Available online at http://www.journalijdr.com

ISSN: 2230-9926

IJDR

International Journal of Development Research
Vol. 07, Issue, 09, pp.15459-15465, September, 2017

ORIGINAL RESEARCH ARTICLE **OPEN ACCESS**

GLICEMIC, LIPIDIC AND ANTHROPOMETRIC CORRELATIONS AMONG MOTHERS AND FULL-TERM NEWBORN BABIES

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ARTICLE INFO

Article History:
Received 14th June, 2017
Received in revised form
28th July, 2017
Accepted 09th August, 2017
Published online 30th September, 2017

Keywords:

Glycaemia,
Lipid,
Pregnancy,
Newborn,
Anthropometry.

ABSTRACT

The study aimed to characterize the glycemic and lipid plasma profile of the binomial mother/full-term newborn, at birth and at six-month-old. Too it was evaluated whether the maternal anthropometric and biochemical conditions are correlated with those of the newborn babies. This is a quantitative, descriptive and observational research. Data collection with 162 mothers/full-term newborn babies at birth, in the maternity and at six-month-old, at the follow-up ambulatory, with 69 children, in a university hospital in western Parana. Laboratory tests were performed on blood samples: glucose, insulin, total cholesterol and triglycerides. Data analysis were performed by descriptive and inferential statistics. For the newborn infant, only body mass index and triglycerides presented similar averages at birth and at six-month-old. It was observed that the growth scores of the newborn infants are influenced by the anthropometric variables of the mothers ($p < 0.05$). Likewise, the biochemical dosages of the newborn babies are influenced by the same maternal dosages ($p < 0.10$). The glycemic characterization was in agreement with the expected parameters. However, in the lipid characterization, only the total cholesterol, because the triglycerides were above the desirable levels. Thus, it is suggested that it may have occurred a programming of maternal characteristics in newborn infants.

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Citation: Hugo Razini Oliveira, Beatriz Rosana Gonçalves de Oliveira Toso, Ana Tereza Bittencourt Guimarães *et al*. 2017. "Glicemic, Lipidic and Anthropometric correlations among mothers and full-term newborn babies", *International Journal of Development Research*, 7, (09), 15459-15465.

INTRODUCTION

Birth is an expected moment of satisfaction for parents who see this process being developed in a condition of normality (Borsa, 2007; Maldonado, 2013). Since gestation is a physiological phenomenon, its evolution happens, predominantly, without intercurrences, therefore, denominated low risk (Buchabqui *et al*., 2011). Among the physiological changes that occur during the gestational period, there are those related to changes in glycemic and lipidemic levels (Ribas *et al*., 2015). Nutritional or hormonal changes, which may occur during the gestational period (considered critical period of development), can affect the individual metabolism and predispose to the onset of diseases in adult life, a phenomenon known as metabolic programming (Luo *et al*., 2010). Thus, early identification of clinical or metabolic conditions, which may be associated with health problems throughout life, can be a great ally in preventive treatment, such as counselling, changes in lifestyle, all of them related to eating habits and physical activities. According to Ferreira *et al*. (2011), it is necessary to develop easily applicable, accurate and low-cost diagnostic measures in order to predict the existence of metabolic syndrome in the child population. It is emphasized that there is no literature consensus about the parameters of glycaemia, insulin, total cholesterol (TC) and triglyceride (TG) for the full-term newborn population. The glycemic and lipid profiles added to the growth markers are important because they are information that will serve as a reference parameter for this age group. Therefore, in this study, the mother and her healthy-newborn were evaluated, from a gestation without comorbidities, aiming to characterize the plasma and lipid profile of the mother/full-term newborn binomial, at birth and at six months. In addition, it was evaluated whether maternal anthropometric and biochemical conditions are correlated with those of full-term newborn babies.

MATERIALS AND METHODS

The study was quantitative, descriptive and observational, which integrates research financed by the edict MCTI/CNPQ/ Universal 14/2014, being carried out in a public maternity in the west of Paraná. The population of the study, to obtain the sample, was based on the universe of live births occurred in the period of one year. A total of 162 mother/full-term newborn binomials at birth were investigated. To the follow up at six months of life, 69 children returned. Data were collected from November 2015 to December 2016. Pregnant women with no comorbidities, who were in the full term gestational period, over the age of 18, and resident in the municipality of Cascavel-Paraná, were included. The included newborn babies had no comorbidities and were born at the full-term period of gestation. Both of them had blood samples for routine biochemical exams at the institution. Automatically, all the individuals that did not correspond for inclusion criteria were excluded from the study. Also, the blood collections from the umbilical cord of the newborn babie were excluded in order to reduce the risks of maternal interferences in the exams results. Even those that did not present conditions (insufficiency of volume, laboratory methodology out of the time) for these study laboratory tests, were discharged. The maternal variables included: age, body mass index (BMI) delta, prenatal hemoglobin mean, prenatal hematocrit mean and prenatal glycaemia mean (secondary data from the pregnant woman's card) and the biochemical glucose, insulin, TC and TG. The variables of the full-term newborn included: gestational age, height, BMI delta, BMI, weight/age Z score (Z W/A), height/age Z score (Z H/A) and cephalic perimeter/age Z score (Z CP/A), as well as the biochemical measurements of glucose, insulin, TC and TG at birth. The data were collected with an instrument developed for the research. The instrument was reformulated after applying two pilot tests, being the first test with six pairs of mothers/NB and the second test with 19 pairs of mothers/NB. The pilot tests' participants were not included in the sample. Maternal and newborn information were obtained from the unit registration books, hospital records (printed and electronic), the prenatal portfolio and, when necessary, from interviews with mothers, which occurred up to 72 hours after birth. Blood samples were collected from the routine laboratory tests of the unit (maternal: serology, blood count and others; NB: serology, bilirubins and others), which were not related to the study. From these samples, the residual blood known as "discard" material, was used to measure plasma parameters. At six months after birth, a new and specific authorization was requested from the parents and, for those who authorized it, the peripheral blood of the child was collected.

Biochemical measurements were performed on serum and blood components separated for analyses. The results of glucose, TC and TG were given in mg/dL and measured by the dry chemical method, using the Chemical Systems VITROS 250/350/950/5,1 FS and 4600 and the Integrated System VITROS 5600. The insulin hormone was measured by the electrochemiluminescence method, following the laboratory methodology which the analyzes were sent to. Insulin concentration was expressed in µUI/mL. In order to evaluate the association of variables of plasma dosages from mothers on the behavior of the same NB's variables, multiple linear regression analyzes were performed, assuming Gaussian distributions. The variables considered as explanatory of the models were those that presented an entrance probability of 0.10 and equivalent exit probability to 0.20. In all statistical analyzes a significance level of 0.05 was established, and the tests were performed in the XLStat program version 2015. All the ethical aspects provided for the Resolution 466 (BRAZIL/CONEP, 2012) were followed and the project was approved by the Research Ethics Committee under Process number 1.228.229.

RESULTS

Mothers' anthropometric and biochemical data

The maternal age ranged from 18.0 to 47.0 years old (28.0 ± 6.3), the previous BMI was 17.5 to 39.8 kg/m2 (25 ± 4.8), the BMI of the last appointment varied from 18.2 to 43.6 kg/m2 (29.9 ± 5) and the BMI delta ranged from -1.4 to 11.8 (4.9 ± 2.6). Maternal screenings, during the prenatal period, presented values for hemoglobin ranging from 7.7 to 14.7 g/dL (12 ± 1); for the hematocrit, ranging from 29.4 to 44.9% (35.67 ± 4.7) and glycaemia ranged from 52 to 148 mg/dL (76.7 ± 9.7). The maternal biochemical dosages of the exams collected at delivery admission presented the following values: glycaemia ranged from 57 to 210 mg/dL (93.4 ± 29.3); insulin ranged from 0.9 to 138.5 µUI/mL (17.1 ± 20.5); the maternal TC from 106 to 342 mg/dL (220.9 ± 50.4), and TG ranged from 47 to 586 mg/dL (217.7 ± 97.3).

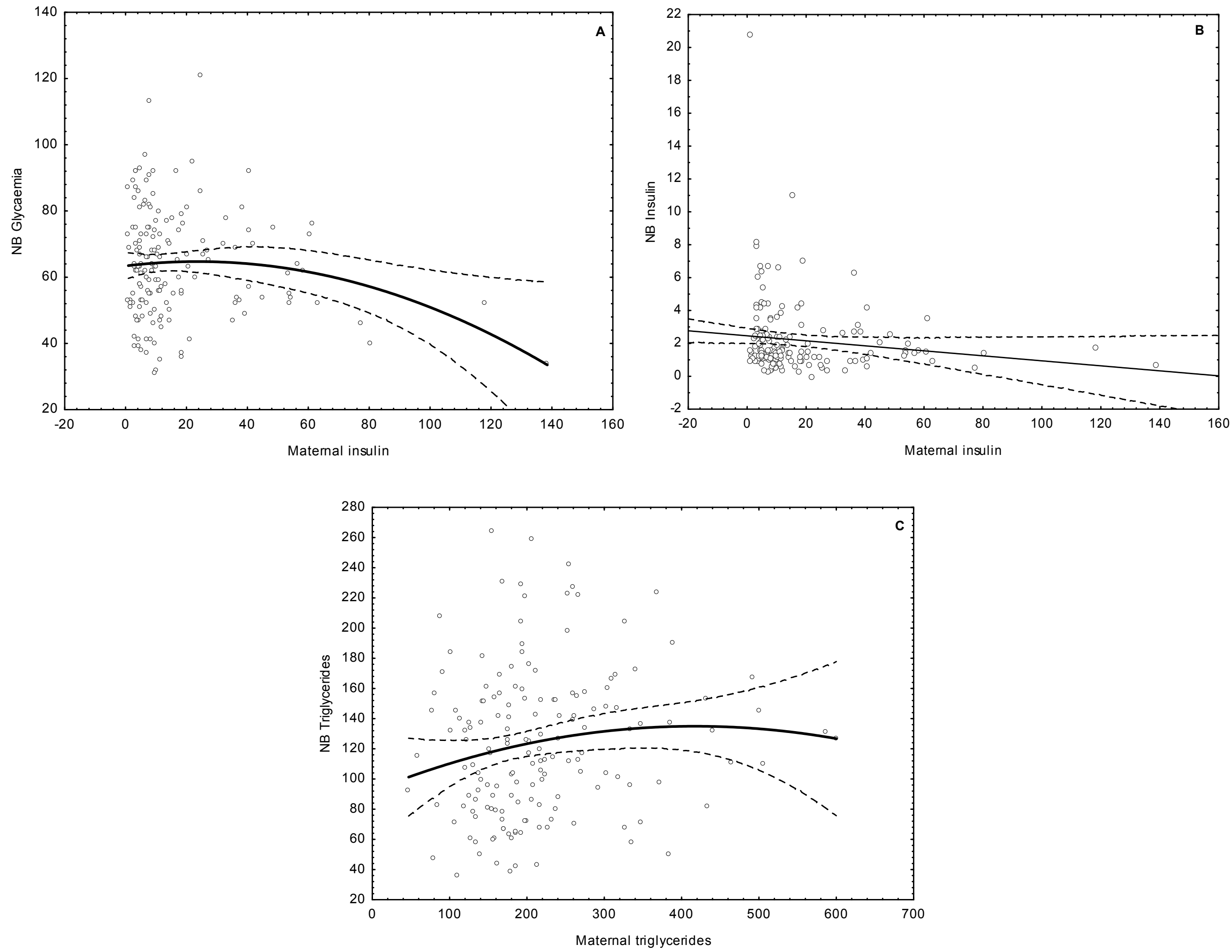
Anthropometric and biochemical data of NB and at six-month-old

Considering the NB, the GA at birth evaluated by the Capurro method presented variations from 37 to 41 weeks (38.9 ± 0.9). For the assessment of the birth weight type, 84.6% (n = 137) were NB with adequate weight at gestational age, 8.6% (n = 14) as small for gestational age and 6.8% (n = 11) as large for gestational age. Regarding the biochemical tests performed at birth and at 6 months of follow-up, it was possible to observe that the glycaemia at birth ranged from 31 to 121 mg/dL (64.19 ± 19.24) and, at six-month-old, 57 to 110 mg/dL (79.31 ± 9.79). By taking in to account the newborn infant insulin level, it ranged from 0.3 to 20.8 µUI/dL (2.08 ± 1.85), later from 0.4 to 20.3 µUI/dL (4.51 ± 3.79). The TC values of the newborn babies at birth ranged from 25 to 183 mg/dL (85.89 ± 22.17) and at six-month-old were from 102 to 231 mg/dL (141.11 ± 26.49). The newborn TG concentration varied from

Table 1. Characterization of the anthropometric parameters and the biochemical dosages of the Newborn Babies (NB) at birth and at six-month-old. Cascavel, 2017

	Birth		Six-month-old	
	Average	SD	Average	SD
Weight (g)	3253,77	455,83	7901,88	843,02
Height (cm)	48,56	2,29	66,71	2,29
CP (cm)	33,87	1,51	43,62	1,10
Z W/A	- 0,15	1,00	0,09	0,88
Z H/A	- 0,59	1,02	- 0,23	1,04
Z CP/A	- 0,32	1,13	0,42	0,81
BMI	15,45	14,29	17,76	1,67
Glycaemia (mg/dL)	64,19	19,24	79,31	9,79
Insulin (µUI/mL)	2,08	1,85	4,51	3,79
TC (mg/dL)	85,89	22,17	141,11	26,49
TG (mg/dL)	127,19	51,29	132,02	48,98

SOURCE: Data bank from research. CP: Cephalic parameter; Z W/A: Z score Weight/Age; Z H/A: Z score Height/Age; Z CP/A: Z score Cephalic parameter /Age; BMI: Body Mass Index; TG: triglyceride; TC: Total cholesterol.

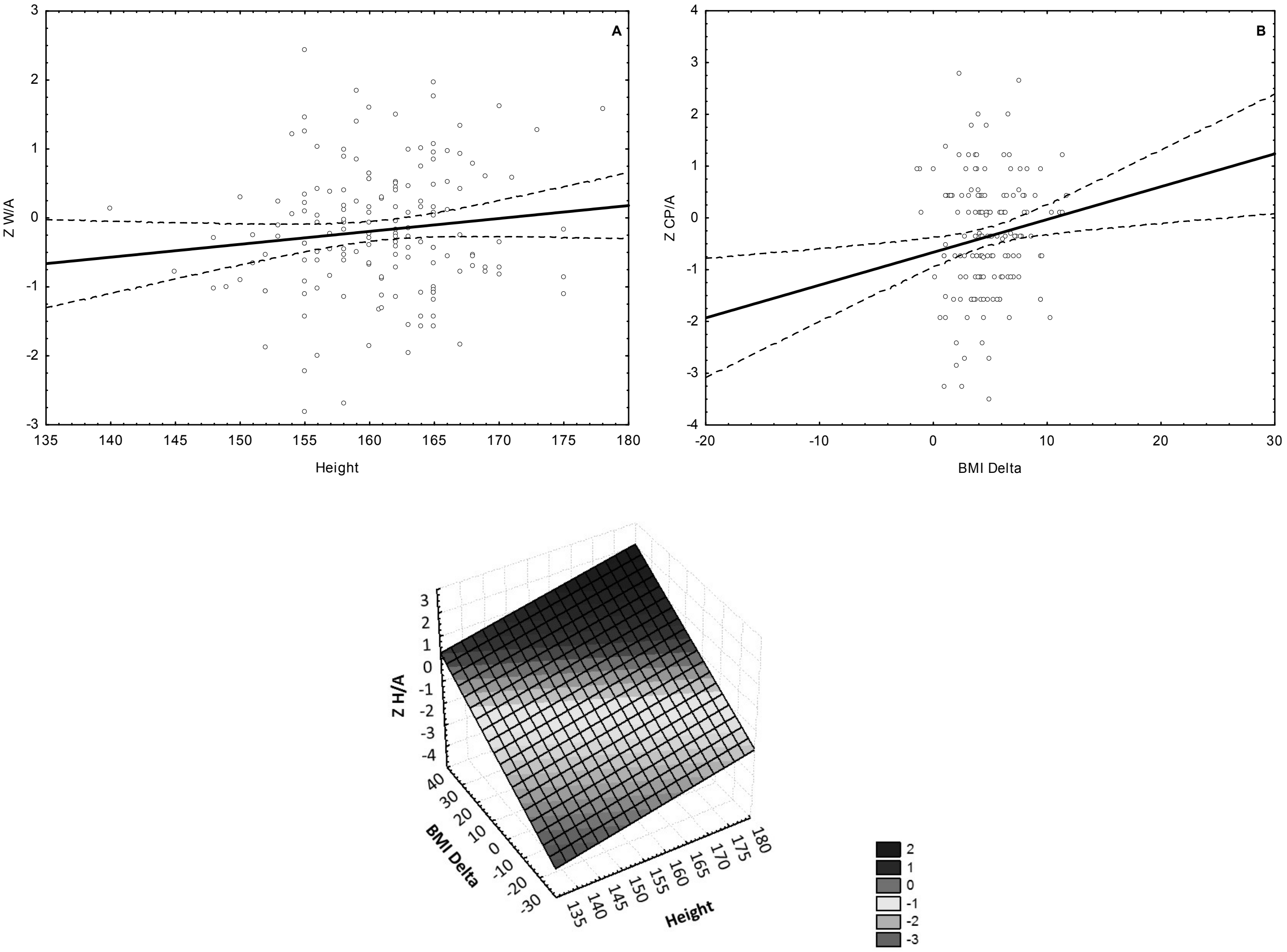


Standardized coefficients of multiple regression analyses

	Predict variables	Coefficient	Standard Error	p-value t test	F	Model p-value
	Intercept	65,444	1,650	**< 0,0001**	2,915	0,090
NB Glycaemia	Maternal insulin	-0,106	0,062	0,090		
	Intercept	2,462	0,232	**< 0,0001**	3,060	0,082
NB Insulin	Maternal insulin	-0,015	0,009	0,082		
	Intercept	108,550	9,246	**< 0,0001**	2,863	0,093
NB Tryglicerides	Maternal tryglicerides	0,065	0,039	0,093		

NB: newborn

Figure 1. Standardized coefficients of multiple regression analyzes between maternal and newborn (NB) glycaemia, insulin, TC and TG variables. Cascavel, 2017



Standardized coefficients of multiple regression analyses

	Fonte	Coefficient	Standard Error	p-value t test	F	Model p-value
Z W/A	Intercept	-4,003	1,908	**0,038**	8,011	**0,000**
	Height	0,022	0,012	0,068		
	BMI Delta	0,068	0,018	**0,000**		
Z H/A	Intercept	-7,446	2,267	**0,001**	6,961	**0,001**
	Height	0,041	0,014	**0,004**		
	BMI Delta	0,056	0,022	**0,011**		
Z CP/A	Intercept	-0,664	0,143	**< 0,0001**	7,450	**0,007**
	BMI Delta	0,063	0,023	**0,007**		

Z W/A: z score weight/age; Z H/A: z score height/age; Z CP/A: z score cephalic perimeter/age; BMI Delta: Body mass index delta

Figure 2. Standardized coefficients of multiple regression analysis between maternal anthropometric parameters and newborns (NB). Cascavel, 2017

36 to 264 mg/dL (127.19 ± 51.29) for 56 to 273 mg/dL (132.02 ± 48.98). Information regarding the newborn and six-month-old infants can be observed in Table 1.

Associations among biochemical and anthropometric variables from mothers and newborn infants

The multiple association of the variables was performed, making it possible to verify that, although the maternal insulin variable is weak, it has a positive correlation with the glucose and insulin variables of the newborn infants (Figure 1A, r^2=0.012 and Figure 1B, r^2=0.019, respectively). Thus, the lower the maternal insulin, the higher the observed values of glycaemia (p = 0.090) and insulin (p = 0.082) of the NB. It was also possible to verify a weak positive correlation between maternal and neonatal TG concentrations (Figure 1C, r^2=0.018). The higher the TG values of the mothers, the higher the values of this variable in the NB (p = 0.093). The NB variable TC, although presenting a significant adjustment in its model, did not present statistical significance among the explanatory variables.

Associations between maternal and newborn anthropometric variables

The multiple association of the variables was performed, allowing to be observed that the oscillation of the Z W/A, Z H/A and Z CP/A scores among the NB are influenced by the anthropometric variables observed in the mothers ($p < 0.05$). The variable BMI of the NB, despite presenting a significant adjustment in its model, did not present a significant association among the explanatory variables (Figure 2). The higher values of maternal height and BMI variation, the higher the scores Z W/A ($p < 0.0001$) and H/A ($p = 0.001$). The higher the values of maternal BMI variation, the higher were the CP/A Z score of the newborn babies ($p = 0.007$).

DISCUSSION

The mothers group characterization of maternal age, classify them mainly as young adults, with 28 ± 6 year-old average. Melo *et al*. (2007), in a study conducted in Campina Grande, Brazil, presented a mean age profile of 24 ± 5. In a study conducted by Paiva *et al*. (2012), the mean age among the groups presented was obtained, ranging from 29.2 to 30 years old. These values differ from the present study, which may be influenced by the regional condition. Previous BMI ranged from 25 ± 4.8 kg/m^2 before gestation to 29.9 ± 5 kg/m^2 at the last medical appointment, with a delta of 4.9 ± 2.6. Using the Atalah Curve (Brasil, 2004), as a reference for evaluation, we observed that the previous mean BMI of these pregnant women was considered adequate, but the BMI in the last medical appointment revealed overweight at pregnancy ending. Fetal exposure to overweight and maternal obesity may lead to increased prevalence of obesity in childhood and adulthood, as well as increase the risk of developing comorbidities associated with overweight (Juonala *et al*., 2011; Gupta *et al*., 2011). The laboratory screening performed during the prenatal period presented hemoglobin with mean values of 12 ± 1 g/dL and mean hematocrit of 35.67 ± 4.7. The mean values of hemoglobin and hematocrit are in line with that proposed by the Ministry of Health (Brasil, 2012), in which, in the absence of anemia, hemoglobin should be >11 g/dL. For Modotti *et al*. (2015), the values determination of these tests is low cost, simple and fast, and should not be analyzed in isolation, as the prevalence of anemia can be underestimated. According to the author, the values of hemoglobin and hematocrit tend to be decreased significantly in the second and third pregnancy trimester, due to the increase in plasma volume. Regarding prenatal glycaemia, the mean was 76.7 ± 9.7 mg/dL, whereas the blood glucose at delivery was 93.4 ± 29.3 mg/dL, increasing in relation to the prenatal values. According to the Ministry of Health (Brasil, 2010), screening for gestational diabetes mellitus is considered positive when fasting blood glucose is ≥85 mg/dL and/or in the risk factors presence. In the present study, none of the pregnant women presented elevated glycaemia that required treatment.

The insulin presented an average value of 17.1 ± 20.5 μIU/mL. The International Diabetes Federation (IDF) (2006) includes insulin resistance as one of the parameters for the diagnosis of Metabolic Syndrome. However, as stated by Samaras *et al*. (2006), few studies suggest normal values for insulin, with no reference intervals for women during normal gestation. Thus, glycemic monitoring becomes a better tracker for the diagnosis of diabetes in this period (Brasil, 2010). For the maternal lipid parameters, obtained at the hospitalization moment for delivery, the TC maintained a mean of 220.9 ± 50.4 mg/dL and the TG of 217.7 ± 97.3 mg/dL, similar to the values found in the literature (Sales, 2013, Okojie *et al*., 2011, Parchwani and Patel, 2011, and Benítez *et al*., 2010). In healthy pregnant women, the concentration of TC and TG increases significantly and progressively in the gestational trimesters. There may be a 25-50% increase in TC concentration and a two-to-four increase in TG concentration (Dukic, 2009). According to Soma-Pillay *et al*. (2016), the increase in TG concentration occurs as a result of increased hepatic lipid synthesis and reduced peripheral lipoprotein lipase activity. In this way, the maternal tissues use the TG as energetic source while the glucose is used for the fetus. Increased cholesterol, specifically LDL-cholesterol, is important for placental steroidogenesis. Regarding the biochemical tests performed at birth and at six-month-old of follow-up, it could be observed that the blood glucose of the newborn infant increased from 64.19 ± 19.24 mg/dL to 79.31 ± 9.79 mg/dL, at six-month-old. Also, the insulin, which ranged from 2.08 ± 1.85 μUI/dL to 4.51 ± 3.79 μUI/dL. The average values of glycaemia, independently of the period, are among the 45 and 145 mg/dL cutoff standards established by the Ministry of Health (Brasil, 2014). Regarding insulin, no reference values were found in the literature.

The TC concentration in the newborn babies was 85.89 ± 22.17 mg/dL and at six months of life, 141.11 ± 26.49 mg/dL, while the TG ranged from 127.19 ± 51.29 mg/DL at birth to 132.02 ± 48.98 mg/dL at six-month-old. According to the Brazilian Consensus for the Standardization of Laboratory Determination of the Lipid Profile, the desirable values of TC for children and adolescents should be <170 mg/dL (fasting or fed), while TG values for children 0-9 years old should be <75 mg/dL and <85 mg/dL, with and without fasting, respectively. Thus, the values found in the present study for TC are in agreement with the Brazilian Consensus just described, but TG values are above. Regarding the associations among the variables, it was observed a positive correlation, although weak, of maternal insulin with the values of glycaemia and insulin in the newborn, at birth. The lower the maternal insulin, the higher the glycaemia and insulin values in the NB. At the beginning of pregnancy there is an increase in insulin secretion and increased sensitivity to this hormone, followed by progressive insulin resistance (Butte, 2000), with a reduction in glucose concentration. This is due to increased glucose uptake by the placental fetal unit (Soma-Pillay *et al*., 2016). Considering the NB, in agreement with the Brazilian Pediatric Society, the glycemic homeostasis in the neonatal period is understood as a smooth transition between the intrauterine environment, with a continuous alimentary supply, and afterwards the state of relative postnatal fasting (SBP, 2014). After three to four hours of birth this blood glucose tends to be around 60 to 70 mg/dL (Brasil, 2014). In the present study, we observed that the glucose and insulin of the newborn baby are influenced by maternal insulin, but more studies are necessary to unravel the real mechanisms involved. Regarding the higher maternal TG values being associated with higher values of TC and TG in the NB at birth, we can say that these parameters are directly related, ie, the higher the maternal lipid profile the greater the lipid profile of the newborn baby. A study conducted in China with 934 pairs of non-diabetic mothers using serum for blood samples and lipid profile classification aimed to investigate the associations between maternal dyslipidemia and adverse pregnancy. The outcomes identified that when the pregnant woman has high levels of TG at the end of pregnancy, there is an association with increased risk for Gestational Diabetes Mellitus, preeclampsia and hepatic cholestasis, large RN for gestational age, macrosomia and reduced risk of small-for-gestational-age infants (Jim *et al*., 2016).

Both values for maternal TC and TG in this study presented values above those recommended by the Brazilian Society of Cardiology (SBC, 2013) and the Brazilian Consensus for the Normalization of Laboratory Determination of the Lipid Profile (Consenso, 2016), which may be due to the overweight observed in the pregnant women of the present study, at the end of gestation. This overweight may have influenced the maternal lipid profile, which in turn influences the lipid profile of the newborn, demonstrating that the maternal nutritional status is an important factor on the newborn baby. It is observed that the results of the present investigation indicate the maternal anthropometric parameters are directly related to the newborn parameters at birth. Thus, we can say that, mothers with higher height and BMI have children with greater weight, height and BMI, although the latest one did not present statistical significance. The research realized by Fonseca *et al*. (2014) corroborates with the present study data. A significant association was observed between the initial BMI classification of the pregnant woman and the newborn weight. In this study, pregnant women with excessive weight had a higher prevalence of NB with adequate weight. Similar to what was observed by Meller and Santos (2009), who evidenced a strong statistical association between maternal height and weight with NB weight at birth. Several factors may influence the newborn anthropometric parameters, as it was pointed out in a study carried out in China, with women between 19-39 years old. It concluded that, when maternal glucose concentrations are low, there is an increased risk of having a small NB to the gestational age. This association is further reinforced when mothers have a low BMI and/or are short (Leng *et al*., 2016). This information indicates the follow-up need of full-term newborns and in a normal condition, in order to compare with other classes of NB, motivated by the changes that occurred in the pediatric profile of the last decades. In the present study, we conclude that, although weak, there were correlations between the nutritional status of the mother (insulin and triglycerides) with the nutritional state of the newborn (glycaemia, insulin and triglycerides) as well as associations between maternal and neonatal anthropometric data. We suggest that these alterations may be due to the overweight observed in the mother at the end of gestation and that, due to epigenetic alterations, such as DNA methylation, it may have been passed on to the newborn babies. However, further studies are needed to uncover the mechanisms associated with these changes.

Gratefully

To the National Council of Scientific and Technological Development (CNPq) for the financial support to the research.

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