Pregnant women’s diet composition and transitional milk fatty acids: factor analysis

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Abstract

Introduction: The variation in the nutrients contained in the milk is the result of changes to the breast metabolism, placenta metabolism and the diet of pregnant women. Various factors influence fatty acid composition which are one of the major components of woman’s breast milk.

In our research, we wanted to determine the relationship between the components of the diet of and the transitional milk fatty acid composition mothers who delivered healthy full-term babies, preterm and small for gestational age neonates.

Materials and methods: The study group comprised of 95 healthy women who were divided into three sub-groups: mothers of appropriate for gestational age (AGA) neonates (group A); mothers of preterm neonates (group B); and mothers who gave birth to small for gestational age (SGA) babies (Group C). The women’s elements diet and the content of biochemical components were estimated based on the dietary questionnaire. The FAs in the mother’s milk were analyzed using GCMS chromatography. The results of the studies of the dietary components and fatty acids of the milk underwent factor analysis.

Results: In group A, 10 correlations (5 positive and 5 negative) were found between the components of the mother’s diet and the FAs in the milk (correlation varying from 0.285 - 0.366). In group B, only negative correlations were observed and these had higher absolute correlation values (0.354-0.500). The most correlations between dietary components and FAs in the milk were found in group C (0.537 - 0.800).

Conclusion: Nature of the correlations between the variables examined in groups A, B and C are different.

Key words: transitional milk / fatty acids / preterm infants / SGA infants / AGA infants / factor analysis /
Introduction
A woman’s diet is said to be the most important factor in determining the components of breast milk. Various factors influence the nutritional value of the milk, including the mother’s dietary habits, the method of feeding, caloric content of food and the mutual proportions of particular dietary components [1, 2]. One of the most important components of breast milk is fat. Fatty acids in particular are responsible for the correct development of a child’s nervous system. They are also essential for the metabolism of neuron membranes and other cells as well as general biochemical metabolism [3-5]. The mammary glands need substrates for milk biosynthesis. The main source of those substrates is the diet because they are taken directly from the peripheral blood which distributes recently consumed components. Another source of substrates is tissue deposits. Their composition reflects the mother’s diet over the last few weeks and even months. Out of all the dietary components, fats, proteins and carbohydrates have the greatest influence on the composition of fatty acids in the mother’s milk. Fats included in the diet are used directly, albeit partially, as fatty acid precursors. These include fatty acids of different chain lengths and different saturation degrees [6-7]. Fatty acids (FA) may also be produced as the result of indirect transformations of non-fat compounds such as proteins and carbohydrates. The process of adjusting the composition of the milk according to the degree of development and/or maturity of the foetus and the child’s condition at any given time is extraordinarily complex and is probably initiated during the gestation period [2]. The quantity and mutual proportions of FAs in the milk may be regulated according to the child’s changing needs.

So far, neither the FA composition of the milk nor the diet composition changes occurring in mothers who gave birth in the period of time immediately preceding 38 weeks of pregnancy and in mothers whose children were born at term SGA have been analyzed.

The FA metabolism of breast milk at the interface of physiology and pathology of pregnancy is therefore not known. It is also not known relationships between the diet and transitional milk of mothers of AGA, SGA and preterm neonates. Therefore the objective of the study was to analyze the influence of a mother’s dietary intake on the fatty acid composition of her transitional milk.

Materials and methods.
Study population
The study group consisted of 95 women selected randomly out of a total of 1,856 women who gave birth at the Provincial Specialist Hospital nr 1 in Tychy, Poland, in 2007. All the participants gave their written consent to take part in the research program. Women who participated in the research program were classified into three groups according to the following criteria:

Group A (n = 52): healthy mothers, routine and uneventful pregnancy, full-term delivery neonates (bw 10th – 90th percentile);
Group B (n = 31): mothers who gave birth prematurely between 35-37 weeks (bw 10th – 90th percentile);
Group C (n = 12): mothers who gave birth to full-term but small for gestational age (SGA) neonates (bw <10th percentile) (Table I).

The following exclusion criteria were applied to potential study participants:

• chronic diseases;
• pathologies during the course of pregnancy such as gestational high blood-pressure, infections during pregnancy, miscarriages and/or premature birth resulting in the death of the child, developmental anomalies in the foetus;
• AIDS and sexually transmitted diseases;
• lack of the mother’s consent to take part in the research program or withdrawal of consent during the study;
• children whose weight exceeded the 90th percentile (LGA).

The first ultrasound examination of pregnant women was performed between the 12th and 14th weeks of gestation, the second one between the 20th and 22nd weeks and the third one in the 32nd-33rd week. SGA neonates were identified and defined by the third and final ultrasound performed during pregnancy. Fetuses with in utero abdominal measurements below the 10th percentile
Table I. Characteristic of the studied population. Results are mean (±SD).

<table>
<thead>
<tr>
<th></th>
<th>AGA (A)</th>
<th>Preterm (B)</th>
<th>SGA (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>26.6 ± 4.7</td>
<td>27.7 ± 3.7</td>
<td>29.0 ± 5.1</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.7 ± 3.8</td>
<td>23.2 ± 4.1</td>
<td>23.1 ± 4.8</td>
</tr>
<tr>
<td>Delivery (wk)</td>
<td>39.2 ± 1.2</td>
<td>34.65 ± 1.1</td>
<td>38.0 ± 1.0</td>
</tr>
<tr>
<td>Neonatal weight</td>
<td>3535.9 ± 392.9</td>
<td>2402 ± 424.5</td>
<td>2297 ± 158.9</td>
</tr>
<tr>
<td>Placental weight</td>
<td>499.2 ± 103.1</td>
<td>320.4 ± 98.6</td>
<td>358.6 ± 82.8</td>
</tr>
<tr>
<td>Mode of delivery</td>
<td>42n/12cs=54</td>
<td>21n/11cs=32</td>
<td>12n/11cs=23</td>
</tr>
<tr>
<td>Apgar score</td>
<td>9-10</td>
<td>9-10</td>
<td>9-10</td>
</tr>
</tbody>
</table>
Results

Based on factor analysis, 9 factors for the dietary components were determined and 8 factors for the fatty acids in the mothers’ transitional milk were determined.

The first dietary factor that was identified (Table IV) consisted of 11 fatty acids (FL>0.7), out of which C12:0 (FL=0.945) had the highest value. C12:0 was therefore assigned to the correlation studies. In the other remaining factors - 2, 3, 4, 5 and 6 - the variables singled out for study were: folic acid (0.826), C20:5 (0.961), C18:3 (0.806), a percent of energy coming from carbohydrates (-0.833) and beta carotene (0.951). The remaining three factors studied were – 7, 8 and 9 – and were represented by the single variables: lactose (0.833), alcohol (0.724) and animal protein (0.736).

The first factor of the transitional milk that was identified (Table V) consisted of 4 fatty acids (FL>0.7), of which C20:1 (0.881) had the highest value. As far as the second factor was concerned, no variable out of the several dozen analysed reached FL>0.7. In factors 3 and 7 the variables designated to undergo correlation studies included C12:0 (0.894) and C24:0 (0.742). Factors 4, 5, 6 and 8 also underwent correlation studies, represented by the single variables C16:1 (0.843), C13:0 (0.940), C18:3n3 (0.800) and C18:1t (0.708).

All the above-mentioned dietary components and fatty acid components of transitional milk underwent correlation analysis in every studied group. In group A, 10 statistical correlations were identified at the level of significance P<0.05 (Figure 1).

These 10 correlations involved 7 dietary components and 5 components of the transitional milk. The dietary components correlated negatively with the fatty acids in the transitional milk in the following configurations: animal protein (AP)&C18:1t, AP&C20:1, C12:0&cC20:1, C20:5&C13:0 and alcohol&cC13:0.

The remaining dietary components correlated positively with the transitional milk FAs in the following configurations: C12:0&C12:0, total fatty acids (TFA)&C12:0, C18:3&C12:0, percent of energy coming from carbohydrates (PEC)&C20:1 and PEC&C24:0. The absolute correlation coefficient values ranged between 0.285-0.366.

In group B, 6 statistically significant correlations were identified at the level of significance P<0.05 (Figure 2). They included 3 dietary components and 3 components of the transitional milk. In all the analyzed cases the dietary components correlated negatively with transitional milk FAs in the following configurations: animal protein&C18:3n3, C12:0&C20:1, C12:0&C24:0, TFA&C18:3n3, TFA&C20:1 and TFA&C24:0. In group B the absolute correlation coefficient values were higher than in group A and ranged from 0.354 to 0.500.

In group C (similarly to group A), 10 statistically significant correlations were obtained at the level of significance P<0.05 (Figure 3). They included 5 dietary components and 3 components of the transitional milk. The dietary components correlated negatively with transitional milk FAs in the following configurations: AP&C18:1t, AP&C24:0, C12:0&C18:1t, C12:0&C24:0, TFA&C18:1t, TFA&C24:0, C18:3&C24:0, lactose (LAC)&C18:1t and LAC&C24:0. There was only one positive correlation observed in the following configuration LAC&C16:1. The absolute correlation coefficient values in group C were the highest of all the groups studied and ranged between 0.537-0.800.

The dietary elements and transitional milk FAs selected using factor analysis revealed a different number of correlations in each group studied. In the case of the dietary components, the components which correlated the most frequently were C12:0 (6 times), TFA (6 times) and protein (5 times). As far as fatty acids in the milk were concerned, the ones which correlated the most often were C24:0 (8 times), C20:1 (5 times) and C18:1t (5 times). The dietary components did not correlate evenly across the three
groups (A, B and C). This phenomenon was most noticeable in the case of C12:0 and C13:0 which only correlated with FAs in group A. C18:3n3 correlated twice only in group B. C24:0 correlated 8 times altogether, 5 times in group C. 4 out of the 5 C18:1t correlations were found in group C. It must be added here that it was only in group C that a correlation between lactose in the diet and transitional milk FAs was evident.

The studies also showed differences in the degree of saturation and the chain length of the correlating milk FAs. Medium chain saturated acids correlated five times (all cases occurring in group A), long chain saturated acids correlated eight times, whereas long chain monounsaturated fatty acids correlated eleven times. Five out of the eleven incidences were connected with trans isomer FAs. Finally, polyunsaturated acid only correlated with the dietary components in two cases (both incidences occurring in group B).

**Discussion**

The results of previous studies have proven that the composition of fatty acids in the transitional milk depends not only on fat (including fatty acids in the diet) but also on other dietary components [5, 9-15]. The aim of our study was to investigate how various components of the maternal diet shape the fatty acid composition of breast milk. Factor analysis was used to analyze the data and this made it possible to identify the most significant dietary components and fatty acids in the transitional milk. The most significant dietary components included some selected FAs, folic acid, PEC, beta-carotene, lactose, alcohol and animal protein (Table IV). Similarly, in the case of the transitional milk, factor analysis identified the most significant fatty acids (Table V).

The correlated data showed some statistically relevant relationships between the dietary components and the fatty acids in the transitional milk in every group studied. The value and the direction of interactions of the variables differed between the groups. However, similarities were found within each group that was investigated.

The differences between the groups studied concerned the values of the correlation coefficients. The lowest values were observed in the group of mothers who gave birth to AGA neonates (group A). Their levels varied from 0.285 to 0.366. Higher correlation coefficient values were observed in the group of mothers who delivered prematurely (group B). The correlations observed in this group had an absolute value of between 0.362-0.500. The highest correlation coefficient values (with levels varying from 0.537 to 0.800) were observed in the group of mothers who gave birth to SGA neonates (group C). The study groups also differed
in a sign of correlated components of the diet and FAs of the breast milk. In group A, half of the correlations were positive and the other half were negative (Figure 1). In groups B and C, all correlations with the exception of one were negative (Figure 2). In no case was there any repetition of the correlated pairs across any of the three groups studied. Only in groups B and C were two cases observed that involved the same pairs of correlated compounds. These related to C12:0 and TFA in the mother’s diet and C24:0 and C20:1 in the transitional milk. In both cases, the correlations were negative.

The results of our studies indicate that the nature of the correlations between the variables examined in groups A, B and C are different. However, there are some similarities within the last two groups. This applies to both the direction of the correlations (almost all of them are negative) and in some cases identical pairs of correlated compounds. The mothers in groups B and C were those who gave birth prematurely but with a small degree of prematurity, and those who gave birth to children small for gestational age (SGA) at term, respectively. Thus, both groups appear to be similar in terms of the pathology of pregnancy - their degree is low. Analyzing the dynamics of changes in the composition of transitional milk, based on our results and in the context of literature data, it can be concluded that even "late prematurity" and SGA are sufficient stimulus for secretion of transitional milk of a modified composition. Moreover, nature of correlations between variables examined in groups A, B and C are different. It probably kind of adjustment of the composition of breast milk to the child's needs dependent at least partly of diet of mothers [16-17]. Preterm and SGA neonates have enzymatically underdeveloped digestive system so they cannot degrade many compounds with great efficiency [18-22]. The different correlation profiles between the groups may be explained not only by maternal diet during pregnancy but also by differences in placental function [23-26]. Referring the obtained results to well-known biochemical mechanisms considered in the context of not only maternal mammary gland or placenta, but also systemic processes in the mother and her child, it is difficult to explain the mutual relations between the numerous components presented in Figure 1-3.

It cannot be excluded that factor analysis has revealed the existence of hitherto unknown relationships between the dietary components of mothers and the fatty acids contained in their breast milk. In order to better understand the relationship between maternal diet and breast milk FAs, further research using factor analysis is required.

**Conclusion**

Nature of the correlations between the variables examined in groups A, B and C are different.

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**References**


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