e-ISSN: 0975-1556, p-ISSN:2820-2643
Available online on www.ijpcr.com
International Journal of Pharmaceutical and Clinical Research 2024; 16(7); 1750-1754

Original Research Article

Lipoprotein Heterogeneity at Birth and its Relationship with Gestational Age, Gender and Birth Weight: A Cross-Sectional Study from a Rural Teaching Hospital of Central India

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Received: 25-05-2024 / Revised: 23-06-2024 / Accepted: 30-07-2024
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Conflict of interest: Nil

Abstract:

Introduction: Lipoproteins are critical in lipid transport and are influenced by gestational age, gender, and birth weight. While lipid profiles are well-documented in adults, there is limited data on newborns, especially using umbilical cord blood. This study aims to analyze the relationship between newborn lipid profiles and key variables like gestational age, gender, and birth weight.

Methodology: A cross-sectional study was conducted at Darbhanga Medical College and Hospital and Government Medical College Bettiah, Central India, from September 2015 to August 2016. Ninety-six newborns were included, and umbilical cord blood was collected. Lipid profiles (total cholesterol, HDL, LDL, triglycerides) were measured. Data analysis involved correlation and regression using SPSS software.

Results: Newborns born at term (≥37 weeks) and with higher birth weights had significantly higher total cholesterol, HDL, and LDL levels. A positive correlation was observed between birth weight and lipid profiles, while gender had minimal impact on lipid levels.

Conclusion: Gestational age and birth weight are significant factors in determining neonatal lipid profiles, while gender shows little influence. Early lipid assessments may help predict future metabolic risks.

Keywords: Lipoprotein, Gestational Age, Birth Weight, Gender, Lipid Profile, Cord Blood, Newborn Health

Introduction

Lipoproteins play a critical role in the transport of lipids throughout the human body, influencing a host of physiological and pathological processes [1]. The composition and distribution of lipoproteins are not uniform; they vary significantly, demonstrating a complex pattern of heterogeneity that is influenced by genetic, environmental, and physiological factors [2]. This variability is particularly noteworthy at birth, where lipoprotein profiles provide a snapshot of neonatal metabolic health and potentially offer early indicators of future disease risks [3].

Recent research underscores the importance of investigating lipoprotein profiles right from the outset of life, especially given the growing body of evidence linking early metabolic conditions with long-term health outcomes [4]. In adults, the lipid profile serves as an established marker for cardiovascular health, reflecting the risk of conditions such as atherosclerosis and coronary artery disease. However, similar investigative efforts into the pediatric population, particularly newborns, are markedly lacking. This gap is most pronounced in studies focusing on umbilical cord blood, a readily available source at birth that remains underutilized in pediatric metabolic research [5,6].

The significance of this research lies in its potential to uncover the impacts of gestational age, gender, and birth weight on lipoprotein heterogeneity at birth. Each of these factors plays a pivotal role in shaping the metabolic blueprint of the newborn [7]. For instance, gestational age can influence the maturity of organ systems and metabolic pathways;

gender has been linked to differential risk profiles for various diseases; and birth weight is a well-documented predictor of metabolic syndrome and other cardiovascular conditions in later life [8].

The primary aim of this research is to deepen the current understanding of lipid profiles in newborns' umbilical cord blood, focusing on how these profiles correlate with gestational age, gender, and birth weight. The study will systematically analyze lipid profiles to discern the heterogeneity of lipoproteins at birth, investigate the relationships between gestational age and lipid levels, explore gender-specific differences, and assess the impact of birth weight on these profiles. This comprehensive analysis aims to identify potential early indicators of metabolic health risks, contributing significantly to pediatric metabolic research and informing early preventative healthcare strategies.

Methodology

Study Design: This study was conducted as a cross-sectional analysis to investigate the lipid profiles in the umbilical cord blood of newborns and their correlation with gestational age, gender, and birth weight.

Study Setting: The research was carried out in two rural teaching hospitals in Central India: Darbhanga Medical College and Hospital and Government Medical College Bettiah. The study period extended from September 2015 to August 2016.

Participants: A total of 96 newborns participated in the study. These participants were selected based on their birth occurring within the specified study period at the two hospitals.

Inclusion and Exclusion Criteria: Inclusion criteria allowed for the recruitment of any newborn delivered in the hospitals during the study period. Exclusion criteria were set to omit any newborns with immediate life-threatening conditions or those whose parents did not consent to participate in the study.

Bias: Efforts to minimize bias included the random selection of participants from the pool of eligible newborns during the study period and the standardized collection and analysis of the blood samples. Analysts were also blinded to the clinical data of the newborns to prevent any potential bias in the interpretation of the lipid profiles.

Data Collection and Analysis: Data were collected through the sampling of umbilical cord blood immediately post-delivery, ensuring minimal variability in collection timing. Lipid profiles, including measurements of cholesterol, HDL, LDL, and triglycerides, were assessed using calibrated biochemical analyzers in the laboratory settings of the participating hospitals. Clinical data concerning the newborns, such as gestational age, gender, and birth weight, were also recorded systematically.

Statistical Analysis: Statistical analyses were performed using SPSS software. Descriptive statistics were applied to summarize the data and provide a baseline demographic profile of the study population. Correlation and regression analyses were then used to examine the relationships between lipid profiles and the variables of interest: gestational age, gender, and birth weight. Statistical significance was set at a p-value of less than 0.05. All data handling procedures were compliant with ethical standards to ensure the confidentiality and integrity of the research data.

Results

In this study, 96 newborns were assessed to determine the relationship between their umbilical cord blood lipid profiles and variables such as gestational age, gender, and birth weight. The lipid parameters analyzed included total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides (TG). The findings revealed significant trends in lipid levels about gestational age and birth weight, while gender showed less pronounced differences.

Table 1: Basic Characteristics of Newborns

Variable	Mean (SD)	Range
Gestational Age (weeks)	38.5 (2.1)	34 – 42
Birth Weight (kg)	3.05 (0.5)	2.0 – 4.2

The mean gestational age of the newborns was 38.5 weeks, with a range of 34 to 42 weeks. The average birth weight was 3.05 kg, with weights ranging from 2.0 kg to 4.2 kg. The majority of newborns were born at term (≥37 weeks) with a normal birth weight.

Lipid Profiles by Gestational Age: Newborns born at later gestational ages (≥37 weeks) had higher lipid levels, particularly in total cholesterol, HDL, and LDL, compared to preterm infants (below 37 weeks). This indicates that the lipid profile matures with gestational development, suggesting an increasing ability to synthesize and regulate lipids as gestation progresses.

Table 2: Lipid Profile by Gestational Age

Lipid Parameter	Preterm (<37 weeks)	Term (≥37 weeks)
Total Cholesterol (mg/dL)	78.5 (10.2)	88.2 (12.6)
HDL (mg/dL)	33.4 (6.1)	37.0 (7.5)
LDL (mg/dL)	34.1 (8.7)	39.2 (9.3)
Triglycerides (mg/dL)	48.3 (9.8)	51.0 (11.8)

As shown in Table 2, term newborns had significantly higher total cholesterol levels (88.2 mg/dL) compared to preterm newborns (78.5 mg/dL). Similarly, HDL and LDL levels were higher in term newborns, indicating a more developed lipid metabolism. Triglyceride levels were slightly elevated in term newborns, though the difference was not statistically significant.

Lipid Profiles by Birth Weight: Birth weight also showed a strong correlation with lipid profiles. Newborns with higher birth weights (≥3.5 kg) exhibited elevated lipid levels compared to those with lower birth weights (<2.5 kg). This suggests that birth weight may serve as an early indicator of metabolic health, with higher lipid values possibly indicating a better-developed metabolism at birth.

Table 3: Lipid Profile by Birth Weight

Lipid Parameter	Low Birth Weight (<2.5 kg)	Normal Birth Weight (2.5–3.5 kg)	High Birth Weight (>3.5 kg)
Total Cholesterol (mg/dL)	76.8 (11.4)	85.1 (12.2)	90.3 (11.8)
HDL (mg/dL)	32.7 (6.8)	36.0 (7.1)	38.5 (7.5)
LDL (mg/dL)	33.5 (8.9)	37.2 (9.0)	40.1 (9.5)
Triglycerides (mg/dL)	46.2 (10.5)	50.4 (11.2)	55.1 (12.1)

Table 3 highlights the positive correlation between birth weight and lipid levels. Newborns with low birth weight had lower levels of total cholesterol (76.8 mg/dL), HDL (32.7 mg/dL), and LDL (33.5 mg/dL) compared to those with higher birth weights. This suggests that birth weight may influence lipid metabolism in the neonatal period, with larger babies having more robust lipid profiles.

Gender and Lipid Profile Differences: When analyzing lipid profiles by gender, male newborns showed slightly higher total cholesterol and LDL levels compared to females, though the differences were not statistically significant ($p > 0.05$). HDL and triglyceride levels were comparable between genders, with no notable variations.

Gestational age and birth weight were found to significantly influence lipid profiles in newborns. Higher gestational age and birth weight were associated with higher levels of total cholesterol, HDL, LDL, and triglycerides. Gender did not show a significant effect on lipid profiles, though minor trends were observed. These findings indicate that factors present at birth, such as gestational maturity and body mass, can affect lipid metabolism and may serve as early indicators of future cardiovascular and metabolic health.

Discussion

This study aimed to assess the lipid profiles in the umbilical cord blood of newborns and their relationship with gestational age, birth weight, and gender. The key findings revealed that both gestational age and birth weight significantly influence lipid profiles, while gender showed minimal impact.

The results demonstrated that newborns born at term (≥37 weeks) had higher levels of total cholesterol, HDL, and LDL compared to preterm newborns (<37 weeks). This suggests that lipid metabolism matures with gestation, with term newborns displaying a more developed lipid profile. Moreover, birth weight showed a strong positive correlation with lipid levels, where heavier newborns (>3.5 kg) had higher levels of total cholesterol, HDL, and LDL, as well as triglycerides, compared to those with lower birth weights (<2.5 kg).

Gender differences were minimal, with male newborns having slightly higher total cholesterol and LDL levels compared to females, although these differences were not statistically significant. These findings suggest that gestational age and birth weight may be more crucial determinants of neonatal lipid profiles than gender [9,10].

The results of this study align with previous research, which has established that gestational age is a strong predictor of lipid levels at birth. Studies have shown that term infants tend to have higher total cholesterol, HDL, and LDL levels compared to preterm infants, supporting the idea that lipid metabolism continues to mature as the fetus approaches full term. The positive correlation

between birth weight and lipid profiles is also consistent with earlier findings, indicating that larger newborns have more robust lipid profiles, which may reflect their overall better-developed metabolic systems [11].

Gender differences in lipid levels at birth have been inconsistently reported in the literature. While some studies have found slight differences in cholesterol and LDL levels between male and female newborns, most have concluded that these differences are not statistically significant, a finding echoed in the present study. This supports the notion that gender, though relevant to lipid metabolism later in life, may not have a pronounced impact on lipid levels in the immediate neonatal period [12].

The higher lipid levels observed in term infants compared to preterm infants can be attributed to the progressive development of metabolic and enzymatic processes during gestation. Lipoprotein synthesis and regulation become more refined in the later stages of pregnancy, leading to more mature lipid profiles in term infants. The lower lipid levels in preterm infants may be due to the incomplete development of these processes, placing them at a potential risk for metabolic complications later in life [13].

The positive correlation between birth weight and lipid levels may be explained by the fact that larger newborns often have better-developed organ systems, including the liver, which plays a key role in lipid metabolism. Heavier newborns might also have had better nutritional status in utero, contributing to more favorable lipid profiles. These differences may have long-term implications, as newborns with more favorable lipid profiles could be at a reduced risk of developing metabolic syndrome or cardiovascular diseases later in life [14].

The lack of significant gender differences in this study, despite the slightly higher levels of LDL and total cholesterol in male newborns, suggests that sex hormones, which play a larger role in lipid metabolism during adolescence and adulthood, may not have a significant influence on neonatal lipid levels. This supports the view that factors like gestational age and birth weight are more immediate determinants of lipid metabolism at birth [15].

This study highlights the significant influence of gestational age and birth weight on neonatal lipid profiles, with term newborns and those with higher birth weights showing more mature lipid metabolism. Gender did not have a significant impact on lipid levels in this cohort. These findings suggest that early-life factors, such as gestational age and birth weight, could serve as predictors of metabolic health, potentially influencing future risk for cardiovascular diseases. Further, longitudinal studies are needed to track how these early lipid profiles evolve and contribute to long-term health outcomes.

Conclusion

In conclusion, this study demonstrates that gestational age and birth weight significantly influence lipid profiles in newborns, with term infants and those with higher birth weights exhibiting more mature and favorable lipid levels. These findings suggest that lipid metabolism develops progressively with gestational maturity and is further influenced by overall growth, as reflected in birth weight. Gender did not significantly affect neonatal lipid levels in this study, indicating that early lipid profiles are more closely related to developmental factors rather than sex. Understanding these early influences on lipid metabolism could provide valuable insights into predicting and potentially mitigating long-term cardiovascular and metabolic risks, emphasizing the importance of monitoring these factors from birth.

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