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Research Article

Diet Profile and Metabolic Parameters from Birth to 6 Months among Fullterm and Preterm Infants Diet and Metabolic Changes among Infants

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Abstract

Background: Phenotype expression in adulthood is closely related to lifestyle, particularly eating habits in early childhood. In addition, children born prematurely are subject to metabolic complications that lead the early onset of chronic diseases such as hypertension and diabetes.

Aim: To correlate the dietary profile of premature and term infants and theirrelationship with plasma biochemical parameters from birth to six months of life.

Method: It is a secondary data analysis study, based on the variables collected at birth (T0) and the 6-month follow-up (T1) of term infants (n=73) and premature infants (n=39).

Analyzed variables: Weight, type of food intake, adequacy of birth weight, gestational age and, biochemical tests (triglycerides, cholesterol, glucose, and insulin). The study sample consisted of premature and term infants, classified about birth weight and gestational age.

Results: Glucose and triglyceride values between the two evaluated groups were influenced only by the gestational age ($p<0.01$). Premature infants have higher triglycerides concentration (T0–T1=57.97 ± 87.65) then the term ones (T0-T1==7.97 ± 68.66). Predictors regarding the adequacy of birth weight and dietary types did not influence glucose and triglyceride variation. However, the baby's diet based on vegetables ($p=0.047$), and born prematurely ($p<0.01$), exerted influence on the variation of insulin and cholesterol in the evaluated period.

Implication for practice: The intake of vegetable soup showed an increase in insulin and cholesterol concentrations, regardless of a preterm or term birth. Preterm infants are more vulnerable to lipid changes at six months when compared to term babies.

BACKGROUND AND SIGNIFICANCE

Prematurity is a global problem that contributes significantly to infant mortality, being the most frequent cause of neonatal morbidity [1]. The survival of Premature (PT) and low birth weight infants has increasing and some repercussions of this condition have been identifying in short and long term, such as metabolic changes throughout their lives.

Notably, premature births seem to have a greater tendency to develop obesity and overweight in adolescence, with a higher risk for arterial hypertension, glucose intolerance, and dyslipidemia in adolescence and adulthood [2].

These changes could lead the early onset of chronic diseases, for example, hypertension and diabetes. Literature evidences have shown that the phenotype expression in adulthood can be closely related to lifestyle and may particularly be affected by eating habits [3]. The relationship between prematurity and the onset of diseases in adulthood refers to the concept of metabolic programming [4], considered an event that occurs in critical stages of development (intrauterine, lactation, and adolescence) favoring the installation of comorbidities in adulthood.

These repercussions in adulthood can be reduced by continuous care strategies, from hospitalization to home. One of these strategies refers to the maintenance of exclusive breastfeeding until the sixth month of PT corrected age, as recommended by the World Health Organization (WHO). It is the ideal food for promoting healthy growth and development, considered a protective factor for the health of the PT infant, since it provides adequate weight gain, harmonic growth, and prevents problems such as Metabolic Syndrome – MS [5]. Therefore, it is desirable that at six months of age, childrenare still exclusively breastfeeding. However, PT infants are significantly more likely to be introduced to complementary foods early compared with term infants [3]. The establishment of metabolic reference parameters for young children is still not well defined in the literature. Therefore, a more detailed analysis about this group requires a characterizing of their entire development, including the dietary profile, with the metabolic and health condition. Thus, the study question is: there is a correlation between the glycemic and lipid profile of term and PT infants with feeding received from birth to six months of life? The study aiming to correlate the dietary profile of PT and term infants and their relationship with plasma biochemical parameters from birth to six months of life.

METHODS

Studies carried out recently with term [6] and PT [7], infants in the west of Paraná, Brazil, show that the lipid profile of these babies was altered at six months of age. The primaries studies [6,7], were developed by a prospective cohort study from birth to six months of age for term infant and sixth month of corrected age for PT infant. Longitudinal evaluation of anthropometry measures and blood samples of triglycerides, total cholesterol, glucose and insulin obtained at birth and the six months of age. In both groups, the triglyceride values were above what was indicated by the consensus of clinical analyzes without fasting [8,9].

Furthermore, these studies [6,7], did not evaluate the relationship among the infant's feeding and their lipid and glycemic profile. The influence of food, especially breastfeeding, is evidenced as a protector against the development of metabolic changes, such as diabetes mellitus [5]. Thus, using the primary research database [6,7], it was proposed to analyze secondary data, aiming to correlate the dietary profile of PT and term infants and their relationship with plasma biochemical parameters from birth to six months of life. So, the study was quantitative research, with secondary data analysis [10].

Sample

The PT infant group includes those with less than 37 weeks of Gestational Age (GA), child birthed in the field study hospital, who remain in the NICU for a period equal to or superior than seven days and returned to the outpatient clinic during follow-up visits scheduled. The group of term infants (TI) included every newborn birthed in the hospital under study, with mothers without metabolic changes or underlying diseases diagnosed until delivery, who attended the follow-up appointment scheduled for the sixth month of life.

In both sample groups were included the infant who born with intrauterine growth restriction (IUGR). All the newborn infants with some congenital malformation, born from adolescent mothers or diabetic mothers were excluded of the sample in both primary studies. The sample consisted of 82 term and 115 PT infants, included in primary studies at birth. At six months, there was a loss in the follow-up and the sample consisted of 73 term and 39 PT infants, of both sexes. The follow-up sample lost in the term group was 11% and in the PT group was 66%. This lost occurred due to the study participants did not attend a scheduled visit to the outpatient clinic for data collection, even after three appointments scheduled or loss of participant contact because the telephone change of the PT infants' parents or death among the PT infant group participants.

Instruments and Variables

The variables collected were related to the moment of birth (Time zero - T0), and the follow-up at six months after birth (Time 1 - T1), and included: body weight (grams -g); type of food intake at home (fruit-based diet – included all kind of fruits; sweet-based diet – included sugar in the meal preparation; vegetable soup – included all kind of vegetables in the diet plus oil; protein-based diet – different types of meats; carbohydrate- based diet – included all kind of carbohydrate; only breastfeeding; formula fed; mixed diet – included breastfeeding plus formula or some kind of meal), This information was obtained through mother interview; birthweight classification; gestational age (GA in weeks), and biochemical tests - glucose (mg/dL), triglycerides (mg/dL), total cholesterol (mg/dL), and insulin (UI/mL).

In both primary studies, biochemical tests followed the same methodology: glucose, triglycerides, cholesterol, and insulin blood samples were collected from 24 to 72 hours after birth and at six months. These samples were analyzed for the institution laboratory by dry chemistry method with 10mg/dL of sensibility for the triglycerides, 20mg/dL for glucose and 50mg/dL for cholesterol. The insulin exam was analyzed by electrochemiluminescence method with 0,03nUI/mL of sensibility. The data regarding food introduction was obtained through interviews with mothers in the follow-up consultation.

Premature and term infants evaluated were classified as Appropriate for Gestational Age (AGA), considered those among the percentiles 10 and 90; Small for Gestational Age (SGA), classified as less than the 10th percentile and Large for Gestational Age (LGA), those greater than the 90th percentile. PT infants were assessed in the follow-up according to the corrected gestational age to enable comparison with the group of term infants. The PT infant group include infants born from 24 to 36 weeks. The term infant group include infants from 37 to 41 weeks.

Statistical analyses

The sample was characterized by descriptive statistics when comparing both groups of term and PT infants. Once this procedure was carried out, statistical tests were applied to measure the effect of predictors (the type of diet, birthweight classification and birth GA) in the variation of glucose, triglycerides, cholesterol, and insulin. The average variation was performed by the equation:

Variation = (value of the variable in Time 1 - value of the variable in Time 0).

Due to the lack of homoscedasticity of such values (Bartlett's test) and the normality of the residues (Shapiro-Wilk test), Analysis of Variance (ANOVA) was used. Followed by the multiple comparison test of Boostrap averages, with 1000 permutations [15]. For all tests used, the level of significance considered was p<0,05. The hypothesis tested at ANOVA were presented in Table 1.

The statistical software used was R [11], with the help of ExpDes.pt packages [12,13]. The primary studies were approved by the Research Ethics Committee at State University of Parana western – Unioeste, under process No. 1.134.712. The informed consent form was read and signed by parents or guardians prior to start the study data collection.

RESULTS

Related to the sex among 82 term infants at birth, 44 (53.66%), were male and 38(46.34%), were female. Of the total sample in the PT infants group, 48 (41.74%), were male and 67 (58, 26%) were female at birth. At the sixth month, 18 (46%), PT and 39 (56,5%), of the TI infants were exclusively breastfed. Therefore, in the PT infant group most of them had already introduced complementary feeding before the six months of corrected age. Comparing the average variation of glucose (F = 10.96, DL = 1, p <0.01) and triglycerides (F = 10.68, DL = 1, p <0.01), between the predictors, only the birth variable was statistically significant. Predictors related to the birthweight classification and types of diet did not influence these variables, between the period T0 and T1 for both groups (Table 2).

Children in the TI group tended to increase glucose values between T0 and T1, with an average variation of 15.77 ± 20.35 (Table 2). On the other hand, in the PT infant group, there was drop-in blood glucose between T0 and T1 with a variation of -0.23 ± 30.11mg/dL (Table 2). The TI group tends increase their glycemic averages, in contrast to PT infants, who did not show vast variance during the follow-up. The PT infants presented significantly higher triglyceride variation averages than the TI group (Table 2).

Regarding the insulin variable, the predictive variables 'birth' (F = 17.29; DL = 1; p <0.01), and 'vegetable soup' (F = 4.01; DL = 1; p = 0.047), were statistically significant. No other diet (exclusive breastfeeding, mixed or formula) or the birthweight classification had any effect on the variation of insulin.

In general, PT infants showed a decline in insulin values from T0 to T1 when compared to the TI group, which showed an increase in means for this variable (Table 3). Independently of being born term or preterm, children who did not consume a vegetable soup diet tended to decrease their insulin values when compared to ones who ate such feeding. That variation showed stability over the analyzed period (Table 3).

For the total cholesterol variable, the predictors T0 (F = 27.45; DL = 1; p <0.01), and vegetable soup diet (F = 3.88; DL = 1; p = 0.035), were statistically significant. No other diet (exclusive breastfeeding, mixed or formula), or birthweight classification, had any effect on the cholesterol variation (Table 3).

Table 1: Predictors considered for effect under the variable's lipid and glycemic responses. Brazil, 2018.

Mean variation	Predictors	Answer variables
Mean variation =	Birth (term or preterm)	Glucose,
Time 0 (birth) - Time	Birthweight classification	Triglycerides,
1 (6 months after	- Food: fruit-based diet, sweet-based diet,	Cholesterol,
leaving the hospital)	vegetable soup, protein-based diet,	Insulin
	carbohydrate-based diet	

Table 2: Mean ± Standard deviation (n-1) of the variable glycemia and triglyceride in relation to the variable birth and six months. Brazil, 2018.

Evaluation periods	Blood Glucose Average (mg/dL)		p-value
	PT	TI	
	n=39	n=73	
T0 (Birth) **T1 (6 month after birth)**	86.31 ± 29.08 86.08 ± 14.33	63.15 ± 18.68 78.92 ± 9.56	
Average variation (T1– T0)	-0.23 ± 30.11[a]	15.77 ± 20.35[b]	<0.01
Evaluation periods	**Triglicerydes average(mg/dL)**		**p-value**
	PT	**TI**	
	n=39	n=73	
T0 (Birth)	97.72 ± 56.93	123.178 ± 49.89	
T1 (6 month after birth)	155.69 ± 75.79	131.15 ± 49.30	
Average variation (T0 – T1)	57.97 ± 87.65b	7.97 ± 68.66a	<0.01

Reference values: Glucose – 145 mg/dL (hyperglycemia); <45 mg/dL (hypoglycemia); Triglycerides - <75mg/dL (fasting); 85mg/dL (no fasting), for age between 0 to 9. Letters "a" and "b" indicate that the meanings are different in the line.

Children in the PT infant group tended to have significantly higher averages of variation in the serum concentration of total cholesterol compared to the TI group. Regarding vegetable soup diet, independently of the group, those who presented this diet also showed significantly higher variation averages when compared to those who did not receive it.

DISCUSSION

When correlating the glycemic and lipid profile of term and PT infants with the kind of food received from birth to six months of life, the researchers observed that to be a preterm or term infant at birth influenced the glucose and triglycerides values. Also, insulin was only influenced by the type of complementary diet. Besides, total cholesterol was affected by premature birth and the introduction of a vegetable soup diet. Independently of being a term or PT infant, those who were on complementary feeding with the introduction of vegetable soup were more susceptible to having their serum total cholesterol values higher than those who were exclusively breastfeeding, mixed or with formula.

Thus, being born term or preterm was a statistically significant predictor of the glucose and triglyceride variation. The birthweight classification in SGA or AGA did not influence the concentrations of triglycerides and glucose in our study. Similar data was shown in other studies [14-16]. In contrast, this relationship was identified as a predictor for changes in triglycerides at earlier periods, such as at birth or one year of age [17,18].The term infants tend to increase their glycemic averages from T0 to T1, in contrast to PT infants, that did not show wide variation between birth and six months. Possibly, it may occur due to the immaturity of the PT infant enzyme and endocrine mechanism, in which hypoglycemia can commonly occur at birth [19].

Table 3: Mean ± Standard deviation (n-1) of the variable insulin and total cholesterol in relation to the variable birth and six months after birth and the variable vegetable based-diet. Brazil, 2018.

Evaluation periods	**Insulin (UI/mL)**		
	PT	**TI**	**p-value**
	n=39	n =73	
T0 (Birth)	10.08 ± 12.95	2.00 ± 1.77	
T1 (6 month after birth)	5.17 ± 4.58	3.95 ± 3.74	
Average variation (T1– T0)	-4.91 ± 13.28[a]	1.95 ± 3.58[b]	<0.01
	Vegetable soup		
	PT	**TI**	
Evaluation periods	No (2)	Yes (1)	**p-value**
	n=38	n=73	
T0 (Birth)	6.15 ± 10.88	4.05 ± 7.04	
T1 (6 month after birth)	3.36 ± 3.02	4.90 ± 4.45	
Average variation (T1– T0)	-2.79 ± 10.92[a]	0.85 ± 7.34[b]	0.047
	Total Cholesterol (mg/dL)		

Reference values: Insulin - 2,6 a 24,9 uUI/mL; Total Cholesterol - <170mg/dL, independently of fasting or not for the age of 0 to 2years. Letters “a” and “b”, indicate that the means are different in the line.

In addition, neonates have poorly developed regulatory mechanisms to combat hypoglycemia. In a hypoglycemic state, the protective effect of the newborn will occur, generating a reduction in insulin secretion and an increase in glucagon, epinephrine, growth hormone and cortisol secretion. This reaction will lead to the production of glucose and the mobilization of fatty acids from adipose tissues [20].

Related to triglycerides, being born prematurely was a predictor that influenced this concentration. Moreover, preterm had higher serum values than term infants. This may come from the type of nutrition that PT infants receives during hospitalization, which is rich in calories to promote and achieve growth catch-up [21].

Therefore, early nutrition is a key factor in growth and metabolism, but certainly not the only one. Study [25], suggests that the introduction a high protein diet but not more calories. In other words, enriched food before discharge, can prevent the excessive accumulation of fat and the long-term health risks of the PT infants. Regarding the insulin variation, it was found that for PT infants the values were higher than for the TI group. However, PT infants showed a decline in serum concentration from T0 to T1, while TI infants showed an increase in values at the same period. This drop-in serum insulin concentration in the PT infant group, according to a study by the Pediatric Endocrinology Society [22], occurs as a defense of the organism to maintain adequate glucose concentrations.

The findings showed that PT infants tended to have significantly higher mean total cholesterol variation compared to the TI group. Literature shows that the initiation of breastfeeding can raise cholesterol levels during the first six months. Since breast milk has a higher concentration of cholesterol than formula milk, however, in the long term, breastfeeding has benefits on lipid metabolism in adulthood [23]. Likewise, being born AGA for PT infant is a protective factor for metabolic changes at the age of two years corrected [24].

Furthermore, both fetal and child growth are related to cholesterol metabolism programming in premature children [25]. Besides, investigations correlating infant’s type of diet to insulin and cholesterol concentrations are scarce or inconclusive. A study [26], suggests that research should be developed to assess the needs of TI and PT infants for long-chain polyunsaturated fatty acids, the sites of action and the clinical effects of lipid mediators on immunity and inflammation, its role in metabolic, neurological and immunological outcomes and the mechanisms by which lipids act in the short and long term health.

Thus, the serum concentrations of total cholesterol and insulin were related to the vegetable soup diet in the period evaluated. This relationship may be due to the type of feeding that PT infant receives at hospitalization. While TI usually receives only breast milk, considered protective for such metabolic changes, PT infant receives numerous interventions, such as the inclusion of catecholamine infusions to increase and hydrocortisone to promote blood pressure, which contribute significantly to the common physiological disorders in these infants. These factors also produce a highly variable gastrointestinal function in the intestinal motility of the PT infants. Moreover, they make use of antibiotics, which contribute significantly to changes in the intestinal microbiota and in the ability to effectively manage enteric nutrients but still little analyzed [26].

Another point is that the parenteral nutrition alone already promotes changes in enteral feeding, as it reduces gastrointestinal villous development, decreases the production of digestive enzymes, reduces the exudation of incretins (intestinal hormones, such as glucagon-like peptides 1 and 2), that promote insulin secretion [27,28]. In this sense, all these interventions happened during hospitalization could produce different effects on biochemical parameters during the PT infant follow-up.

This study identified that the complementary diet introduced based on vegetable soup, for both groups, proved to be statistically significant for the values of total cholesterol and insulin. So, mothers of these infants were not following the WHO guidelines to breastfeed their babies exclusively until the six months. In this way, the data noticed that among the infants the weaning occurred early, mainly in the PT infant group. This observation is worried due to the exclusively breastfeeding has a protective effect against obesity and cardiovascular disease in the adulthood [29]. Therefore, in the follow-up of children in health units, attention should be dedicated encouraging the exclusive breastfeeding until to six months and after this period to include the complementary diets.

It is noteworthy as a limitation of the study the total cholesterol fractions were not analyzed, as well as, the sample size was small due to the significant loss in the follow- up. Therefore, new studies need to analyze the influence of the diet as vegetables-soup in the infant metabolic profile

The significance for nursing practice is to comprehend that prematurity is a predictive factor for lipid changes (total cholesterol and triglycerides). Besides, vegetable soup influenced the values of insulin and total cholesterol, independently to be preterm or term infant. Thus, during the follow-up appointment the nursing professional should ask mothers about the PT infant feeding. It is recommended in evaluations of children during the postnatal follow-up, as a routine checking about their lipid and glycemic profiles and the type of diet introduced at six months.

According to the literature [3,21,30,31], points out, being born prematurely can contribute to the future development of cardiovascular and metabolic problems. Based on this evidences and changes in total cholesterol and triglycerides throughout the first months of life, identifying in our results, the preterm birth is a possible marker for future metabolic alteration among preterm infants.

Finally, it is encouraging the maintenance of exclusive breastfeeding up to six months to reduce the early introduction of complementary feeding. Then, health professionals who accompany these children must provide support and guide the family in preparing complementary food.

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