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The Relationship between Levels of Lipids and Lipoprotein B-100 in Maternal Serum and Umbilical Cord Serum and Assessing Their Effects on Newborn Infants Anthropometric Indices

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ABSTRACT

Background & aim: This study aimed to determine the relationship between lipid and apolipoprotein B-100 (apo B-100) levels in maternal and umbilical cord sera as well as the effects of these components on anthropometric measurements of newborn infants.

Methods: This correlational study was performed on 85 appropriate for gestational age (AGA) newborns and their mothers. For analysis, 5 ml of maternal blood and 5 ml of umbilical venous cord blood were obtained during labor and immediately after delivery, respectively. Sera were separated by centrifugation and analyzed on the same day for estimation of lipid profile including total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and apolipoprotein B-100. Also, anthropometric indices of newborn infants were measured and recorded. Pearson's correlation coefficient was used to determine the relationship between variables.

Results: There was a positive correlation between maternal and neonatal serum TC levels (r=0.23, P=0.042). Maternal LDL-C level was positively correlated with neonatal HDL-C (r=0.24, P=0.035), TC (r=0.29, P=0.01), and apolipoprotein B-100 levels (r=0.25, P=0.031). A significant positive correlation was observed between maternal apolipoprotein B-100 level and neonatal TC (r=0.26, P=0.019), HDL-C (r=0.23, P=0.043), and apolipoprotein B-100 levels (r=0.24, P=0.038). Maternal TG level was positively correlated with neonatal crown-heel length (r=0.27, P=0.018) and birth weight (r=0.23, P=0.039). However, maternal HDL-C level was negatively correlated with neonatal birth weight (r=-0.29, P=0.01) and chest circumference (r=-0.27, P=0.019). A significant negative correlation was found between cord blood TG level and newborn's head circumference (r=- 0.23 P=0.046).

Conclusion: Maternal lipid profile can affect neonatal lipid level and anthropometric measurements.

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Introduction

Coronary artery disease (CAD) is a major cause of morbidity and mortality, worldwide. It is a gradual and progressive disease that usually starts in childhood and manifests clinically in middle to late adulthood (1-2).

Lipids and related compounds are important risk factors for the development of atherosclerosis and cardiovascular diseases (3). Numerous investigations have indicated a strong independent relationship between serum cholesterol and CAD incidence (4). Moreover, scientific studies suggest that serum lipid profile, especially low-density lipoprotein cholesterol (LDL-C) in newborns, is significantly associated with lipid level later in life and development of hypercholesterolemia and CAD during adulthood (5-6).

Various factors influence the composition of

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fetal plasma lipids including placental insufficiency, maternal age, duration of pregnancy, and mode of delivery (7-8). Maternal lipid and lipoprotein levels may also influence cord blood lipid concentration (8). On the other hand, since fetus requires a substantial amount of cholesterol for the development of tissues and organs, lipid concentration is likely to affect neonatal anthropometric parameters.

Hence, the present study was designed to investigate the correlation between lipid and apolipoprotein B-100 (apo B-100) levels in umbilical cord and maternal sera. We also assessed the impacts of these factors on anthropometric measurements of newborn infants.

Materials and Methods

This correlational study was performed on 85 Appropriate for Gestational Age (AGA) newborns and their mothers in the maternity ward of Najmieh Hospital in Tehran, Iran, in 2012. Written informed consents were obtained from all participants before entering the study. The study protocol was approved by the Ethics Committee of Tarbiat Modares University of Medical Sciences, Tehran, Iran.

Inclusion criteria were as follows: 1) singleton pregnancy; 2) gestational age of 37-42 weeks; 3) absence of congenital malformations; 4) newborns with five-minute Apgar score ≥7; and 5) non-use of medications except iron supplements.

Pregnant women with previous history of medical complications such as pre-eclampsia, eclampsia, diabetes mellitus, gestational diabetes, and thyroid disorders were excluded from the study.

For analysis, 5 ml of maternal venous blood was collected during labor and 5 ml of umbilical cord venous blood was obtained immediately after delivery. Body weight (BW), crown–heel length, head circumference (HC), and chest circumference (CC) of all neonates were recorded after transferring the newborns to the nursery room for routine examinations. The newborns' weights were measured, using an infant scale (Seca). Crown–heel length, along with HC and CC (cm), were recorded by a non-stretch tape.

Biochemical analysis

Sera were separated by centrifugation and analyzed on the same day for the estimation of cholesterol, triglyceride (TG), and high-density lipoprotein (HDL), using cholesterol oxidase/p-aminophenazone (CHOD-PAP) method, enzymatic colorimetric method [glycerol phosphate oxidase/p-aminophenazone (GPO–PAP)], and Lopes commercially available enzymatic kits, respectively. Plasma LDL-C level was measured via standard enzymatic, colorimetric assay and apo B-100 was measured using immune-turbidimetry.

Statistical analysis

Continuous data were expressed as mean ± standard deviation (SD). Statistical analysis was conducted using SPSS version 16. The normality of data distribution was verified using Kolmogorov-Smirnov test. Pearson's correlation coefficient was used to determine the relationship between variables. P-value less than 0.05 was considered statistically significant.

Results

A total of 85 newborns (48 female and 37 male subjects), along with their mothers, were recruited. The mean maternal age was 27.9±3.5 years and the mean gestational age at delivery was 39±0.55 weeks. The mean values of BW, crown-head length, HC and CC in newborns were 3309.6±312.1 g, 50±1.6 cm, 34.7±1.1cm, and 33.54±1.1 cm, respectively.

Maternal and neonatal serum lipid levels are shown in Table 1 and correlation coefficients between the umbilical cord and maternal serum lipid levels are presented in Table 2. As the results indicated, there was a significant positive correlation between maternal and neonatal cholesterol concentrations (r=0.23, P=0.042).

Table 1. Mean (SD) of lipid profile in maternal and umbilical cord blood (mg/dl)

Serum lipids	Mothers (n=85)	Neonates (n=85)
TG	242±70.26	33.08±12.82
TC (mg/dl)	221±45.65	52.87±12.9
LDL-C (mg/dl)	125.27±27.28	25.37±8.11
HDL-C (mg/dl)	63±10.7	33.56±8.39
Apolipoprotein B	130±27.99	26.59±6.81

TG: triglyceride; TC: total cholesterol; LDL -C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol

Table 2. Correlation between umbilical cord and maternal lipid levels

		Cord blood				
		Apo B-100	**LDL-C**	**HDL-C**	**TC**	**TG**
Maternal blood	**Apo B-100**	r =0.24 P= 0.038*	r =0.11 P= 0.32	r =0.23 P= 0.043*	r =0.26 P= 0.019*	r =0.045 P = 0.70
	HDL-C	r =-0.081 P = 0.49	r = - 0.12 P = 0.27	r =0.095 P= 0.41	r = -0.118 P = 0.31	r =- 0.212 P= 0.067
	LDL-C	r = 0.25 P = 0.031*	r = 0.16 P = 0.16	r = 0.24 P=0.035*	r = 0. 29 P = 0.01*	r=0.053 P = 0.65
	TG	r =0.069 P= 0.61	r =0.005 P= 0.96	r =0.056 P= 0.63	r =0.07 P= 0. 55	r=0.01 P= 0.9
	TC	r = 0.15 P = 0.17	r = 0.08 P = 0.46	r = 0.21 P = 0.06	r =0.23 P =0.042*	r=- 0.028 P = 0.8

TC: total cholesterol; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; TG: triglyceride; apo B-100: apolipoprotein B-100. *P-value less than 0.05 was considered significant.

Table 3. Correlation between cord blood lipid level and neonatal anthropometric indices

	Neonatal lipid profile				
	Apo B	**HDL-C**	**LDL-C**	**TG**	**TC**
Birth weight (g)	r=0.03 P=0.75	r=0.08 P=0.48	r = 0.05 P=0.6	r = -0.19 P=0.08	r = 0.07 P=0.54
Birth length (cm)	r= 0.18 P=0.11	r= 0.024 P=0.83	r= 0.14 P=0.22	r= 0.11 P=0.33	r= 0.12 P=0.29
Head circumference (cm)	r= - 0.18 P=0.11	r= - 0.16 P=0.8	r= -0.17 P=0.13	r= - 0.23 P=0.046*	r= - 0.05 P=0.65
Chest circumference (cm)	r=- 0.03 P=0.74	r= 0.06 P=0.57	r= -0.05 P=0.6	r= 0.88 P=0.45	r= - 0.18 P=0.87

* P < 0.05 was considered significant

Table 4. Correlation between maternal lipid level and neonatal anthropometric measurements

	Maternal lipid profile				
	Apo B-100	**HDL-C**	**LDL-C**	**TG**	**TC**
Birth weight (g)	r=0.14 P=0.21	r= -0.29 P=0.01*	r = 0.06 P=0.58	r = 0.23 P=0.039*	r = 0.04 P=0.68
Birth length (cm)	r= 0.12 P=0.27	r= - 0.08 P=0.48	r= 0.1 P=0.39	r= 0.27 P=0.018*	r= 0.08 P=0.45
Head circumference (cm)	r= - 0.04 P=0.7	r= - 0.16 P=0.14	r= -0.01 P=0.93	r= 0.1 P=0.36	r= - 0.01 P=0.88
Chest circumference (cm)	r=-0.001 P=0.9	r= -0.27 P=0.01*	r= -0.06 P=0.56	r= 0.12 P=0.27	r= - 0.01 P=0.86

* P < 0.05 was considered significant

Maternal LDL-C level was positively correlated with neonatal HDL-cholesterol (HDL-C) (r=0.24, P=0.035), total cholesterol (TC) (r=0.29, P=0.01) and apo B-100 (r=0.25, P=0.031) levels. Furthermore, a significant positive relationship was observed between maternal apo B-100 level and neonatal TC (r=0.26, P=0.019), HDL-C (r=0.23 P=0.043) and apo B-100 (r=0.24, P=0.038) levels.

As the results indicated, there was a negative correlation between TG level in umbilical cord blood and HC (r=-0.23, P=0.046) (Table 3). Associations between maternal lipid level and neonatal anthropometric indices are shown in Table 4. Maternal TG level had a significant positive correlation with neonate's crown-heel length (r=0.27, P=0.018) and BW (r=0.23, P=0.039). However, Maternal HDL-C level was negatively correlated with neonatal BW (r=-0.29, P=0.01) and CC (r=-0.27, P=0.019).

Discussion

The present study demonstrated a positive relationship between maternal and neonatal serum TC concentrations. This finding is in accordance with some previous studies (7-9),

though it was contradictory to the results of a study by Badruddin and colleagues (10), which did not show any association between maternal and neonatal serum TC concentrations; this discrepancy might be due to the nature of Badruddin's study (a pilot study).

Napoli et al. found that fatty streak formation in fetal aortas from hypercholesterolemic mothers and mothers with temporarily increased cholesterol level during pregnancy is substantially more than fetuses born from normocholesterolemic mothers (11). Therefore, the association between maternal and neonatal TC levels is of high importance, since maternal hypercholesterolemia is probably associated with enhanced lesion formation in fetal aorta and increased susceptibility to atherogenesis later in life (12).

In the present study, we also observed a positive correlation between maternal LDL-C level and neonatal HDL-C, TC, and apo B-100 levels. Similarly, Rodie et al. reported that maternal TC and LDL-C levels were positively correlated with neonatal HDL-C level (13). Similarly, a study by Ortega and colleagues reported a positive correlation between maternal LDL-C and neonatal TC and LDL-C (9). The positive correlation found between maternal LDL-C and neonatal HDL-C in the study by Rodie et al. and the significant positive relationship observed between maternal serum LDL-C and neonatal TC in the study by Ortega et al. are in agreement with the present study results.

Prospective studies indicate that apo B-100 is a more important predictor of CVD risk, compared to TC or LDL-C level (14). In this study, we found that maternal apo B-100 level had a positive association with neonatal apo B-100 level. This relationship may suggest the possibility of placental transfer of intact apo B-100 particles.

Another study by Pocovi et al., performed on 27 mothers and infants, did not show any relationship between maternal and umbilical cord apo B-100 levels (15). This result is inconsistent with that of the present study, which might be explained by the small sample size of the aforementioned research. In addition, in the present study, we discovered that maternal apo B-100 level was positively correlated with neonatal TC and HDL-C levels.

As the results indicated, maternal TG level had a significant positive correlation with neonatal BW. This positive correlation has been reported earlier by several researchers (16-17). In fact, maternal hypertriglyceridemia during late pregnancy is a result of increased hepatic synthesis of very-low-density lipoprotein (VLDL) due to increased oestrogen production and reduced activity of extra-hepatic lipoprotein lipase, which result in reduced utilization of TG and its increased level (18).

The positive relationship between maternal serum TG level and neonatal BW is confusing since maternal serum TG does not seem to pass the placental barrier (19). However, considering the physiological mechanisms, it is hypothesized that placental lipoprotein lipase hydrolyzes maternal TG to release free fatty acids, which are able to cross the placenta (19).

Also, the association between maternal TG concentration and neonatal BW might be explained by the fact that in adult population, elevated serum TG level is positively correlated with insulin resistance (20). Therefore, it is believed that high levels of maternal serum TG level in mid-to-late pregnancy lead to enhanced insulin resistance, and consequently increased neonatal BW (20). Our study also showed a positive correlation between maternal TG level and length of newborns. Our observation of the positive correlation between maternal TG concentration and neonatal length was similar to the result obtained by Mitra and colleagues (21).

Moreover, the current study indicated that maternal HDL-C level was negatively correlated with neonatal BW, which is in agreement with previous reports (22-23); however, on the contrary, Fakhar-un-Nisa et al. (24) showed a positive correlation between maternal HDL-C level and neonatal BW.

The mechanisms by which maternal HDL-C level can affect fetal weight have not been clearly defined. However, some possible functions are noted for HDL-C level, which can affect fetal growth and development; for instance, maternal serum HDL-C plays an important role in fetal cholesterol homeostasis. Cholesterol is used for keeping an ideal sterol balance in extra-embryonic tissues of fetus, which helps with fetal growth and development (25).

The inverse relation between maternal HDL-C and fetal BW can be explained by the fact that fetal weight is more affected by maternal HDL-C, compared to fetal HDL-C; therefore, due to the decreased maternal HDL-C, HDL-C transfer to the fetus decreases and the balance of cholesterol homeostasis is disrupted in extra-embryonic tissues of the fetus. Following that, extra-embryonic tissues of the fetus absorb cholesterol via reparative mechanisms; these mechanisms can affect and increase fetal weight (26).

We also found that maternal HDL-C level was negatively correlated with neonatal CC; this result confirms earlier observations by Mitra and colleagues (21). Our study also indicated that only TG level in umbilical cord blood was negatively correlated with neonatal HC. Some studies showed an inverse association between cord blood TG level, neonatal BW, and abdominal circumference; they explained this association by the reduced activity of lipoprotein lipase (27-28).

We could not suggest a mechanism for the negative relationship between neonatal TG and HC. However, according to the results of the present study (which showed a negative association between umbilical cord TG level and HC) and previous research, which showed an inverse association between neonatal TG, BW, and abdominal circumference, it can be inferred that disproportionate size at time of birth is related to metabolic changes of lipids.

Conclusion

This study showed that maternal lipid profile can affect neonatal lipid level and anthropometric measurements. Hence, it is recommended that longitudinal studies be performed in order to investigate the relationship between anthropo-metric measurements at birth and maternal/ neonatal serum lipid levels and evaluate this relationship in years following birth.

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Conflict of Interest

The authors declare no conflicts of interest.

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