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ORIGINAL CONTRIBUTION

Hajnalka Minda
Elvira Larque
Berthold Koletzko
Tamás Decsi

Systematic review of fatty acid composition of plasma phospholipids of venous cord blood in full-term infants

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H. Minda · T. Decsi (✉)
Department of Paediatrics
University of Pécs
József A. 7
7623 Pécs, Hungary
Tel.: +36-72/535-900
Fax: +36-72/535-971
E-Mail: tamas.decsi@aok.pte.hu

Elvira Larque · Berthold Koletzko
Dr. von Haunersches Kinderspital
Ludwig-Maximilians University, Munich
Lindwurmstr. 4
80337 München, Germany
E-Mail:
bkoletz@helios.med.uni-muenchen.de

Summary The purpose of this review was to systematically evaluate the variability of the fatty acid composition of venous cord blood phospholipids in different populations. In an attempt to review published evidence systematically, we found 19 data sets describing fatty acid composition of venous cord blood phospholipids in 11 European and 2 American countries. The amount of saturated-, monounsaturated- and parent essential polyunsaturated fatty acids exhibited relatively moderate variability among the data sets reviewed. Values of arachidonic acid and docosahexaenoic acid showed two-fold variability among the data sets. The highest values of docosahexaenoic acid were observed in countries with apparently higher consumption of dietary fat from sea fish. Considering the differences in blood sampling, laboratory methods and data presentation, we conclude that fatty acid composition of venous cord blood phospholipids in healthy, full-term infants shows relatively modest variability; hence, it is suitable for the estimation of *in utero* fatty acid supply.

Key words Venous cord blood – phospholipid – essential fatty acids – long-chain polyunsaturated fatty acids

Abbreviations

LA (C18:2n–6)	linoleic acid
AA (C20:4n–6)	arachidonic acid
ALA (C18:3n–3)	α-linolenic acid
DHA (C22:6n–3)	docosahexaenoic acid
EFA	essential fatty acid
PUFA	polyunsaturated fatty acid
LC-PUFA	long-chain polyunsaturated fatty acid
p-FABPpm	placental plasma membrane fatty acid binding protein
PL	phospholipid

Introduction

Physiological availability of essential fatty acids and long-chain polyunsaturates is important for the development of the central nervous system, for body growth and for the synthesis of eicosanoid hormones [1, 2]. Synthesis activity of long-chain polyunsaturated fatty acids in the fetus and the newborn does not appear to meet the demand for the above-mentioned functions. Hence, long-chain polyunsaturated fatty acids are supplied by the maternal circulation for the fetus, and by human milk or certain formulas for the infant.

It is well known that fat content and fatty acid composition of human milk are variable, and influenced by maternal parity, the duration of pregnancy, stage of lactation, various genetic factors, and – probably foremost – by maternal diet [3]. Fatty acid composition of human

colostrum also appears to be markedly influenced by geographic differences between populations [4]. It is much less known, however, to which extent can these factors influence the fatty acid status of the fetus. Neither the putative barrier function of the placenta nor the suspected active transport between mother and fetus has been clearly characterized as yet.

Several studies investigated the lipid composition of venous cord blood in different parts of the world. Recent data suggest that lipid composition at birth may determine fatty acid status for later periods of infancy [5]. Therefore we decided to review the published information on fatty acid composition of venous cord blood lipids.

Methods of this review

We screened the literature of the past 30 years for data on fatty acid composition of umbilical cord venous blood plasma. We carried out a National Library of Medicine search by using Pubmed utilities on databases covering the period from 1970 to 2001. The searching expressions were as follows: arachidonic acid or docosahexaenoic acid or essential fatty acid, together with umbilical cord or infant or neonatal. Thereafter we also checked the list of references in recent reviews and utilised the database constructed for our previous reviews on the role of essential fatty acids in infant nutrition [1, 6].

Fatty acid composition of plasma phospholipids was reported in several studies, whereas data obtained in other lipid classes were published only in a few reports. We identified a total of 19 data sets reporting cord blood venous plasma phospholipid data from 13 countries. Each of these studies investigated healthy, full-term infants. Both pregnancy and delivery were normal in all these studies, i. e., no maternal hypertension, proteinuria, edema, preeclampsia, gestational diabetes, placental dysfunction or diabetes mellitus was reported, and gestational ages were between 38 and 42 weeks. There was no history of disease of the offspring. We excluded those studies from this review in which any of the aforementioned critera were not met.

In 17 data sets, venous blood samples were collected from the umbilical cord immediately after clamping. In two studies [7, 8], the exact time of the venipuncture was not mentioned; it was stated only that the samples were collected from the infants at birth. We hypothesized that immediately after birth the fatty acid composition of the infants' venous blood closely resembles the fatty acid composition of umbilical venous blood at delivery, and also took these 2 studies into consideration. Results of the fatty acid composition were presented as weight percentages of all phospholipid fatty acids identified in 18 studies, whereas in the study of Jensen et al. the data were presented as molar percentages. The paper of Otto et al. reported the data in weight concentrations (mg/l), but for the purposes of this study we transformed these data into weight percentages. (This calculation was rendered possible by the fact that the authors also published the total amount of fatty acids determined.)

Methods used in the studies reviewed

There were some methodological differences in the studies reviewed. The samples were collected into heparinized or EDTA-containing tubes. Storage temperature was either –20 °C or –80 °C. Lipid extraction was carried out by chloroform and methanol, and the separation of different lipid fractions was performed by thin layer chromatography in most studies; however, some investigators used aminopropyl-bounded phase columns. Fatty acid analysis was carried out by gas-liquid chromatography in all studies. In 4 studies, a packed column was used which tends to resolve fewer fatty acids and be less accurate than the up-to-date capillary columns used in the studies providing the other 15 data sets.

The n-6 essential fatty acid, linoleic acid (C18:2n-6, LA) as well as arachidonic acid (C20:4n-6, AA) and docosahexaenoic acid (C22:6n-3, DHA) were reported in all studies, whereas the n-3 essential fatty acid, α-linolenic acid (C18:3n-3, ALA), was not reported in more than half of the data sets evaluated (12/19). Only five data sets reported also the geometric *trans* isomers of unsaturated fatty acids.

Comparison of cord blood venous plasma phospholipid fatty acid profiles

Fatty acid composition of venous cord blood phospholipids from 19 data sets obtained in 13 countries are shown in Table 1. Eleven of the populations investigated were from Europe, one was from North America and one was from South America.

Total saturated fatty acids were reported to be the lowest in one data set from the Netherlands [9] (mean: 40.4 % by wt), and the highest in Austria [10] (median: 57.13 % by wt), whereas in the majority of the studies mean or median values of total saturated fatty acids ranged from 42 % to 49 % by wt. Total monounsaturates (calculated as the sum of 2 to 7 fatty acids) were the lowest in the Netherlands [11] (mean: 11.6 % by wt) and in Austria [10] (median: 11.5 % by wt), whereas the highest value was reported for Hungary [10] (median: 14.4 % by wt). Total *trans* fatty acids (calculated as the sum of 3 *trans* fatty acids) showed large differences between Germany [12] (median: 0.21 % by wt) and Hungary [10] (median: 1.19 % by wt).

Table 1 Fatty acid composition of umbilical venous blood phospholipids from 19 data sets obtained in 13 different countries

Country	Austria	Belgium	Ecuador	England	Finland	France	Germany	Germany	Hungary
Year	1999	1994	1997	1997	1997	1999	1998	1994	1999
First author	Decsi	Kohn	Otto	Otto	Otto	Guesnet	Berghaus	Decsi	Decsi
No. of subjects	13	64	22	50	50	83	41	10	13
Analytic column	Capillary	Capillary	Capillary	Capillary	Capillary	Capillary	Capillary	Capillary	Capillary
Expression of data (% by wt)	median (Q3-Q1)	median (Q3-Q1)	mean	mean	mean	median (Q3-Q1)	median (Q3-Q1)	median (Q3-Q1)	median (Q3-Q1)
Total (mg/l)	–	–	627.1 (32.3)	697.4 (17.8)	601.7 (15.0)	–	625.5 (180.8)	–	–
C18:3n-3	0.04 (0.01)	ND	–	–	–	–	0.00 (0.03)	ND	0.05 (0.18)
C20:3n-3	0.23 (0.11)	ND	–	–	–	–	0.00 (0.00)	–	1.00 (0.43)
C20:4n-3	–	–	–	–	–	–	–	–	–
C20:5n-3	0.05 (0.03)	0.27 (0.19)	0.21	0.25	0.56	0.40 (0.20)	0.20 (0.16)	0.15 (0.08)	0.06 (0.09)
C22:5n-3	–	0.42 (0.20)	0.42	0.51	0.51	0.50 (0.20)	0.34 (0.24)	0.49 (0.16)	–
C22:6n-3	3.75 (1.25)	6.18 (0.14)	5.60	6.62	6.96	8.60 (2.70)	4.76 (1.70)	5.09 (1.27)	4.11 (3.64)
Σ n-3 PUFA	4.16 (0.82)	7.54 (2.49)	6.34	7.47	8.14	–	5.47 (2.17)	–	4.33 (3.64)
Σ n-3 LC-PUFA	4.12 (0.84)	6.71 (1.96)	6.33	7.46	8.12	–	5.44 (2.12)	5.65 (1.45)	4.28 (4.38)
C18:2n-6	7.10 (2.08)	7.00 (1.83)	8.34	6.99	7.01	9.30 (2.80)	7.42 (1.37)	6.83 (0.92)	6.21 (3.28)
C18:3n-6	0.08 (0.03)	ND	–	–	–	–	0.10 (0.14)	0.05 (0.03)	0.15 (0.27)
C20:2n-6	0.35 (0.37)	0.47 (0.24)	–	–	–	–	0.35 (0.08)	0.35 (0.04)	0.21 (0.23)
C20:3n-6	4.11 (0.84)	4.63 (1.12)	6.17	5.52	5.35	–	4.82 (0.83)	0.05 (0.03)	4.22 (2.69)
C20:4n-6	13.69 (1.73)	16.00 (2.38)	15.65	16.64	15.21	21.70 (3.30)	16.14 (2.49)	15.76 (1.30)	19.79 (11.09)
C22:2n-6	0.16 (0.15)	0.00 (0.05)	–	–	–	–	–	–	0.12 (0.11)
C22:4n-6	0.57 (0.12)	0.77 (0.18)	0.76	0.80	0.62	0.70 (0.20)	0.66 (0.21)	0.73 (0.17)	0.66 (0.46)
C22:5n-6	0.49 (0.45)	0.74 (0.46)	0.97	0.89	0.70	0.80 (0.80)	–	–	0.79 (0.59)
Σ n-6 PUFA	26.94 (2.26)	31.30 (4.86)	32.95	31.91	29.76	–	30.66 (2.75)	–	34.20 (18.31)
Σ n-6 LC-PUFA	19.14 (2.4)	22.88 (2.77)	23.56	23.85	21.88	–	22.55 (2.56)	21.75 (1.25)	26.59 (14.87)
C20:3n–9	–	–	0.52	0.48	0.64	0.30 (0.20)	0.48 (0.43)	–	–
Σ PUFA	–	37.26 (3.81)	–	–	–	–	–	–	–
Σ MUFA	11.54 (1.33)	11.89 (1.90)	12.65	12.61	13.28	–	13.36 (2.24)	12.91 (0.54)	14.44 (6.83)
Σ SAFA	57.13 (1.90)	49.57 (2.77)	46.07	47.00	47.59	–	49.93 (1.71)	49.38 (1.80)	48.78 (24.71)
Σ trans	0.81 (0.40)	0.51 (0.30)	–	–	–	–	0.21 (0.24)	0.69 (0.12)	1.19 (0.57)

Table 1 *Continued*

Country	Hungary	Italy	Netherlands	Netherlands	Netherlands	Netherlands	Netherlands	Spain	Sweden	USA
Year	1997	1996	1997	1995	2001	1991	1990	1986	1970	1996
First author	Otto	Houwelingen	Otto	Al	Ramp	Shouw	Al	De Lucci	Olegard	Jensen
No. of subjects	50	17	50	44	627	1991	15	20	20	17
Analytic column	Capillary	Capillary	Capillary	Capillary	Capillary	Packed	Packed	Packed	Packed	Capillary
Expression of data % by wt	mean	mean (SEM) [30]	mean	mean (SEM)	mean (SEM) [31]	mean (SEM)	mean (SEM)	mean (SEM)	mean (SD)	mean (SEM) % by mol
Total (mg/l)	699.3 (19.7)	556.1 (23.88)	571.1 (15.5)	–	590.4 (251.5)	–	–	–	–	–
C18:3n-3	–	–	–	0.07 (0.01)	ND	–	–	2.45 (0.68)	0.44 (0.11)	0.10 (0.05)
C20:3n-3	–	–	–	–	–	–	–	–	–	
C20:4n-3	–	–	–	0.09 (0.01)	–	–	–	–	–	
C20:5n-3	0.08	0.56	0.23	0.23 (0.01)	0.23 (0.00)	0.40 (0.06)	0.50 (0.14)	0.17 (0.04)	0.40 (0.31)	0.11 (0.05)
C22:5n-3	0.32	0.51	0.49	0.47(0.02)	0.47 (0.01)	1.90 (0.12)	1.40 (0.17)	0.23 (0.08)	0.50 (0.19)	0.21 (0.05)
C22:6n-3	5.23	6.96	6.49	6.18 (0.14)	6.21 (0.05)	7.40 (0.41)	6.70 (0.41)	3.60 (0.37)	6.80 (1.39)	3.94 (0.89)
Σ n-3 PUFA	5.71	8.14	7.32	–	7.04 (0.06)	8.70 (0.39)	8.60 (0.40)	–	–	–
Σ n-3 LC-PUFA	5.70	8.12	7.29	–	6.99 (0.06)	–	–	–	–	–
C18:2n-6	6.95	7.01	7.27	7.55 (0.11)	7.48 (0.05)	7.4 (0.45)	7.80 (0.30)	5.99 (0.38)	8.80 (1.31)	16.70 (3.70)
C18:3n-6	–	–	–	–	–	–	–	–	–	
C20:2n-6	–	–	–	–	–	–	0.32 (0.06)	–	–	
C20:3n-6	4.83	5.35	5.09	5.5 (0.07)	5.11 (0.03)	5.7 (0.35)	4.90 (0.31)	4.00 (0.40)	5.50 (0.75)	–
C20:4n-6	18.30	15.21	17.08	16.5 (0.13)	16.81 (0.06)	18.4 (0.05)	19.80 (0.51)	11.66 (1.07)	16.70 (1.40)	15.00 (2.40)
C22:2n-6	–	–	–	–	–	–	–	–	–	
C22:4n-6	0.10	0.62	0.81	–	0.80 (0.01)	–	–	1.87 (0.30)	0.70 (0.15)	0.48 (0.13)
C22:5n-6	1.43	0.70	0.83	0.82 (0.02)	0.85 (0.01)	1.1 (0.06)	1.30 (0.13)	0.72 (0.13)	0.60 (0.24)	0.89 (0.30)
Σ n-6 PUFA	33.63	29.76	32.18	–	32.12 (0.07)	33.8 (0.86)	35.60 (0.82)	–	–	–
Σ n-6 LC-PUFA	25.56	21.88	23.82	23.2 (0.14)	23.56 (0.06)	26.4 (0.66)	27.70 (0.69)	–	–	–
C20:3n–9	0.45	0.64	0.36	–	0.47 (0.01)	0.6 (0.05)	–	0.62 (0.18)	0.60 (0.39)	–
Σ PUFA	–	–	–	–	39.55 (0.07)	44.1 (0.87)	45.60 (0.97)	–	–	–
Σ MUFA	12.13	13.28	11.60	–	11.83 (0.07)	13.3 (0.37)	13.70 (0.46)	–	–	–
Σ SAFA	47.60	47.59	47.85	–	47.64 (0.06)	41.9 (0.79)	40.40 (0.96)	–	–	
Σ trans	–	–	–	–		–	–	–	–	

LC-PUFA long-chain polyunsaturated fatty acid, *PUFA* polyunsaturated fatty acid, *MUFA* monounsaturated fatty acid, *SAFA* saturated fatty acid. Σ n-6 PUFA = C18:2n-6 + C18:3n-6 + Σ n-6 LC-PUFA. Σ n-3 PUFA = C18:3n-3 + C18:4n-3 + Σ n-3 LC-PUFA. Σ n-6 LC-PUFA = C20:2n-6 + C20:3n-6 + C20:4n-6 + C22:4n-6 + C22:5n-6. Σ n-3 LC-PUFA = C20:3n-3 +, C20:5n-3 + C22:5n-3 + C22:6n-3. Σ MUFA = C16:1n-7 + C17:1n-7 + C18:1n-7 + C18-1n-9 + C20:1n-9 + C22:1n-9 + C24:1n-9. Σ SAFA = C12:0 + C14:0 + C16:0 + C17:0 + C18:0 + C20:0 + C22:0 + C24:0 or a part of these fatty acids. Σ trans = C16:1t + C18:1t + C18:2tt

The highest value of LA was observed in France [5] (median: 9.30 % by wt), whereas the lowest in Spain [13] (mean: 5.99 % by wt); in most populations LA values were around 7 to 8 % by wt. Numerical values for ALA were published in 7 of the 19 data sets. In one study, the median ALA value was zero with minimal interquartal distances. In 4 data sets, values of ALA were ≤ 0.1 % by wt [7, 9, 10] (4 data sets are mentioned but only 3 references are given, because reference 10 containes two different data sets). In contrast, de Lucchi [13] and Olegard [14] published mean ALA values of 2.45 % by wt and 0.44 % by wt, respectively. It should be noted that these classical studies [13, 14] were carried out using packed analytical columns.

The contribution of AA to cord venous blood phospholipids exhibited a nearly two fold variation: mean values as low as 11.66 % by wt in Spain [13] to median values as high as 21.70 % by wt in France [5] were described. Most studies reported AA values ranging from 15 % by wt to 17 % by wt. Values of DHA were ranged from 4.76 % by wt to 7.40 % by wt in 16 data sets, whereas the highest value was reported for France [5] (median: 8.60 % by wt), and the lowest values were described for Austria (median: 3.75 % by wt) and Hungary (median: 4.11 % by wt) within the same study.

Total values of the polyunsaturated fatty acids were published in only three of the studies. However, total n-3 and n-6 polyunsaturated fatty acid (PUFA) and n-3 and n-6 long-chain PUFA (LC-PUFA) values were reported in most of the published studies. The lowest n-3 PUFA values were found in Austria and Hungary [10] (median: 4.16 and 4.33 % by wt, respectively), whereas the highest value was seen in studies from the Netherlands [9, 15] (mean: > 8.5 % by wt). The n-3 LC-PUFA values presented similar variations as the n-3 PUFA values. In most data sets, the ranges of n-3 PUFA and n-3 LC-PUFA values were relatively small (5.44 to 8.14 by wt). n-6 LC-PUFA values ranged between 22 % and 27 % by wt and n-6 PUFA values ranged between 30 % and 35 % by wt; the lowest values of n-6 PUFA and n-6 LC-PUFA were observed in Austria [10] (median: 19.14 % by wt, median: 26.94 % by wt).

Discussion

LC-PUFAs are important for early human development; they represent essential constituents of biologic membranes and modulate such membrane properties as fluidity, permeability and activity of membrane-bound receptors and enzymes. LC-PUFAs play a decisive role in the synthesis of prostaglandins, leukotrienes and thromboxanes with various regulatory functions.

During pregnancy, the fetus is supplied with preformed LC-PUFA by placental transfer. The biochemical mechanisms involved in the underlying transport processes are not fully understood, and it is unknown to which extent maternal dietary intakes can effect the LC-PUFA transfer from the mother to the fetus. At birth, plasma lipids of mothers contain higher levels of the essential fatty acids ALA and LA than the cord blood lipids of their healthy term infants [12]. In contrast, percentage values for LC-PUFA are clearly and significantly higher in infants than in their mothers. These results point to a preferential and selective materno-fetal LC-PUFA transfer [16].

Placental transfer of fatty acids is a stepwise process with initial placental uptake of nonesterified fatty acids and fatty acids hydrolized from maternal triglycerides by lipoprotein lipase [17]. A portion of the fatty acids are esterified within the placenta, while the rest crosses the tissue to the fetal circulation without incorporation into lipids [17]. Several proteins have been proposed as being involved in the fatty acid movement across the placenta [18–22]. Only the placental plasma membrane fatty acid-binding protein (p-FABPpm) has been identified as having a significantly higher affinity and binding capacity for LC-PUFA (apparent binding capacity (Bmax) values for AA and DHA were 3.5 ± 0.11 and 4.0 ± 0.10 mol per mol of p-FABPpm, respectively) than for oleic acid and LA (2.1 ± 0.17, and 2.0 ± 0.14, respectively) [23]. There is no information available about the significance of cytosolic FABP in this process. Thus, p-FABPpm may be involved in the preferential uptake of LC-PUFA by the placenta but definitive evidence about the structure and function of p-FABPpm must await analysis of its complete amino acid and/or cDNA sequence. In relation to the different concentration of AA detected in cord blood relative to their maternal intake, it has been suggested that a compartmentalization of AA in the PL fraction of the placenta and later in PL of cord blood could be the mechanism for placental regulation of the transfer of this fatty acid [24]. There is evidence of a selective accumulation of ^{14}CAA relative to ^{14}CDHA in PL of placental choriocarcinoma cells (BeWo cells) (60 % vs. 35 %) [25]. The selective accumulation of AA in PL would inhibit their recrossing the placental barrier and thus they might be selectively retained in the fetal circulation; a similar mechanism could also be operative for DHA although this has to be confirmed.

Al et al. [26] observed that consecutive pregnancies were associated with a reduction in a so-called functional PUFA status (particularly that of DHA), i. e., multiple pregnancy may cause maternal DHA depletion. The observed decreases in maternal EFA and LC-PUFA statuses during consecutive pregnancies [11, 26] may also indicate a suboptimal PUFA status in the newborn. LC-PUFA requirements are particularly high during the third trimester of pregnancy, when the development of the central nervous system is very intense and fetal body stores are still poor. LA can be stored in adipose tissue and mobilized if necessary, but ALA and LC-PUFA con-

tents of adipose tissue stores are relatively low. Moreover, the total amount of adipose tissue in newborn and particularly in preterm infants is rather limited. It is also known that there are strong and positive maternal-fetal correlations for all EFAs and their LC-PUFAs [12, 16].

This review compares neonatal fatty acid status among different populations with potential differences in maternal dietary habits. Considering also the differences of applied analytical methods and genetic and environmental differences of study populations, mean or median fatty acid values of venous cord blood phospholipids showed surprisingly moderate variability in this review (Table 1). All data sets except the one from Austria [10] showed less than 50 % by wt contribution of total saturated fatty acids. The lowest and highest values of total *cis* monounsaturates (mean: 11.5 % by wt, median: 14.5 % by wt, respectively) were rather close to each other. In contrast, values of total *trans* isomeric fatty acids showed a large variability among the five data sets describing these data. *Trans* isomeric fatty acids can cross the placenta and interfere with the conversion of parent EFAs into their LC-PUFA metabolites [27–29]. Although the consumption of *trans* unsaturated fatty acids is decreasing in most Western countries [16], the negative association between *trans* fatty acids and LC-PUFA status deserves further attention. The significantly higher values of *trans* fatty acids in the Hungarian compared to German studies may represent the difference between the *trans* fatty acid content of the food consumed by the mothers.

Numerical values for LA showed very small variability. In contrast, ALA values were found within a very large range in the 7 data sets reporting ALA values. However, large differences were observed between results obtained by packed columns and the much more sensitive capillary columns. For comparison of the findings obtained by packed and capillary columns, we calculated a median value from reported venous cord blood phospholipid data derived from the 4 data sets obtained with packed and the 14 data sets obtained with capillary column, respectively (Table 2). (As Jensen et al. [7] presented their data in molar percentages, this data set was excluded from this calculation.)

The observed trend of a gradient from higher to lower n-3 LC-PUFA and n-3 PUFA values from Western to Central-Eastern European countries appears to reflect differences in dietary intakes of n-3 LC-PUFA. The main components of n-3 LC-PUFA are DHA and eicosapentaenoic acid. Diets in coastal countries like the Netherlands, Finland or Italy contain much more fish (rich in DHA), than those in Hungary or Austria. No apparent geographical differences were found in n-6 LC-PUFA values.

In summary, fatty acid composition of venous cord blood phospholipids shows relatively moderate differences among the data sets published during the last 30 years. However, marked variability was seen in the values of the biologically probably most important fatty acid, DHA. The differences found may be caused either by the different laboratory methods used or by the different dietary habits of the populations studied, or the combination of these factors.

Table 2 Median values and ranges calculated from phospholipid fatty acid data reported in studies on umbilical venous blood. Data obtained in studies using capillary chromatography are compared to those obtained in studies using packed column chromatography

	Capillary column n = 14 median (min-max)	Packed column n = 4 median (min-max)
C18:3n-3	0.05 (0.04–0.07)	1.43 (0.40–2.45)
C20:3n-3	0.23 (0.00–1.00)	–
C20:4n-3	0.09 (0.09–0.09)	–
C20:5n-3	0.23 (0.05–0.56)	0.40 (0.17–0.50)
C22:5n-3	0.49 (0.32–0.51)	0.95 (0.23–1.90)
C22:6n-3	6.18 (3.75–8.60)	6.75 (3.60–7.40)
Σ n-3 PUFA	7.04 (4.16–8.14)	8.65 (8.60–8.70)
Σ n-3 LC-PUFA	6.52 (4.12–8.12)	–
C18:2n-6	7.06 (6.21–9.30)	7.48 (5.99–8.80)
C18:3n-6	0.09 (0.05–0.15)	–
C20:2n-6	0.35 (0.21–0.47)	0.32 (0.32–0.32)
C20:3n-6	5.09 (0.05–6.17)	5.20 (4.00–5.70)
C20:4n-6	16.32 (13.69–21.70)	17.55 (11.66–19.80)
C22:2n-6	0.12 (0.00–0.16)	–
C22:4n-6	0.70 (0.10–0.81)	1.28 (0.70–1.87)
C22:5n-6	0.81 (0.49–1.43)	0.91 (0.60–1.30)
Σ n-6 PUFA	31.91 (26.94–34.20)	34.70 (33.80–35.60)
Σ n-6 LC-PUFA	23.20 (19.14–26.59)	27.05 (26.40–27.00)
C20:3n–9	0.48 (0.30–0.64)	0.60 (0.60–0.62)
Total n-3 + n-6 PUFA	38.41 (37.26–37.26)	44.85 (44.10–45.60)
Total monounsaturated	12.63 (11.54–14.44)	13.50 (13.30–13.70)
Total saturated	47.85 (46.07–57.13)	41.15 (40.40–41.90)
Total trans	0.69 (0.21–1.19)	–

LC-PUFA long-chain polyunsaturated fatty acids, *PUFA* polyunsaturated fatty acids. Σ n-6 PUFA = C18:2n-6 + C18:3n-6 + Σ n-6 LC-PUFA. Σ n-3 PUFA = C18:3n-3 + C18:4n-3 + Σ n-3 LC-PUFA. Σ n-6 LC-PUFA = C20:2n-6 + C20:3n-6 + C20:4n-6 + C22:4n-6 + C22:5n-6 Σ n-3 LC-PUFA = C20:3n-3 + C20:5n-3 + C22:5n-3 + C22:6n-3. Total monounsaturated = C16:1n–7 + C17:1n–7 + C18:1n–7 + C18:1n–9 + C20:1n–9 + C22:1n–9 + C24:1n–9. Total saturated = C12:0 + C14:0 + C16:0 + C17:0 + C18:0 + C20:0 + C22:0 + C24:0 or a part of these fatty acids. Total trans = C16:1t + C18:1t + C18:2tt

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