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Determining the Correlation between Cord Blood Lipid Profile and Birth Weight among Term Babies

Pallavi A. Rathod [a++], Avinash Namdeo Jadhao [b#*], Meeta Piyush Shah [c†], Santosh Shivpal Pathare [d†], Shubhada Girish Vengurlekar [e†] and Kalpana Ganesh Kinage [f†]

[a] Kasturba Hospital for Infectious Diseases, Mumbai, India.
[b] Department of Biochemistry, Seth GSMC & KEMH, Parel, Mumbai, India.
[c] Bai Gulbai Municipal Dispensary G North, India.
[d] Department of Physiology, Seth GSMC & KEMH Parel Mumbai, India.
[e] 45 BDD Municipal Dispensary G South, Mumbai, India.
[f] Drug Deaddiction Centre, Psychiatry Department, Seth GSMC & KEMH Parel Mumbai, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aimed to examine the association between cord blood lipid levels and neonatal birth weight.
Study Design: Hospital based prospective cross-sectional study.

[++] Senior Resident;
[#] Associate Professor;
[†] Laboratory Technician;
**Corresponding author: Email: avinashjadhao@kem.edu;*

Place and Duration of Study: Study was conducted in Government medical College Nagpur, a tertiary care hospital that provides maternal and child health services between June 2011 to March 2013

Methodology: 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.

Results: 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 AGA than SGA 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: SGA babies had significantly higher cord blood lipid profile levels than AGA babies. The lipid profile of umbilical cord blood is related to the fetal nutritional status and growth and development. This may have implications for the prevention and management of low birth weight and its associated complications

Keywords: Umbilical cord blood; lipid profile; small for gestational age; appropriate for gestational age.

1. 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 [1-4]. 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].

Although serum lipid profile have been extensively studied in, limited studies are available in paediatric population in our country Cord blood lipid profile is a measure of the levels of cholesterol, triglycerides, and other lipids in the blood of newborns. Birth weight is an important indicator of the health and development of infants. Several studies [16,17,18] have investigated the possible association between cord blood lipid profile and birth weight among term babies, but the results are inconsistent and inconclusive. Some study have found a positive correlation, suggesting that higher lipid levels are associated with higher birth weight [16]. Other study have found a negative correlation, implying that lower lipid levels are linked to higher birth weight [17]. Yet other study have found no significant correlation at all, indicating that cord blood lipid profile and birth weight are independent of each other [19]. The reasons for these discrepancies are unclear, but may depend on various factors such as maternal

diet, gestational age, placental function, genetic variations, and environmental influences. Therefore, more research is needed to clarify the relationship between cord blood lipid profile and birth weight among term babies, and to identify the underlying mechanisms and implications for neonatal health. The present study was undertaken for early detection of abnormal lipid profile at earliest (at birth) in the term newborns so that high risk babies can be under vigilant monitoring in future. Objective of our study was to assess to compare the cord blood lipid profile between term SGA(small for gestational age) and AGA(appropriate for gestational age) neonates and to correlate to with anthropometric measurement of newborns.

Early diagnosis followed by prudent dietary supplementation and drug therapy in these high risk neonates may provide an opportunity for long range amelioration of risk factors that contribute to development of cardiovascular diseases in adult life.

To estimate cord lipid profile (total cholesterol [TC], triglyceride [TG], high density lipoprotein [HDL], low density lipoprotein [LDL], (VLDL) (very low density lipoprotein) in SGA and AGA of neonates and compare the cord blood lipid profile between term SGA and AGA neonates and to correlate to with anthropometric measurement of newborns.

2. MATERIALS AND METHODS

2.1 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.

2.2 Study Population

This study is a prospective cross-sectional analysis of 200 pregnant women who attended antenatal care at the Departments of Obstetrics and Gynaecology 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.

2.3 Study Variables

Term neonates - Neonates born in between 37 to <42 weeks of gestation.

Preterm neonates - Neonates born before 37 completed weeks of gestation.
Appropriate for gestational age - Neonates with birth weight between 10th percentile and 90th percentile for gestational age.

Small for gestational age - Neonates with birth weight less than 10th percentile for gestational age.
Lower birth weight is a term used to describe babies who are born weighing less than 2,500 grams.

2.4 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).

2.5 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.

2.6 Sample Size

Sample size was sample of convenience. A total of consecutive 200 term neonates were included in the study. The study group consist of 150 AGA and 50 SGA.

2.7 Method of Study

Newborn who fulfilled the inclusion criteria were enrolled in this study, 5 ml of umbilical cord blood was collected immediately after the delivery in a plain yellow topped vacutainer. Cord blood

immediately sent to laboratory where the samples were centrifuged at 2000 revolution per minute for 10 minutes and then serum was separated and stored at -20^{o} C until analysis.

2.8 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

2.9 Statistical Analysis

The categorical variable was presented in number and percentage and the continuous variable was presented as mean ±SD and median. The normality of data was tested by the Kolmogorov-Smirnov test. If the normality was rejected then the nonparametric test was used.

The statistical test were applied as follows-

1. Quantitative variables were compared using ANOVA/KRUSKAL WALLIS test (when the data sets were not normally distributed) between more than two groups. For two groups, unpaired t-test/Mann-Whitney test were used.
2. The qualitative variables were correlated using the chi-square test/Fischer exact test.
3. Pearson correlation coefficient/spearman rank correlation coefficient (for nonparametric data) was used to correlate quantitative variables with each other.

A p-value of <0.05 was considered statistically significant. The data was entered in MS EXCEL spreadsheet and analysis was done using Graph Pad Prism version 9.

3. RESULTS AND DISCUSSION

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: Small for gestational age, AGA: Appropriate for gestational age

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 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.

Cord lipids have become a topic of growing interest because childhood is the origin of many serum lipid disorders and atherosclerosis may start early in life [17]. “The lipid profile reflects the cardiovascular health of the individual, and there is a direct link between lipid profile abnormalities and the risk of cardiovascular events and death” [18]. “The cord serum lipid levels indicate the status of lipid metabolism in the infant at birth, since most of the fetal lipids are produced from glucose conversion to various fatty acid compounds. Only a fraction of them come from the placental circulation, so measuring the cord blood lipid profile is equivalent to measuring the

Table 1. Comparison of anthropometric measurements of babies based on neonatal birth weight

Anthropometric parameters	SGA (*n*=50)	AGA (*n*=150)	*P value*
Birth weight (kg)	2.24±0.3	2.83±0.4	0.01
Head circumference (cm)	31.5±1.5	33.4±1.8	0.04
Recumbent length (cm)	51.2±0.3	53.6±0.2	0.04
Ponderal Index (g/cm^{3})	2.24±0.6	2.35±0.3	0.03

Table 2. Comparison of the levels of measured parameters in cord blood samples based on birth weight (mean±standard deviation)

Parameters	Small for gestational age (<2.5kg) (*n*=50)	Appropriate for gestational age (>2.5 kg) (*n*=150)	*P value*
Cholesterol (mg/dl)	81.46±3.11	59.94±1.55	0.001
Triglycerides (mg/dl)	188±2.36	53.1±3.29	0.001
HDL (mg/dl)	28.4±1.47	35.9±0.10	0.001
LDL (mg/dl)	28.4±1.3	19.9±1.6	0.001

Fig. 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 < 0.001)

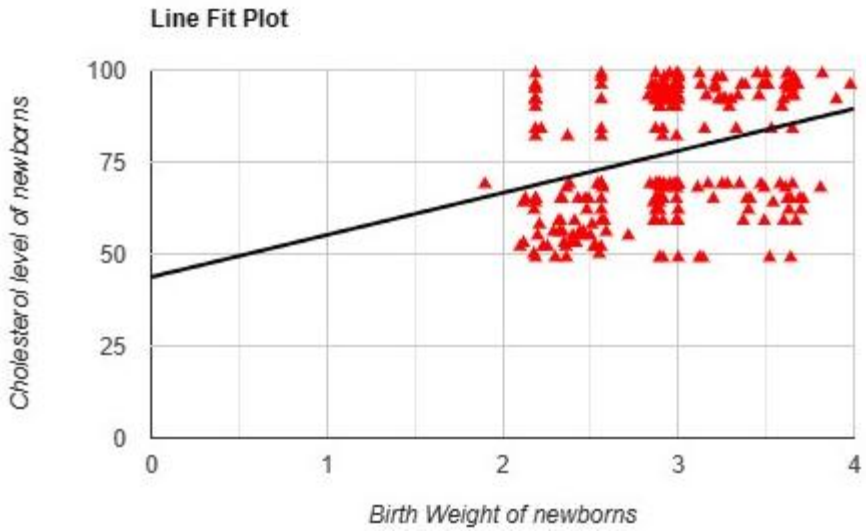

Fig. 2. Results of the pearson correlation indicated that there is a significant medium positive relationship between Birth Weight of newborns and Cholesterol of Newborns, (r(247) = 0.316, p < 0.001)

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) = 0.157, p = 0.013)

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) = 0.0717, p = .260)

lipid metabolism during fetal development and at birth" [19]. "Among the various factors involved in atherosclerosis, high levels of cholesterol and/or triglycerides are considered to be the most critical. Moreover, many researchers regard LDL and HDL as the main risk factors for the development and progression of atherosclerotic vascular diseases. Therefore, measuring the cord lipid profile can help identify babies at higher risk earlier, as some studies suggest that atherosclerotic lesions may begin in childhood. There are also many studies that show a direct association between lipid profile abnormalities in preterm and SGA neonates and cardiovascular diseases. The aim of this study was to detect any abnormalities in the lipid profile as early as possible (at birth), especially in preterm and SGA neonates, so that these high-risk babies can be monitored closely in the future" [20].

The table 2 shows the results of measuring different types of lipids in the blood of SGA and AGA neonates. We found that SGA neonates had higher levels of Triglycerides, Total

cholesterol, LDL, and VLDL, and lower levels of HDL than AGA neonates. However, only the difference in Triglycerides was statistically significant (P<0.005). This may be because SGA neonates produce more Triglycerides and VLDL, and break them down less efficiently due to lower lipoprotein lipase activity [21]. Jane Oba et al. reported similar findings in their study, where they compared Preterm SGA, Preterm AGA, Term SGA, and Term AGA groups. They found that all lipid levels were significantly higher in SGA groups than in AGA groups, with P values ranging from <0.0001 to <0.01[22].

"Our study agrees with the finding of Ajay Kumar et al., who reported that Term AGA and Preterm AGA had higher TC levels than Term SGA and Preterm SGA, but the difference was not statistically significant. On the other hand, Term SGA and Preterm SGA had higher TG levels than Term AGA and Preterm AGA, and the difference was statistically significant (p=<0.05)" [23].

In their research paper, Tejasree Katragadda and colleagues investigated the association between small for gestational age (SGA) status and lipid profile in newborns. They measured the serum levels of total cholesterol, triglycerides, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) in 50 SGA and 50 appropriate for gestational age (AGA) infants" [24]. They found that SGA infants had significantly higher levels of total cholesterol, triglycerides, and LDL than AGA infants, while HDL levels were similar between the two groups. These results suggest that SGA infants may have an increased risk of developing dyslipidemia and cardiovascular diseases later in life.

Low birth weight infants are at risk of intrauterine malnutrition, which affects their metabolism and growth. One of the consequences of this condition is the breakdown of fetal fat tissue, which releases free fatty acids into the bloodstream. These fatty acids are not used for energy production, but instead are converted into triglycerides in the liver. This leads to high levels of triglycerides in low birth weight babies. Intrauterine malnutrition may be caused by placental insufficiency or other factors [25].

Many people think that coronary heart disease is mainly caused by unhealthy habits in adulthood, such as lack of physical activity, high-fat diet and smoking. However, the fetal hypothesis proposes that fetal nutrition is also an important factor that influences the development of this disease. According to this hypothesis, genetic factors and lifestyle factors are not the only determinants of coronary heart disease, but they interact with fetal nutrition to shape the risk profile of individuals. Some studies have shown that hyperlipoproteinemia at birth is associated with increased risk of coronary artery disease later in life [26].

We performed a pearson correlation analysis to investigate the association between Birth Weight of newborns and four lipid parameters in umbilical cord blood: 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 correlation between Birth Weight and Triglyceride of umbilical cord blood of neonates, ($r(247) = 0.496$, $p < 0.001$), and between Birth Weight and Cholesterol of umbilical cord blood of neonates, ($r(247) = 0.316$, $p < .001$). There was also a significant small positive correlation between Birth Weight and HDL-Cholesterol of umbilical cord blood of neonates, ($r(247) = 0.157$, $p = 0.013$). However, there was no significant correlation between Birth Weight and LDL-Cholesterol of umbilical cord blood of neonates, ($r(247) = 0.0717$, $p = 0.260$). The significance of these findings is that they suggest that the lipid profile of umbilical cord blood may reflect the nutritional status of the fetus and influence its growth and development [27-29]. This may have implications for the prevention and management of low birth weight and its associated complications.

4. CONCLUSION

The lipid profile of umbilical cord blood may reflect the nutritional status of the fetus and influence its growth and development. This may have implications for the prevention and management of low birth weight and its associated complications. The conclusion is based on the results of measuring different types of lipids in the blood of SGA and AGA neonates, and performing a correlation analysis between birth weight and lipid parameters. The conclusion is supported by the findings that SGA neonates had higher levels of Triglycerides, Total cholesterol, LDL, and VLDL, and lower levels of HDL than AGA neonates, and that there was a significant positive correlation between birth weight and Triglyceride, Cholesterol, and HDL-Cholesterol of umbilical cord blood. The conclusion is also consistent with previous studies that reported similar findings. The

conclusion is important because it may help to understand the mechanisms of fetal growth restriction and its consequences, and to develop interventions to improve the outcomes of low birth weight infants. Further research is needed to confirm our results and explore the underlying mechanisms of this association.

5. LIMITATIONS OF OUR STUDY

The current study has some limitations

1. The various factors affecting neonatal birth weight like maternal nutrition, pre pregnancy weight, and weight gain during pregnancy were not considered in this study.
2. The Present study was cross sectional study with small sample size.
3. Another major limitation of our study was its inability to determine the cut-off lipid levels for cardiovascular risk stratification.

CONSENT AND ETHICAL APPROVAL

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. As per international standard parental consent has been collected

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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