Original Research Article

Is there any correlation between Cord Blood Lipid Profile and Birth Weight among Term Babies?

Abstract :

Background: One of the major causes of poor outcomes for newborns is abnormal birth weight, which can increase the risk of complications and death. The levels of lipids in the cord blood may play a role in determining the birth weight of infants. Objective: This study aimed to examine the association between cord blood lipid levels and neonatal birth weight.

Methods: We enrolled 200 healthy pregnant women who attended antenatal clinics in our hospital. We collected 5 mL of cord blood from the umbilical vein and measured the serum levels of total cholesterol, triglycerides, HDL cholesterol, and LDL cholesterol using spectrophotometric methods. We calculated LDL cholesterol using Friedewald's formula, and we measured anthropometric parameters using standard methods. We used Student's t-test and Pearson correlation coefficient to analyze the data.

Result : Neonates with SGA had significantly lower birth weight (2.24 ± 0.3 vs 2.83 ± 0.4; P < 0.01), head circumference (31.5 ± 1.5 vs 33.4 ± 1.8; P < 0.04), recumbent length (51.2 ± 0.3 vs 53.6 ± 0.2; P < 0.04), and Ponderal Index (2.24 ± 0.5 vs 2.35 ± 0.2; P < 0.03) than AGA babies. The cord blood lipid profile levels were also significantly lower (P < 0.001) in SGA than AGA babies. There was a positive correlation between birth weight and total cholesterol (r = 0.31; P < 0.001) and triglycerides (r = 0.46; P < 0.001), and a small positive correlation between birth weight and HDL cholesterol (r = 0.157; P = 0.013).

Conclusion: AGA babies had significantly higher cord blood lipid profile levels than SGA babies.

Introduction

Lipid profile levels are important indicators of cardiovascular health, which can be affected by factors such as gestational age, genetics, and environment. Previous studies have shown that abnormal lipid profile levels in early life can increase the risk of cardiovascular diseases (CVDs) later in life.[1] However, there is limited data on the lipid profile levels of neonates with different gestational ages, especially in our setting. Furthermore, lipid profile levels vary across different countries and regions, suggesting that they are influenced by various physiological factors.[5,6]

Birth weight is a crucial factor that influences the risk of cardiovascular diseases (CVD) in later life. CVD are the leading cause of morbidity and mortality worldwide, and they are influenced by both genetic and environmental factors.[7] Some of the modifiable risk factors for CVD include high cholesterol, high blood pressure, smoking, obesity, and physical inactivity.[8,9] Additionally, some studies have suggested that prenatal conditions can also affect the development of these risk factors.[10] Furthermore, maternal and fetal characteristics, such as hypertension, diabetes, obesity, and low or high birth weight, can alter the lipid profile of the fetus.[11]

Low birth weight (LBW) is associated with higher incidence of CVD, hypertension, and type II diabetes in adulthood.[12] LBW newborns may have altered blood lipids due to relative insulin resistance, which can increase the risk of atherosclerosis later in life. LBW is a risk factor for CVD that is comparable to smoking or hypertension in adolescence.[11,13] Hence, there seems to be a link between birth weight and CVD mortality in adulthood.[14]

On the other hand, high birth weight is associated with higher levels of insulin-like growth factor-1 (IGF-1), which can change the composition and concentration of lipoproteins at birth and increase the risk of CVD.[15] Therefore, it is important for public health to investigate whether there is an association between umbilical cord lipids and neonatal birth weight in term babies. This study aimed to examine the relationship between cord blood lipid profile and neonatal birth weight in term babies.

Materials and Methods

Study area

The study site is the Government medical College Nagpur, a tertiary care hospital that provides maternal and child health services. The hospital serves a population of about 2.5 million people in the Nagpur district of Maharashtra state, India.

Study population

This study is a cross-sectional analysis of 200 pregnant women who attended antenatal care at the Departments of Obstetrics and Gynecology of the Government medical College Nagpur. The participants were selected by consecutive sampling during their antenatal visits and followed up until delivery at the same facility. The gestational age was estimated by counting the number of weeks from the first day of the last menstrual period. A structured questionnaire was used to collect demographic and clinical data from the participants.

Inclusion criteria

The inclusion criteria for this study were: (1) pregnant women aged 18 years or above; (2) singleton pregnancy; (3) antenatal care attendance throughout the pregnancy; and (4) delivery at the Government medical College Nagpur. The study included women who delivered vaginally or by cesarean section at term (37-42 weeks).

Exclusion criteria

The exclusion criteria for this study were: (1) pregnant women with pre-existing conditions such as diabetes mellitus, cardiovascular diseases, or parity more than four; (2) obstetric complications that could affect fetal growth such as preterm delivery, previous adverse pregnancy outcomes, placenta previa or abruption, fetal congenital anomalies, pregnancy-induced hypertension, polyhydramnios, endocrine disorders, or other severe maternal illnesses; (3) clinical signs of infection, benign tumors, or malignancies; and (4) missing or incomplete data.

Ethical consideration

This study was approved by the Ethics and Research Committee of the Government medical College Nagpur. Written informed consent was obtained from all participants before data collection. The confidentiality and privacy of the participants were maintained throughout the study.

Sample size calculation

To estimate the number of participants needed for this study, The formula is:

$N = Z2pq/d2$

Where N is the desired sample size, Z is the standard normal deviate, set at 1.96, p is the proportion of SGA in India, which is 24%[17], q is the complement of p, which is 0.76, and d is the margin of error, set at 0.05. Substituting these values, we obtain:

$N = 1.962 \times 0.24 \times 0.76/0.0025 = 185$

Hence, we required a sample size of 185 for this study.

Therefore, 200 subjects will be recruited for this studySample collection

The cord blood samples were obtained from pregnant women who delivered at the hospital. The cord was clamped and cut immediately after birth, and 5 mL of blood was drawn from the umbilical vein into a plain tube. The tube was labeled and stored at room temperature until clotting occurred. The blood was then centrifuged at 3000 rpm for 15 minutes to separate the serum. The serum samples were frozen at −20°C and analyzed for lipid profile within two weeks.

Anthropometric measurements

The neonates' weight, head circumference, and length were measured by trained nurses using a digital scale, a metal tape, and a Seca 416 infantometer, respectively. The Ponderal Index (PI) was calculated as weight (g) / length (cm) 3 × 100, to assess the fetal growth pattern.

The lipid profile parameters, namely total cholesterol, triglycerides, and HDL, were measured by XL-300 using Randox reagents according to the instructions provided in each kit. The LDL cholesterol level was derived from the Friedewald formula, which is a mathematical equation that uses the values of the other parameters.

Statistical analysis

We used Graph Pad prism 9 to analyze the data collected in this study. We reported the values as mean ± standard deviation. We performed Student’s t-test, Chi-square, and ANOVA to compare means, and we used linear regression analysis to examine the correlation. We set the significance level at $P < 0.05$.

Results

We randomly recruited 200 healthy pregnant women for the study and admitted them for deliveries when they went into labor. We classified the neonatal body weight into SGA (<2.5 kg) and AGA (>2.5 kg).

SGA:Smallforgestationalage,AGA:Appropriateforgestationalage

Table 1 presents the comparison of anthropometric measurements of babies by neonatal birth weight. The babies with SGA had significantly lower birth weight (P < 0.01), head circumference (P < 0.04), recumbent length (P < 0.04), and PI (P < 0.02) than the babies with AGA.

Table 1 :Comparisonofanthropometricmeasurements ofbabiesbasedonneonatalbirthweight

Anthropometric parameters	SGA(*n*=50)	AGA(*n*=150)	*P*
Birthweight(kg)	2.24±0.3	2.83±0.4	0.01
Headcircumference(cm)	31.5±1.5	33.4±1.8	0.04
Recumbent length (cm)	51.2±0.3	53.6±0.2	0.04
PonderalIndex(g/cm^3)	2.24±0.6	2.35±0.3	0.03

Table 2 shows the comparison of the lipid profile levels in cord blood samples by the birth weight of babies. The SGA babies had significantly lower total cholesterol, triglycerides, HDL‑c, and LDL‑c (P < 0.001) than the AGA babies.

Table 2: Comparison of the levels of measuredparametersincordbloodsamplesbasedonbirthweight (mean±standarddeviation)

Parameters	Smallforgestationalage (<2.5kg)(*n*=50)	Appropriateforgestationalage (>2.5kg) (*n*=150)	*P*
Cholesterol (mg/dl)	59.94±1.55	81.46±3.11	0.001
Triglycerides(mg/dl)	53.1±3.29	188±2.36	0.001
HDL(mg/dl)	28.9±0.10	35.4±1.47	0.001
LDL(mg/dl)	19.9±1.6	28.4±1.3	0.001

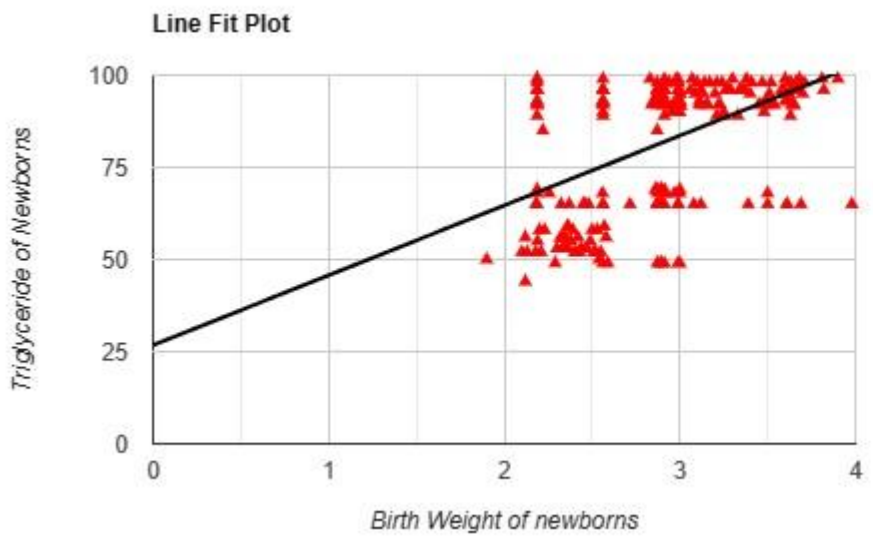

Figure 1.Results of the pearson correlation indicated that there is a significant medium positive relationship between Birth Weight of newborns and Triglyceride of Newborns, ($r(247) = .496$, $p < .001$).

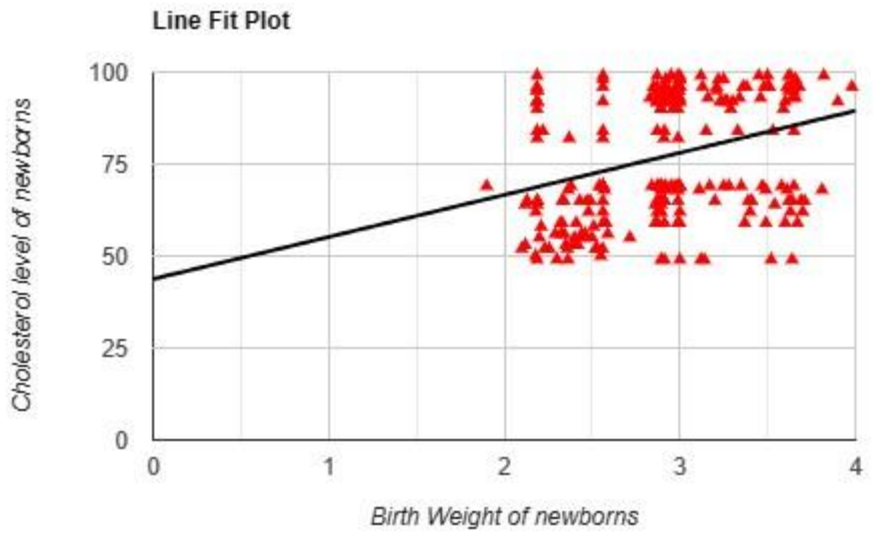

Fig2. Results of the pearson correlation indicated that there is a significant medium positive relationship between Birth Weight of newborns and Cholesterol of Newborns, ($r(247) = .316$, $p < .001$).

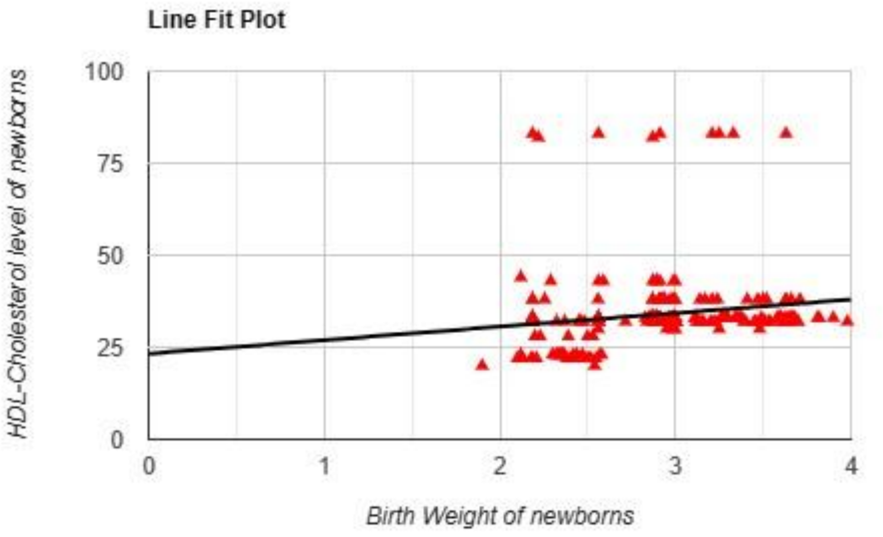

Fig 3. Results of the pearson correlation indicated that there is a significant small positive relationship between Birth Weight of newborns and HDL-Cholesterol level of newborns, ($r(247) = .157$, $p = .013$).

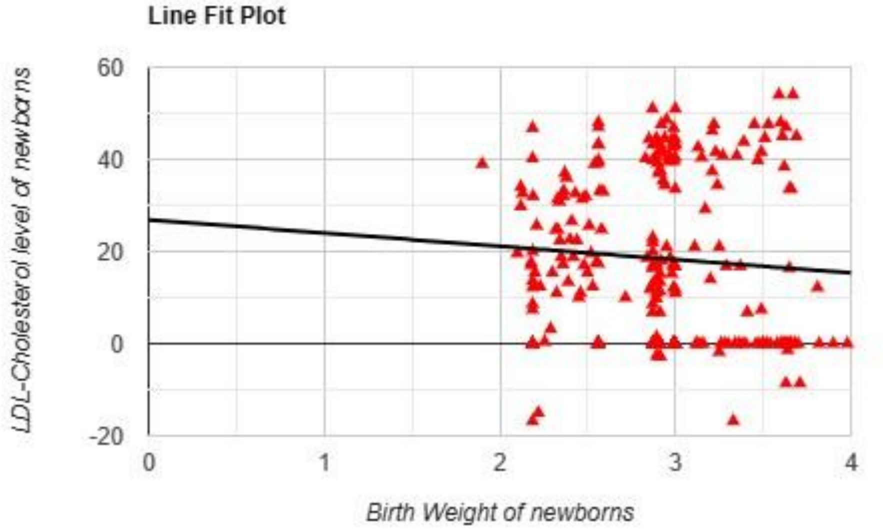

Fig 4.Results of the pearson correlation indicated that there is a non significant very small negative relationship between Birth Weight of newborns and LDL-Cholesterol level of newborns, ($r(247) = .0717$, $p = .260$).

DISCUSSION

The results of this study showed that babies with SGA had significantly lower mean values ofbirth weight, head circumference, recumbent length,and PI than babies with AGA. These anthropometric indices are important diagnostic criteria for evaluating the risk of various conditions in children, such as CVD, hypertension, diabetes mellitus, and others.[18] This is consistent with previous studies that reported lower anthropometric parameters in babies with SGA.[19] This makes sense scientifically because SGA is defined as a birth weight below the 10th percentile for gestational age,[20] and SGA is associated with reduced anthropometric measurements,especially birth weight and recumbent length.[21] The causesof SGA are varied, but maternal and placental factors are the most common. Maternal factors such as chronic medical conditions (hypertension, renal disease, and collagen vascular diseases), infections (toxoplasmosis, rubella, cytomegalovirus, malaria, trypanosomiasis, and HIV), nutritional status, and substance use (cigarette smoking, alcohol, illicit drugs, and medications) can all cause SGA. Other factors that can lead to SGA include placental factors such as a single umbilical artery, placental hemangiomas, placenta previa, low‑lying placenta, and chronic placental abruption.[22] Therefore, the data from this study indicates a significant decrease in the anthropometric indices of SGA babies.

Cord blood lipids reflect the lipid metabolism of the fetus and the newborn, as most of the lipids in the fetus are produced from glucose and converted into various fatty acids. Only a small fraction comes from the placenta. In our study, we found that SGA babies had significantly lower levels of total cholesterol, triglycerides, HDL-c, and LDL-c than AGA babies. This could be due to the altered intrauterine environment caused by maternal factors during pregnancy, which could affect the lipid metabolism of the neonates. This could also explain their differences in body measurements and lipid profile at birth.[15] However, some studies have reported higher levels of total cholesterol, triglycerides, LDL, and VLDL in SGA babies compared to AGA babies.[1,23] This discrepancy could be due to the inclusion of preterm babies in the SGA group. For instance, Shenoy et al.[23] suggested that premature LBW babies, with or without intrauterine growth restriction, may be at risk of CVDs in adulthood. The long-term consequences of the high cord blood cholesterol observed in premature infants for the development of fatty plaques are still unclear. Although atherosclerosis is known to start in childhood, the possibility of reversing the damage at this early stage is still under debate. Some researchers have reported the presence of fatty streaks in the aorta of fetuses, which they attributed to maternal and/or fetal hypercholesterolemia.[24] They also showed that lipid accumulation occurred in the extracranial arteries of aborted fetuses and preterm infants.[25]

We performed a pearson correlation analysis to investigate how Birth Weight of newborns was associated with four lipid parameters: Triglyceride, Cholesterol, HDL-Cholesterol and LDL-Cholesterol. The results are displayed in Figure 1 to Figure 4. The analysis revealed that there was a significant medium positive association between Birth Weight and Triglyceride, ($r(247) = .496$, $p < .001$), and between Birth Weight and Cholesterol, ($r(247) = .316$, $p < .001$). There was also a significant small positive association between Birth Weight and HDL-Cholesterol, ($r(247) = .157$, $p = .013$). However, there was no significant association between Birth Weight and LDL-Cholesterol, ($r(247) = .0717$, $p = .260$).

According to some studies, there was no significant effect of intrauterine growth restriction on HDL‑c and LDL‑c levels in neonates.[26‑29] This was attributed to the fact that SGA neonates had to rely on alternative substrates such as amino acids and lipids for glucose production through gluconeogenesis. This resulted in increased hepatic synthesis of lipids, especially LDL, VLDL, and chylomicrons, and decreased peripheral utilization of lipids due to reduced activity of lipoprotein lipase.[30,31] There was a positive correlation between birth weight and total cholesterol and triglycerides, and a negative correlation between birth weight and HDL‑c. However, Pardo et al.[28] found that lower birth weight was associated with higher total cholesterol, LDL‑cholesterol, and total cholesterol/HDL‑cholesterol and LDL‑cholesterol/HDL‑cholesterol ratios, indicating a different lipid profile between preterm and term infants.

CONCLUSION

The appropriate-for-gestational-age (AGA) infants had markedly elevated levels of cholesterol, triglycerides, and low-density lipoprotein (LDL) compared to small-for-gestational-age (SGA) infants. This finding suggests that AGA infants may have a higher risk of developing cardiovascular diseases later in life than SGA infants. We hypothesize that the differences in lipid profile levels may be related to the intrauterine environment, maternal nutrition, and genetic factors. Further research is needed to confirm our results and explore the underlying mechanisms of this association.

References

1. Gora A, Dev D, Gupta P, Gupta ML. Correlation of maternal lipid profile with newborn's lipid profile. Int J ContempPediatr2018;5:1523-6.

2. Barnes K, Nestel PJ, Pryke ES, Whyte HM. Neonatal plasma lipids. Med J Aust1972;2:1002-5.

3. Neal WA, John CC. Disorders of lipoprotein metabolism and transport. In: Kliegman RM, Stanton BF, St. Game JW, Schor NF, editors. Nelson Textbook of Pediatrics. 20th ed., Vol. 1. Philadelphia: Elsevier; 2016. p. 691-715.

4. Umar LW, Aliyu IS, Akuyam SA. Evaluation of lipid profile in cord blood of full-term Nigerian newborn infants. Sub Saharan Afr J Med 2017;4:9-14.

5. El-Hazmi MA, Warsy AS. Evaluation of serum cholesterol and triglyceride levels in 1-6-year-old Saudi children. J Trop Pediatr2001;47:181-5.

6. Akuyam SA, Isah HS, Ogala WN. Evaluation of serum lipid profile of under-five Nigerian children. Ann Afr Med 2007;6:119-23.

7. Santosa S, Hensrud DD, Votruba SB, Jensen MD. The influence of sex and obesity phenotype on meal fatty acid metabolism before and after weight loss. Am J Clin Nutr2008;88:1134-41.

8. Mago P, Bharatwaj RS, Verma M, Chatwal J. Cord blood lipid profile at birth among normal Indian newborns and its relation to gestational maturity and birth weight − A cross sectional study. Indian J Res 2013;2:215-8.

9. Kelishadi R, Poursafa P. A review on the genetic, environmental, and lifestyle aspects of the early-life origins of cardiovascular disease. CurrProblPediatrAdolesc Health Care 2014;44:54-72.

10. Aletayeb SM, Dehdashtian M, Aminzadeh M, Moghaddam AE, Mortazavi M, Malamiri RA, et al. Correlation between umbilical cord blood lipid profile and neonatal birth weight. Pediatr Pol 2013;88:521-5.

11.Mól N, Zasada M, Klimek M, Kwinta P. Somatic developmentandsomeindicesoflipidmetabolismin11‑year‑oldchildrenbornwithextremelylowbirthweight(<1000G)(long‑termcohortstudy).DevPeriodMed2017;XXI:4.

12.Ramaraj SM, Bharath AP, Sanjay KM. Lipid profile in neonatesand its relation with birth weight and gestational age. Indian JPediatr2015;82:375‑7.

13.MolinaM,CasanuevaV,CidX,FerradaMC,PérezR,DiosG,*etal*.Lipidprofileinnewbornswithintrauterinegrowthretardation.RevMedChil2000;128:741‑8.

14.BelbasisL,SavvidouMD,KanuC,EvangelouE, TzoulakiI.Birth weight in relation to health and disease in later life: Anumbrella review of systematic reviews and meta‑analyses. BMCMed2016;14:147.

15. Nayak CD, Agarwal V, Nayak DM. Correlation of cord blood lipid heterogeneity in neonates with their anthropometry at birth. Indian J Clin Biochem2013;28:152-7.

16. Lwanga SK, Lemeshow S. Sample Size Determination in Health Studies; a Practical Manual. Switzerland: IRIS, World Health Organization; 1991.

17. UNICEF-WHO. Low Birth Weight Babies (% of births)-Nigeria, World Bank Data; 2014. Available from: http://www.data.unicef. org. [Last accessed on 2020 Nov 20].

18. Sipola-Leppänen M, Vääräsmäki M, Tikanmäki M, Matinolli HM, Miettola S, Hovi P, et al. Cardiometabolic risk factors in young adults who were born preterm. Am J Epidemiol2015;181:861-73.

19. Yildiz B, Ucar B, Aksit A, Aydogdu SD, Colak O, Colak E. Diagnostic values of lipid and lipoprotein levels in late onset neonatal sepsis. Scand J Infect Dis 2009;41:263-7.

20. Harder T, Rodekamp E, Schellong K, Dudenhausen JW, Plagemann A. Birth weight and subsequent risk of type 2 diabetes: A meta-analysis. Am J Epidemiol2007;165:849-57.

21. Araújo de França GV, Restrepo-Méndez MC, Loret de Mola C, Victora CG. Size at birth and abdominal adiposity in adults: A systematic review and meta-analysis. Obes Rev 2014;15:77-91.

22. Samaras TT, Elrick H, Storms LH. Birthweight, rapid growth, cancer, and longevity: A review. J Natl Med Assoc 2003;95:1170-83.

23. Shenoy J, Reddy V, Baliga KN. Serum lipid profile in preterm and term appropriate for gestational age Indian newborns: A hospital based comparative study. J Neonatal Biol2014;3:156

24.NapoliC,D'ArmientoFP,ManciniFP,PostiglioneA,WitztumJL,PalumboG,*etal*.Fattystreakformationoccursinhumanfetalaortasandisgreatlyenhancedbymaternalhypercholesterolemia.Intimalaccumulationoflowdensitylipoprotein and its oxidation precede monocyte recruitment intoearlyatheroscleroticlesions.JClinInvest1997;100:2680‑90.

25 Napoli C, Witztum JL, de Nigris F, Palumbo G, D'Armiento FP,PalinskiW.Intracranialarteriesofhumanfetusesaremoreresistant to hypercholesterolemia‑induced fatty streak formationthanextracranialarteries.Circulation1999;99:2003‑10.

26 Jones JN, Gercel‑Taylor C, Taylor DD. Altered cord serum lipidlevels associated with small for gestational age infants. ObstetGynecol1999;93:527‑31.

27 MillánJ,PintóX,MuñozA,ZúñigaM,Rubiés‑PratJ,Pallardo LF, *et al.* Lipoprotein ratios: Physiological significanceand clinical usefulness in cardiovascular prevention. Vasc HealthRiskManag2009;5:757‑65.

28. PardoIM,GelonezeB,TambasciaMA,Barros‑FilhoAA.Atherogenic lipid profile of Brazilian near‑term newborns. Braz JMedBiolRes2005;38:755‑60.

29.Wang C, Zhu W, Wei Y, Su R, Feng H, Hadar E, *et al.* Theassociationsbetweenearlypregnancylipidprofilesandpregnancyoutcomes.JPerinatol2017;37:127‑33.

30. Davey Smith G, Hyppönen E, Power C, Lawlor DA. Offspringbirthweightandparentalmortality:Prospectiveobservationalstudyandmeta‑analysis.AmJEpidemiol2007;166:160‑9.

31.Kazemi SA, Sadeghzadeh M. Lipid profile of cord blood in termnewborns.JCompPediatr2014;5:1‑6