2]
20:3n−6	3.12 ± 0.12	3.19 ± 0.14	3.01 ± 0.11	3.36 ± 0.16	3.53 ± 0.17[3]
20:4n−6	8.68 ± 0.30	9.27 ± 0.26	9.35 ± 0.32[3]	9.04 ± 0.26	9.34 ± 0.35[3]
22:4n−6	0.36 ± 0.02	0.37 ± 0.02	0.34 ± 0.02	0.36 ± 0.02	0.39 ± 0.02
22:5n−6	0.19 ± 0.02	0.22 ± 0.02	0.22 ± 0.02	0.22 ± 0.02	0.29 ± 0.03[2]
n−6 LCP	12.35 ± 0.28	13.05 ± 0.35	12.92 ± 0.33	12.99 ± 0.26	13.55 ± 0.32[2]
Total n−6	35.46 ± 0.45	35.60 ± 0.60	35.54 ± 0.52	35.32 ± 0.59	34.88 ± 0.62
18:3n−3	0.16 ± 0.01	0.16 ± 0.02	0.16 ± 0.01	0.17 ± 0.01	0.23 ± 0.03
20:5n−3	0.63 ± 0.07	0.61 ± 0.06	0.72 ± 0.14	0.60 ± 0.07	0.62 ± 0.11
22:5n−3	0.84 ± 0.03	0.89 ± 0.03	0.88 ± 0.04	0.80 ± 0.03	0.80 ± 0.03
22:6n−3	2.98 ± 0.14	3.36 ± 0.19	3.73 ± 0.19[2]	3.63 ± 0.17[2]	3.93 ± 0.22[2]
n−3 LCP	4.45 ± 0.21	4.86 ± 0.23	5.32 ± 0.29[3]	5.03 ± 0.22[2]	5.35 ± 0.33[2]
Total n−3	4.75 ± 0.21	5.15 ± 0.23	5.60 ± 0.28[3]	5.33 ± 0.23[2]	5.71 ± 0.32[2]
PUFA	40.40 ± 0.52	40.97 ± 0.59	41.32 ± 0.56	40.83 ± 0.57	40.79 ± 0.64
n−6:n−3	7.78 ± 0.35	7.20 ± 0.36	6.68 ± 0.36[3]	6.89 ± 0.30[3]	6.44 ± 0.29[2]
EFA index	3.36 ± 0.11	3.48 ± 0.09	3.50 ± 0.12	3.48 ± 0.13	3.35 ± 0.10
Total (mg/L)	1198.0 ± 31.7	1241.7 ± 49.7	1185.5 ± 33.0	1255.2 ± 41.1	1343.8 ± 44.6[3]

[1] $\bar{x}$ ± SEM. SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; n−6 LCP, long-chain polyenes; 20:3n−6, 20:4n−6, 22:4n−6, and 22:5n−6; n−3 LCP: 20:5n−3, 22:5n−3, and 22:6n−3; PUFA: polyunsaturated fatty acids; EFA index, (sum n−3 + n−6 fatty acids)/(sum n−7 + n−9 fatty acids).
[2,3] Significantly different from prepregnant value (paired t test): [2] $0.001 < P < 0.0001$, [3] $0.01 < P < 0.05$.

erythrocytes, a significant increase was also observed in the percentage of 24:1n−9 (data not shown). No significant changes were found in the other nonessential n−9 unsaturated fatty acids, either in plasma or in erythrocyte phospholipids.

With respect to the percentages of n−6 fatty acids, at week 10 of pregnancy the percentages of most individual n−6 fatty acids were significantly increased, whereas 18:2n−6 was decreased. Comparable results were observed for the erythrocyte phospholipids.

In the n−3 series, plasma and erythrocyte percentages of 22:6n−3, total n−3, and n−3 LCPs increased continuously throughout the first 10 wk of pregnancy. The percentages of plasma 22:5n−3 tended to decline during this period, but at week 10, this fatty acid was not yet significantly different from baseline.

The ratio between total n−6 and total n−3 fatty acids in both plasma and erythrocytes had dropped significantly by week 6 of pregnancy (Tables 2 and 3). The EFA index remained unchanged, as did the sum of the total polyunsaturated fatty acids, during the first 10 wk of pregnancy.

Dietary fatty acid intakes and the relation to plasma and erythrocyte fatty acid compositions

Dietary intakes were assessed twice by using FFQs. In the first period, before pregnancy, intake data of 5 subjects were excluded from analysis and in the second period, at week 10 of pregnancy, intake data of 4 subjects were discarded because the FFQs were incomplete or were not returned. The data of the remaining FFQs from which the dietary fatty acid intake was estimated are presented in **Table 4**. Paired t tests were possible with data from the 15 subjects for which both FFQs were analyzed. No significant differences between the 2 periods were found.

Before pregnancy, significant positive correlations were found between the dietary 22:6n−3 intake and the percentages of 22:6n−3 in plasma (P = 0.009, r = 0.64) and erythrocyte phospholipids (P = 0.007, r = 0.65). These correlations disappeared by week 10 of pregnancy. For the other fatty acids presented in Table 4, a significant correlation was found only between dietary and plasma phospholipid 18:2n−6 at week 10 of pregnancy (P = 0.004, r = 0.67). Analysis of the relation between the change in maternal dietary fatty acid intake and the changes in maternal plasma and erythrocyte phospholipid fatty acid concentrations showed no significant outcomes.

DISCUSSION

The results of the present study show the maternal EFA status in the first 10 wk of pregnancy in a group of healthy women and changes in their dietary intake of EFAs in this period. Al et al (9) reported previously that the fat content and composition of the maternal diet remained unaltered during pregnancy when assessed at ≈week 13, and at weeks 22 and 32 of pregnancy. Using the same FFQs, we observed no major significant changes in dietary fatty acid intake between the prepregnant period and week 10 of pregnancy. The total fat intake and the intakes of saturated and polyunsaturated fatty acids during both periods were comparable with those reported before for Dutch pregnant women (9, 12). However, our results showed a lower intake of 20:4n−6 than reported for British pregnant women (198 mg/d; 13): 26 and 21 mg/d before and at week 10 of pregnancy, respectively. This is probably because, except for poultry and fish, the Dutch food-composition table did not contain information on the amounts of 20:4n−6 in meat (11). The meat consumption in the present study

TABLE 3
Erythrocyte phospholipid fatty acid composition in early pregnancy[1]

Fatty acid	Prepregnant (n = 23)	Week of pregnancy: 4.6 ± 0.1, 32.2 d (n = 21)	6.2 ± 0.1, 43.2 d (n = 21)	8.2 ± 0.1, 57.6 d (n = 24)	10.5 ± 0.1, 73.7 d (n = 23)
			% by wt of total fatty acids		
SFA	40.30 ± 0.23	39.83 ± 0.22	40.06 ± 0.24	39.89 ± 0.33	39.99 ± 0.20
MUFA	17.90 ± 0.22	17.87 ± 0.18	17.97 ± 0.20	17.91 ± 0.22	17.93 ± 0.24
18:2n−6	11.39 ± 0.15	11.18 ± 0.20	10.81 ± 0.18[2]	10.75 ± 0.20[2]	10.30 ± 0.16[2]
20:3n−6	1.42 ± 0.06	1.35 ± 0.09	1.42 ± 0.05	1.46 ± 0.07	1.54 ± 0.07[3]
20:4n−6	10.36 ± 0.18	10.57 ± 0.13	10.52 ± 0.18	10.47 ± 0.16	10.59 ± 0.19
22:4n−6	2.77 ± 0.08	2.78 ± 0.08	2.79 ± 0.08	2.78 ± 0.07	2.88 ± 0.08[3]
22:5n−6	0.29 ± 0.02	0.27 ± 0.02	0.28 ± 0.02	0.27 ± 0.02	0.30 ± 0.02
n−6 LCP	14.84 ± 0.22	14.98 ± 0.18	15.01 ± 0.21	14.98 ± 0.20	15.31 ± 0.24[3]
Total n−6	27.38 ± 0.27	27.31 ± 0.26	26.97 ± 0.25	26.88 ± 0.31	26.85 ± 0.30[3]
18:3n−3	0.11 ± 0.01	0.11 ± 0.01	0.10 ± 0.01[3]	0.11 ± 0.01	0.13 ± 0.01
20:5n−3	0.48 ± 0.04	0.49 ± 0.04	0.50 ± 0.05	0.47 ± 0.04	0.46 ± 0.06
22:5n−3	1.96 ± 0.06	2.01 ± 0.05	2.02 ± 0.06[3]	1.99 ± 0.05	1.97 ± 0.05
22:6n−3	2.94 ± 0.12	3.01 ± 0.13	3.14 ± 0.14[3]	3.18 ± 0.15[2]	3.43 ± 0.15[2]
n−3 LCP	5.38 ± 0.17	5.51 ± 0.17	5.65 ± 0.20	5.64 ± 0.20[3]	5.86 ± 0.21[2]
Total n−3	5.54 ± 0.17	5.67 ± 0.18	5.80 ± 0.20	5.80 ± 0.20[3]	6.04 ± 0.20[2]
PUFA	33.04 ± 0.30	33.13 ± 0.21	32.89 ± 0.27	32.78 ± 0.34	33.01 ± 0.28
n−6:n−3	5.06 ± 0.18	4.92 ± 0.17	4.78 ± 0.19[3]	4.78 ± 0.19[3]	4.56 ± 0.16[2]
EFA index	1.84 ± 0.03	1.84 ± 0.03	1.82 ± 0.03	1.82 ± 0.04	1.83 ± 0.04
Total (mg/L)	1052.6 ± 26.5	1079.8 ± 28.5	1103.5 ± 24.5	1078.1 ± 35.9	1035.1 ± 34.4

[1] $\bar{x}$ ± SEM. SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; n−6 LCP, long-chain polyenes; 20:3n−6, 20:4n−6, 22:4n−6, and 22:5n−6; n−3 LCP: 20:5n−3, 22:5n−3, and 22:6n−3; PUFA, polyunsaturated fatty acids; EFA index, (sum n−3 + n−6 fatty acids)/(sum n−7 + n−9 fatty acids).
[2,3] Significantly different from prepregnant value (paired t test): [2] $0.001 < P < 0.0001$, [3] $0.01 < P < 0.005$.

was slightly higher than that reported for pregnant women in the Dutch National Food Consumption Survey (mean daily intake of 110.8 g prepregnant and 136.0 g at week 10 of pregnancy compared with 104 g; 12). The dietary 22:6n−3 intake in our group was also low, although higher than that reported for vegetarian pregnant women (13) and for Spanish women ingesting <2 fish meals/mo (14). Similar to meat, the consumption of fish was slightly higher than that reported in the Dutch national food consumption survey (14.84 and 16.33 g/d compared with 11 g/d).

Pregnancy is generally associated with a marked hyperlipidemia involving all lipid classes (15–20). It was suggested that these elevated lipid concentrations improve fetal access to EFAs (21, 22). The concentration of plasma phospholipids was reported to increase >65% from the first trimester through term (15, 17, 23). An increase in phospholipid-associated fatty acids during pregnancy was also reported (5, 24). Results of the present study show that plasma total fatty acid content starts to increase within the first 10 wk of pregnancy.

For its supply of 22:6n−3, the fetus depends largely on placental transfer (25). Previously, Al et al (5) reported a continuous increase of ≈52% in the amounts of 22:6n−3 in maternal plasma from week 10 through term. In the present study we observed that at week 10 of pregnancy (mean: 73.7 d), the absolute and relative amounts of 22:6n−3 had already increased significantly. This observation might reflect maternal adjustments at this stage of development to meet requirements for 22:6n−3 incorporation in the embryonic tissues. Note that the neural tube from which the central nervous system will be formed starts to develop in these early days after conception (26).

At the first measurement during pregnancy, the amounts (mg/L) of 22:6n−3 had already increased by 14.26% from prepregnancy values. Although the power of the study was too limited for this small change to become fully significant, the P value attained (P = 0.013) indicates a true increase in the amounts of 22:6n−3 during this early phase of pregnancy. This is supported by the significant, positive linear regression between the change in the amount of 22:6n−3 and gestational age (r = 0.36, P = 0.0006).

The mean estimated dietary 22:6n−3 intake in the present study, over both periods, was 117 mg/d (range: 3–1061 mg). Daily supplementation of nonpregnant women with either 285 mg 22:6n−3 alone as a microalgal oil (DHASCO; Martek Biosciences, Columbia, MD) or with 266 mg 22:6n−3 as tuna fish oil for a 4-wk period increased plasma phospholipid 22:6n−3 by ≈34% and 31%, respectively (27). In the present study, the absolute amounts of plasma 22:6n−3 increased from 35.80 ± 9.90 mg/L prepregnancy to 52.26 ± 14.47 mg/L at week 10 of pregnancy (Figure 1), representing an increase of ≈46% from the nonpregnant state. This shows that the effect of early pregnancy on the 22:6n−3 content of plasma phospholipids is considerably stronger than that of increased consumption of ≈270 mg 22:6n−3/d. Because a small but not significant increase in dietary 22:6n−3 intake was observed (90 mg/d prepregnancy compared with 142 mg/d at week 10 of pregnancy), the increased 22:6n−3 content of plasma phospholipids is unlikely of dietary origin only. Moreover, there was no correlation between the change in dietary 22:6n−3 intake and the change in this fatty acid in either maternal plasma or erythrocyte phospholipids. Because plasma phospholipids mainly originate from hepatic synthesis, the increase in 22:6n−3 concentrations during pregnancy might reflect a pregnancy-associated adjustment in the hepatic synthesis of 22:6n−3, with an enhanced or selective incorporation of this fatty acid into the phospholipids.

No changes were observed in amounts of the erythrocyte phospholipid total fatty acids (Table 3). Nevertheless, clear

TABLE 4
Fatty acid intake before pregnancy and at week 10 of pregnancy[1]

Fatty acid	Prepregnancy (n = 19)	Week 10 (n = 20)
	g/d	
Total fat	88.20 ± 6.08	86.94 ± 3.95
Saturated fatty acids		
16:0	15.56 ± 1.30	15.37 ± 0.85
18:0	7.70 ± 0.66	7.31 ± 0.44
Total	35.03 ± 3.22	34.10 ± 1.74
Monounsaturated fatty acids		
18:1n−9	20.42 ± 1.51	20.88 ± 1.19
Total	31.07 ± 2.07	30.94 ± 1.56
n−6 fatty acids		
18:2n−6	13.22 ± 0.90	13.17 ± 0.90
18:3n−6	0.02 ± 0.00	0.01 ± 0.00
20:4n−6	0.03 ± 0.01	0.02 ± 0.00
Total	13.24 ± 0.90	13.19 ± 0.90
n−3 fatty acids		
18:3n−3	1.09 ± 0.12	1.02 ± 0.09
20:5n−3	0.05 ± 0.02	0.08 ± 0.03
22:5n−3	0.01 ± 0.00	0.02 ± 0.01
22:6n−3	0.09 ± 0.03	0.14 ± 0.05
Total	1.27 ± 0.13	1.29 ± 0.12
Polyunsaturated fatty acids		
n−6:n−3	11.31 ± 0.76	11.97 ± 1.55
Total	15.87 ± 1.05	15.69 ± 0.90

[1] $\bar{x}$ ± SEM. There were no significant differences between the 2 assessment periods.

compositional shifts were observed among the fatty acids, which largely reflected the changes found in plasma. As in plasma, there was a marked decrease in the percentages of 18:2n−6 accompanied by a significant increase in the percentages of the n−6 LCPs, which suggests enhanced elongation and desaturation of 18:2n−6 during early pregnancy.

In conclusion, this study showed that the amounts of 22:6n−3 in maternal plasma and erythrocyte phospholipids start to rise in very early pregnancy, which cannot be explained by changes in dietary intake alone. This rise likely reflects enhanced synthesis of 22:6n−3 from its precursor fatty acids; however, mobilization from maternal stores, reduced oxidation, or both, cannot be excluded.

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