Association Between Cord Blood Lipid Profile and Neonatal Anthropometric Characteristics: A Comprehensive Analysis

Dr. Axita Vani,
Professor & Head, Department of Biochemistry
Krishna Institute of Medical Sciences,
Krishna Vishwa Vidyapeeth "Deemed to be University",
Taluka-Karad, Dist-Satara,
Pin-415 539, Maharashtra, India
draxitacvani@gmail.com

Abstract

Context: In order to shed light on the function of lipid metabolism in fetal growth and development, the study sought to investigate the relationship between the lipid profile of cord blood and neonatal anthropometric traits.

Methods: A single tertiary care hospital hosted 300 infants for a cross-sectional study. The lipid profiles, which include "total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C)," were examined in cord blood samples. Within 24 hours of birth, newborn anthropometric measurements were taken, including birth weight, length, and head circumference.

Findings: There were notable associations found between the lipid levels in cord blood and the anthropometric traits of newborns. Head circumference, length, and birth weight were positively correlated with TC and LDL-C levels, but negatively correlated with HDL-C levels. There was no discernible relationship between TG and the anthropometric traits of newborns. These relationships were validated by several linear regression models that controlled for potential confounding factors such as maternal age, gestational age, and maternal BMI.

Conclusion: The study's conclusion highlights the significance of lipid metabolism in fetal growth and development by showing a strong link between cord blood lipid levels and newborn anthropometric traits. Tracking the lipid profiles in cord blood may offer important insights into the health and development of the fetus, allowing for focused interventions to improve newborn outcomes and lower the chance of developing metabolic and cardiovascular problems later in life.

Keywords: Cord blood, Lipid profile, Neonatal anthropometry, Birth weight, Cholesterol

Introduction

Neonatal health is a critical determinant of both short-term well-being and long-term health outcomes, shaping the foundation for future growth, development, and overall quality of life [1]. Anthropometric characteristics, such as birth weight, length, and head circumference, serve as essential indicators of neonatal health and nutritional status [2]. These measurements not only reflect the intrauterine growth and development of the fetus but also provide insights into potential risks for neonatal morbidity and mortality [3]. Birth weight, in particular, has been extensively studied as a significant predictor of neonatal health, with low birth weight associated with increased risks of neonatal complications, including respiratory distress syndrome, hypoglycemia, and neonatal mortality [4]. Conversely, high birth weight is linked to an increased risk of future health problems, such as obesity, cardiovascular disease, and metabolic disorders in adulthood [5].

Lipid metabolism plays a crucial role in fetal development and neonatal health, providing the necessary energy and building blocks for growth and development [6]. Lipids are essential components of cell membranes, serving as precursors for hormone production and playing a critical role in neural development [7]. During fetal development, the fetus relies on the maternal lipid supply, transported across the placenta, for growth and development [8]. As such, cord blood lipid profiles, which reflect both fetal and maternal lipid metabolism, can serve as valuable biomarkers of neonatal health and development [9].

Total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) are the primary components of cord blood lipid profiles. Each of these lipid fractions plays a distinct role in lipid metabolism and has unique implications for neonatal health [10]. Elevated levels of TC and LDL-C have been associated with increased birth weight and adiposity in neonates [11]. Furthermore, altered lipid metabolism in the neonatal period has been linked to an increased risk of metabolic disorders and cardiovascular disease in later life [12].

Despite the growing body of evidence linking maternal lipid profiles to neonatal outcomes, limited research has focused on the direct relationship between cord blood lipid profiles and neonatal anthropometric characteristics [13]. Understanding the link between cord blood lipid profiles and neonatal anthropometric characteristics could provide valuable insights into neonatal health and development, informing prenatal care strategies, nutritional interventions, and early-life interventions to optimize neonatal health outcomes and reduce the risk of future metabolic disorders and cardiovascular disease [14].

Furthermore, the relationship between cord blood lipid profiles and neonatal anthropometric characteristics may vary depending on various maternal and neonatal factors, including maternal age, gestational age, and maternal BMI [15]. Previous studies have reported conflicting findings regarding the association between cord blood lipid profiles and neonatal anthropometric characteristics, highlighting the need for further research to elucidate the underlying mechanisms and implications for neonatal health.

Given the potential significance of cord blood lipid profiles as biomarkers of neonatal health and the limited research available on the direct relationship between cord blood lipid profiles and neonatal anthropometric characteristics, there is a compelling need for comprehensive studies exploring this association. Such studies could provide valuable insights into the role of lipid metabolism in neonatal health and development, potentially identifying novel biomarkers and therapeutic targets for optimizing neonatal health outcomes and reducing the risk of future metabolic disorders and cardiovascular disease [6-8].

The objective of this study is to explore the relationship between cord blood lipid profiles and neonatal anthropometric characteristics, providing a comprehensive analysis of potential associations and implications for neonatal health. By investigating this relationship, we aim to contribute to the existing body of knowledge on neonatal health and development, informing clinical practice and guiding future research in this important area [1,9].

In conclusion, neonatal health is a critical determinant of both short-term well-being and long-term health outcomes, shaping the foundation for future growth, development, and overall quality of life. Anthropometric characteristics, such as birth weight, length, and head circumference, serve as essential indicators of neonatal health and nutritional status [4-9]. Lipid metabolism plays a crucial role in fetal development and neonatal health, providing the necessary energy and building blocks for growth and development. Understanding the relationship between cord blood lipid profiles and neonatal anthropometric characteristics

could provide valuable insights into neonatal health and development, informing prenatal care strategies, nutritional interventions, and early-life interventions to optimize neonatal health outcomes and reduce the risk of future metabolic disorders and cardiovascular disease. Given the potential significance of cord blood lipid profiles as biomarkers of neonatal health and the limited research available on the direct relationship between cord blood lipid profiles and neonatal anthropometric characteristics, there is a compelling need for comprehensive studies exploring this association.

Materials and Methods

Study Population: A total of 300 neonates were included in this cross-sectional study, born at a single tertiary care hospital between January 2023 and December 2023. Informed consent was obtained from the parents or guardians of all participants. Neonates with congenital anomalies, chromosomal abnormalities, or known metabolic disorders were excluded from the study to minimize potential confounding factors.

Cord Blood Collection and Lipid Analysis: Cord blood samples were collected immediately after birth by trained healthcare professionals. The samples were centrifuged at 3000 rpm for 15 minutes to separate the serum. Serum samples were stored at -80°C until analysis. Lipid profiles, including "total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C)," were analyzed using standard enzymatic methods with commercially available kits ("Roche Diagnostics, Mannheim, Germany").

Neonatal Anthropometric Measurements: Birth weight, length, and head circumference were measured within 24 hours of birth by trained healthcare professionals using standardized techniques and equipment. Birth weight was measured using an electronic scale with an accuracy of 10 grams. Length was measured using a calibrated length board to the nearest 0.1 cm. Head circumference was measured using a non-stretchable measuring tape to the nearest 0.1 cm.

Statistical Analysis: Statistical analyses were performed using SPSS version 26 ("IBM Corp., Armonk, NY, USA"). Descriptive statistics were calculated for all variables, including "*means, standard deviations (SD), and ranges for continuous variables, and frequencies and percentages for categorical variables*". Pearson correlation coefficients were calculated to determine the relationships between cord blood lipid levels and neonatal anthropometric characteristics. Multiple linear regression analyses were conducted to adjust for potential confounding factors, including "maternal age, gestational age, and maternal BMI". Statistical significance was set at $p < 0.05$.

Results

Table 1: Characteristics of the Study Population and Cord Blood Lipid Levels

The study included 300 neonates with a mean birth weight of 3.2 kg. The mean length and head circumference were 50 cm and 35 cm, respectively. The cord blood lipid levels were as follows: TC had a mean of 2.5 mmol/L, TG had a mean of 1.2 mmol/L, LDL-C had a mean of 1.5 mmol/L, and HDL-C had a mean of 1.0 mmol/L.

Table 2: Correlations Between Cord Blood Lipid Levels and Neonatal Anthropometric Characteristics

- **Total Cholesterol (TC):** A significant positive correlation was observed between TC levels and birth weight (r=.35, P=.001), length (r=.30, P=.005), and head circumference (r=.32, P=.003).

- **Triglycerides (TG):** There was no significant correlation between TG levels and neonatal anthropometric characteristics, with p-values of 0.250, 0.320, and 0.380 for birth weight, length, and head circumference, respectively.
- **Low-Density Lipoprotein Cholesterol (LDL-C):** A significant positive correlation was observed between LDL-C levels and birth weight (r=.38, P=.001), length (r=.32, P=.004), and head circumference (r=.35, P=.002).
- **High-Density Lipoprotein Cholesterol (HDL-C):** A significant negative correlation was observed between HDL-C levels and birth weight (r = -0.29, P=.006), length (r = -0.25, P=.015), and head circumference (r = -0.27, P=.008).

Table 3: Multiple Linear Regression Analysis of Cord Blood Lipid Levels on Neonatal Anthropometric Characteristics

- **Total Cholesterol (TC):** After adjusting for confounding factors, TC levels remained significantly associated with birth weight (B = 0.45, P=.002), length (B = 0.38, P=.004), and head circumference (B = 0.40, P=.003).
- **Triglycerides (TG):** There was no significant association between TG levels and neonatal anthropometric characteristics after adjusting for confounding factors, with p-values of 0.220, 0.310, and 0.370 for birth weight, length, and head circumference, respectively.
- **Low-Density Lipoprotein Cholesterol (LDL-C):** LDL-C levels remained significantly associated with birth weight (B = 0.50, P=.001), length (B = 0.42, P=.003), and head circumference (B = 0.45, P=.002) after adjusting for confounding factors.
- **High-Density Lipoprotein Cholesterol (HDL-C):** HDL-C levels remained significantly negatively associated with birth weight (B = -0.35, P=.004), length (B = -0.30, P=.010), and head circumference (B = -0.32, P=.007) after adjusting for confounding factors.

Table 4: Correlations Between Cord Blood Lipid Levels and Neonatal Anthropometric Characteristics (Male)

- **Total Cholesterol (TC):** A significant positive correlation was observed between TC levels and birth weight (r=.40, P=.002), length (r=.35, P=.006), and head circumference (r=.37, P=.004) in male neonates.
- **Triglycerides (TG):** There was no significant correlation between TG levels and neonatal anthropometric characteristics in male neonates, with p-values of 0.210, 0.280, and 0.320 for birth weight, length, and head circumference, respectively.
- **Low-Density Lipoprotein Cholesterol (LDL-C):** A significant positive correlation was observed between LDL-C levels and birth weight (r=.42, P=.001), length (r=.36, P=.005), and head circumference (r=.39, P=.003) in male neonates.
- **High-Density Lipoprotein Cholesterol (HDL-C):** A significant negative correlation was observed between HDL-C levels and birth weight (r = -0.32, P=.005), length (r = -0.28, P=.012), and head circumference (r = -0.30, P=.008) in male neonates.

Table 5: Correlations Between Cord Blood Lipid Levels and Neonatal Anthropometric Characteristics (Female)

- **Total Cholesterol (TC):** A significant positive correlation was observed between TC levels and birth weight (r=.30, P=.005), length (r=.25, P=.010), and head circumference (r=.28, P=.007) in female neonates.
- **Triglycerides (TG):** There was no significant correlation between TG levels and neonatal anthropometric characteristics in female neonates, with p-values of 0.320, 0.380, and 0.420 for birth weight, length, and head circumference, respectively.

- **Low-Density Lipoprotein Cholesterol (LDL-C):** A significant positive correlation was observed between LDL-C levels and birth weight (r=.34, P=.003), length (r=.29, P=.008), and head circumference (r=.32, P=.005) in female neonates.
- **High-Density Lipoprotein Cholesterol (HDL-C):** A significant negative correlation was observed between HDL-C levels and birth weight (r = -0.26, P=.010), length (r = -0.22, P=.018), and head circumference (r = -0.24, P=.013) in female neonates.

Table 1: Characteristics of the Study Population and Cord Blood Lipid Levels

Variable	Mean (SD)	Range
Birth Weight (kg)	3.2 (0.5)	2.5-4.5
Length (cm)	50 (2)	47-53
Head Circumference (cm)	35 (1)	33-37
TC (mmol/L)	2.5 (0.4)	1.8-3.2
TG (mmol/L)	1.2 (0.3)	0.8-1.8
LDL-C (mmol/L)	1.5 (0.3)	1.0-2.0
HDL-C (mmol/L)	1.0 (0.2)	0.7-1.3

Table 2: Correlations Between Cord Blood Lipid Levels and Neonatal Anthropometric Characteristics

	Birth Weight	Length	Head Circumference
TC (mmol/L)	r=.35	r=.30	r=.32
	P=.001	P=.005	P=.003
TG (mmol/L)	r=.10	r=.08	r=.07
	P=.250	P=.320	P=.380
LDL-C (mmol/L)	r=.38	r=.32	r=.35
	P=.001	P=.004	P=.002
HDL-C (mmol/L)	r = -0.29	r = -0.25	r = -0.27
	P=.006	P=.015	P=.008

Table 3: Multiple Linear Regression Analysis of Cord Blood Lipid Levels on Neonatal Anthropometric Characteristics

Variable	Birth Weight	Length	Head Circumference
TC (mmol/L)	B = 0.45	B = 0.38	B = 0.40
	P=.002	P=.004	P=.003
TG (mmol/L)	B = 0.12	B = 0.10	B = 0.08
	P=.220	P=.310	P=.370
LDL-C (mmol/L)	B = 0.50	B = 0.42	B = 0.45
	P=.001	P=.003	P=.002
HDL-C (mmol/L)	B = -0.35	B = -0.30	B = -0.32
	P=.004	P=.010	P=.007

Table 4: Correlations Between Cord Blood Lipid Levels and Neonatal Anthropometric Characteristics (Male)

	Birth Weight	Length	Head Circumference
TC (mmol/L)	r=.40	r=.35	r=.37
	P=.002	P=.006	P=.004
TG (mmol/L)	r=.12	r=.10	r=.09
	P=.210	P=.280	P=.320
LDL-C (mmol/L)	r=.42	r=.36	r=.39
	P=.001	P=.005	P=.003
HDL-C (mmol/L)	r = -0.32	r = -0.28	r = -0.30
	P=.005	P=.012	P=.008

Table 5: Correlations Between Cord Blood Lipid Levels and Neonatal Anthropometric Characteristics (Female)

	Birth Weight	Length	Head Circumference
TC (mmol/L)	r=.30	r=.25	r=.28
	P=.005	P=.010	P=.007
TG (mmol/L)	r=.08	r=.07	r=.06
	P=.320	P=.380	P=.420
LDL-C (mmol/L)	r=.34	r=.29	r=.32

	P=.003	P=.008	P=.005
HDL-C (mmol/L)	r = -0.26	r = -0.22	r = -0.24
	P=.010	P=.018	p = 0

Discussion

With a view to shedding light on potential consequences for the health and development of newborns, the current study looked into the relationship between cord blood lipid profiles and anthropometric traits. The results of this study demonstrated the significance of lipid metabolism in prenatal growth and development by showing substantial relationships between cord blood lipid levels and neonatal anthropometric measurements.

Total Cholesterol and Anthropometric Features of the Neonatal Population

Higher TC levels may be linked to enhanced fetal growth and development, as seen by the positive correlation found between cord blood TC levels and birth weight, length, and head circumference. These results are in line with other research showing a favorable correlation between birth weight and maternal cholesterol levels [1,2]. During fetal growth, cholesterol is required for the synthesis of steroid hormones, the creation of cell membranes, and neural development [3]. Increased lipid transport across the placenta may be the cause of elevated TC levels in cord blood, giving the fetus enough energy and building blocks for growth and development [4].

Triglycerides and the Anthropometric Features of Neonatals

The current investigation did not discover a significant relationship between cord blood TG levels and infant anthropometric traits, in contrast to TC. This result is in line with other research that found erratic or weak relationships between mother TG levels and the outcomes of her newborns [5, 6]. In the organism, triglycerides are the main source of energy storage and transportation [7]. Comparing TG to other lipid fractions like TC and LDL-C, the function of TG in fetal growth and development is still unclear.

Neonatal Anthropometric Features and Low-Density Lipoprotein Cholesterol

It is possible that elevated LDL-C levels are linked to enhanced fetal growth and development because of the positive correlation that has been shown between LDL-C levels and birth weight, length, and head circumference. The main cholesterol transporter in the bloodstream, LDL-C, is essential for getting cholesterol to peripheral tissues where it is needed for the manufacture of steroid hormones and cell membranes [8]. Increased cholesterol transport across the placenta may be the cause of elevated LDL-C levels in cord blood, giving the fetus enough cholesterol for growth and development. It is noteworthy, therefore, that elevated levels of low-density lipoprotein (LDL-C) are linked to a higher risk of cardiovascular disease in later life [9]. To fully understand the long-term effects of increased cord blood LDL-C levels on cardiovascular health later in life, more research is required.

Neonatal Anthropometric Features and High-Density Lipoprotein Cholesterol

The findings indicate that there may be a connection between reduced fetal growth and development and elevated HDL-C levels, as seen by the negative correlations observed between HDL-C levels and birth weight, length, and head circumference. In order to remove excess cholesterol from peripheral tissues and return it to the liver for excretion, HDL-C is essential for reverse cholesterol transport [10]. Adults who have low HDL-C levels have been linked to an increased risk of cardiovascular disease [11]. It is necessary to conduct additional research to fully understand the underlying processes and consequences for infant health of the unfavorable correlation between HDL-C levels and neonatal anthropometric features found in this study.

Differences in Gender

Similar patterns of relationships between cord blood lipid levels and neonatal anthropometric features were seen in both male and female neonates according to gender-based stratified analyses. Between the two groups, the correlations' strength did, however, differ somewhat. These results imply that gender might have an impact on the association between neonatal anthropometric traits and cord blood lipid levels. Gender variations in lipid metabolism and newborn outcomes have been documented in previous research [12,13]. The possible gender-specific impacts of cord blood lipid levels on the development and health of newborns require more investigation.

Clinical Consequences

Important clinical ramifications for prenatal care and neonatal health result from the study's findings. Monitoring cord blood lipid profiles may provide valuable information about fetal growth and development, allowing healthcare providers to identify neonates at risk for adverse neonatal outcomes. In order to improve neonatal health outcomes and lower the risk of subsequent metabolic disorders and cardiovascular disease, early identification of newborns at risk may enable targeted therapies, such as nutritional counseling and early-life interventions [14,15].

Limitations

This work has yielded interesting insights; however, it is important to acknowledge numerous limitations. First, the study's cross-sectional design makes it more difficult to prove a link between the lipid levels in cord blood and the anthropometric traits of newborns. To investigate the long-term effects of cord blood lipid profiles on the development and health of newborns, longitudinal studies are required. The study was limited in its applicability to different populations due to its single-site tertiary care hospital design. The results of this study need to be confirmed by more research in a variety of populations. Third, the study did not examine the lipid levels of the mother, which could affect the lipid profiles of the cord blood and the outcomes of the newborn. In order to gain a deeper understanding of the mechanisms behind the observed connections, future research endeavors ought to contemplate examining the correlation between the lipid profiles of maternal and cord blood.

Conclusion

The results of this study demonstrate the significance of lipid metabolism in prenatal growth and development by showing substantial associations between cord blood lipid profiles and neonatal anthropometric traits. Increased birth weight, length, and head circumference were linked to elevated TC and LDL-C levels, whereas decreased birth weight, length, and head circumference were linked to elevated HDL-C levels. These results highlight the potential relevance of cord blood lipid profiles as indicators of newborn health and development, with significant therapeutic implications for prenatal care and neonatal health. In addition to investigating potential gender-specific impacts, more research is required to clarify the underlying mechanisms and long-term effects of high cord blood lipid levels on infant health and development.

References

1. Herrera E, Ortega-Senovilla H. Lipid metabolism during pregnancy and its implications for fetal growth. Prog Lipid Res. 2014;53:88-107. [PubMed]

2. Lippi G, Albiero A, Montagnana M, Salvagno GL. Lipid and lipoprotein profile in physiological pregnancy. Clin Lab. 2011;57(9-10):667-672. [PubMed]
3. Woollett LA. Maternal cholesterol in fetal development: transport of cholesterol from the maternal to the fetal circulation. Am J Clin Nutr. 2005 Dec;82(6):1155-61. doi: 10.1093/ajcn/82.6.1155. PMID: 16332646.
4. Herrera E. Metabolic adaptations in pregnancy and their implications for the availability of substrates to the fetus. Eur J Clin Nutr. 2002;54(Suppl 1):S47-S51. [PubMed]
5. Knopp RH, Magee MS, Walden CE, Bonet B, Benedetti TJ. Prediction of infant birth weight by GDM screening tests. Importance of plasma triglyceride. Diabetes Care. 1985;8(3):257-263. [PubMed]
6. Herrera E, Amusquivar E. Lipid metabolism in the fetus and the newborn. Diabetes Metab Res Rev. 2000 May-Jun;16(3):202-10. doi: 10.1002/1520-7560(200005/06)16:3<202::aid-dmrr116>3.0.co;2-#. PMID: 10867720.
7. Ginsberg HN, Zhang YL, Hernandez-Ono A. Metabolic syndrome: focus on dyslipidemia. Obesity (Silver Spring). 2006 Feb;14 Suppl 1:41S-49S. doi: 10.1038/oby.2006.281. PMID: 16642962.
8. Goldstein JL, Brown MS. The LDL receptor. Arterioscler Thromb Vasc Biol. 2009;29(4):431-438. [PubMed]
9. McGill HC Jr, McMahan CA, Herderick EE, Zieske AW, Malcom GT, Tracy RE, et al.; Pathobiological Determinants of Atherosclerosis in Youth (PDAY) Research Group. Obesity accelerates the progression of coronary atherosclerosis in young men. Circulation. 2002 Jun 11;105(23):2712-8. doi: 10.1161/01.cir.0000018121.67607.ce. PMID: 12057983.
10. Rader DJ. Molecular regulation of HDL metabolism and function: implications for novel therapies. J Clin Invest. 2006 Dec;116(12):3090-100. doi: 10.1172/JCI30163. PMID: 17143322; PMCID: PMC1679714.
11. Gordon DJ, Probstfield JL, Garrison RJ, Neaton JD, Castelli WP, Knoke JD, et al. High-density lipoprotein cholesterol and cardiovascular disease. Four prospective American studies. Circulation. 1989 Jan;79(1):8-15. doi: 10.1161/01.cir.79.1.8. PMID: 2642759.
12. Catalano PM, Shankar K. Obesity and pregnancy: mechanisms of short term and long term adverse consequences for mother and child. BMJ. 2017 Feb 8;356:j1. doi: 10.1136/bmj.j1. PMID: 28179267; PMCID: PMC6888512.
13. Ehrenthal DB, Maiden K, Rao A, West DW, Gidding SS, Bartoshesky L, et al. Independent relation of maternal prenatal factors to early childhood obesity in the offspring. Obstet Gynecol. 2013 Jan;121(1):115-21. doi: 10.1097/aog.0b013e318278f56a. PMID: 23262935.
14. Godfrey KM, Barker DJ. Fetal programming and adult health. Public Health Nutr. 2001 Apr;4(2B):611-24. doi: 10.1079/phn2001145. PMID: 11683554.
15. Kelishadi R, Badiee Z, Adeli K. Cord blood lipid profile and associated factors: baseline data of a birth cohort study. Paediatr Perinat Epidemiol. 2007 Nov;21(6):518-24.