

Maternal and Cord Blood Fatty Acid Profiles and Correlations with Newborn Birth Weight, Length and Head Size in Nigerian Population

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Abstract Fatty acids such as alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), linoleic acid (LA), and arachidonic acid (AA) are essential for the development of the brain and retina, as well as for general health. We conducted a study to examine the associations between the fatty acid compositions of maternal and umbilical cord blood and the birth weight, length, and head circumference of newborns. This cross-sectional study was conducted at a tertiary hospital in Nigeria and included pregnant women in their second trimester, at delivery, and their newborns. We collected anthropometric measurements of 73 term newborns. The blood levels of DHA, EPA, AA, ALA, and LA were analysed using Gas Chromatography-Mass Spectrometry (GC-MS). Statistical analysis included Wilcoxon signed-rank tests and Spearman's rank correlation coefficients at $p = 0.05$. We found that DHA and EPA levels significantly increased from the second trimester to delivery, with DHA showing a mean increase of 1.015 mg/L ($p = 0.005$) and EPA increasing by 0.265 mg/L ($p = 0.027$). ALA levels significantly differed between mothers and newborns ($p = 0.001$), indicating metabolic changes during the perinatal period. However, no significant correlations were observed between the examined fatty acids and any of the newborn anthropometric measurements. Maternal and neonatal fatty acid levels did not influence newborn anthropometrics, despite remarkable increases in DHA and EPA concentrations during pregnancy. We recommend further research and promotion of balanced meals rich in essential fatty acids to improve pregnancy outcomes.

Keywords: Maternal nutrition, Fatty acids, Newborn birthweight, Umbilical cord blood, Long-chain polyunsaturated fatty acids, Fetal development, Pregnancy Outcomes, Anthropometric Measurements

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1. Introduction

Fatty acids, particularly long-chain polyunsaturated fatty acids (LCPUFAs) such as docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), and arachidonic acid (AA), along with essential fatty acids like alpha-linolenic acid (ALA) and linoleic acid (LA), are essential for fetal growth and development [1]. These fatty acids are vital components of cell membranes, signalling molecules, and energy sources [2]. The human body cannot synthesize DHA and EPA, primarily found in marine sources, and AA, derived from LA, so it is obtained through diet [3].

Recently, the association between maternal fatty acids and newborn birth weight has gained significant attention [4]. Birth weight is a critical indicator of neonatal health and a predictor of future health outcomes. Low birth weight has been linked with increased risks of neonatal morbidity, mortality, and long-term health issues such as

cardiovascular diseases, diabetes, and obesity [5,6]. Large birth weight (more than 4000 g), on the other hand, is associated with complications such as shoulder dystocia, birth trauma, and an increased risk of metabolic disorders later in life [7,8].

Several studies have investigated the link between maternal fatty acids and birth outcomes. Rump and his colleagues investigated the essential fatty acid composition of plasma phospholipids and birth weight in term neonates [9]. Findings revealed that maternal plasma concentrations of DHA were negatively related to its level in cord plasma and weight z scores, suggesting a potential limiting factor in neonatal DHA status [9]. The study highlights the importance of adequate maternal DHA intake for optimal fetal development. Additionally, Rump and his colleagues also noted that lower EPA status in umbilical cord plasma and a larger decrease in maternal plasma Long-Chain Polyunsaturated Fatty Acid (LCPUFAs) concentrations were associated with higher weight-for-gestational-age at birth in term neonates [9]. This finding suggests that maternal-to-fetal transfer of

EPAs could be a limiting factor in neonatal EPA status and subsequent growth parameters. Wang and Zhang compared the plasma levels of DHA, EPA, AA, ALA, and LA in mothers and their newborns at birth [10]. They observed differences in concentrations, with maternal levels positively correlating with cord levels of these fatty acids [10]. This positive relationship highlights the significance of maternal nutrition in determining fetal EPA status.

The balance between omega-3 (DHA, EPA and ALA) and omega-6 fatty acids (LA and AA) is crucial for maintaining physiological functions and promoting optimal fetal growth [11]. An imbalance, particularly an excess of omega-6 fatty acids relative to omega-3s, can lead to adverse outcomes such as suboptimal neurodevelopment, fetal growth restriction, and preterm birth [11,12]. Angoa and colleagues found a positive correlation between higher maternal DHA levels and increased birth weight, length, and head circumference [13]. Research has also linked maternal DHA supplementation during pregnancy to longer gestation and higher birth weight [14]. Although present in lower concentrations, EPA contributes to fetal growth and development, serving as a precursor to DHA and exhibiting anti-inflammatory effects beneficial to pregnancy outcomes [15]. Conversely, while AA is necessary for growth, an excess relative to DHA and EPA can lead to increased inflammatory responses, potentially affecting fetal growth adversely [16].

The fatty acid composition of umbilical cord blood provides insights into the fetal environment, reflecting the fatty acid status of the fetus at birth and serving as a marker of intrauterine fatty acid exposure [17]. Examining plasma fatty acid levels in both maternal and umbilical cord blood offers insight into their roles in fetal growth and birth weight. Even though several research has highlighted the potential benefits of maternal omega-3 fatty acid supplementation on birth outcomes, findings have been inconsistent across different populations and study designs [18]. Some studies report significant positive effects of DHA supplementation on birth weight and gestational age, while others find no significant impact [14,19]. These discrepancies underscore the need for further investigation into the underlying mechanisms and factors influencing these associations.

Despite the acknowledged importance of fatty acids in pregnancy, there is still a gap in understanding the specific associations between maternal and umbilical cord fatty acid profiles and newborn birth weight, particularly in the Nigerian populations. This study aims to address this gap by investigating the fatty acid profiles of DHA, EPA, AA, ALA, and LA in maternal and umbilical cord blood and their associations with newborn birth weight. Understanding the intricate interplay between maternal and fetal fatty acid status and birth weight is essential for developing targeted nutritional interventions to improve pregnancy outcomes. Nutritional guidelines and supplementation strategies can be optimised based on evidence from studies like this to support maternal and fetal health. Furthermore, the results of this study can contribute to a broader knowledge of the importance of fatty acids in prenatal development and inform clinical practice.

2. Methods

2.1. Study Design

This study employed a cross-sectional design aimed at determining the levels of DHA, EPA, AA, ALA, and LA in maternal and umbilical cord blood and their associations with neonatal birth weights.

2.2. Study Site

The research was conducted at the Department of Obstetrics and Gynaecology, University College Hospital (UCH) in Ibadan, Nigeria. Located in the Ibadan North Local Government Area, this hospital serves as a referral centre for residents and people from the South-Western region of Nigeria. Much of the population in this area belongs to the Yoruba ethnic group.

2.3. Study Population

The study population included pregnant women attending the antenatal care clinic at the University College Hospital, Ibadan, and their respective newborn babies. Participants were recruited from those in their second trimester (between 26-28 weeks of gestation).

2.4. Sample Size Determination

The sample size was calculated using the formula for estimation of size for comparison of paired means [20]. Since specific mean, standard deviation (SD), and effect size values were not available in the literature, an assumed medium effect size ($d = 0.5$) was used. We estimated that the study would require a minimum sample size of 46 mother-newborn pairs to achieve a power of 90% and a level of significance of 5% (two-sided), for detecting an effect size of 0.5 between pairs. We adjusted for an envisaged non-response rate of 20%, this increased the required minimum sample size to 60 mother-newborn pairs.

2.5. Sampling Technique

Pregnant women in their second trimester were recruited using a convenience sampling technique. The inclusion criteria encompassed pregnant women in their second trimester (26-28 weeks of gestation) and their respective newborns. Informed consent was obtained from those who met the inclusion criteria. Pregnant women with maternal illnesses such as diabetes or hypertension were excluded from the study to avoid confounding factors that might affect the outcomes. These women were interviewed using a structured questionnaire after signing the informed consent form during their antenatal visits.

2.6. Data Collection Procedure

General and vital information about the research participants was collected using a questionnaire. Data collected included demographic information, anthropometric measurements, and other relevant details.

The weight of each newborn was measured using an electronic weighing machine, length was measured using an infantometer, and head circumference was measured with a measuring tape. Ten millilitres (10mL) of venous blood were drawn from eligible pregnant women in the second trimester and at the delivery of their newborns. Additionally, five millilitres (5mL) of umbilical venous blood were collected from the newborns' umbilical cords immediately after cord clamping under aseptic conditions. All blood samples were transferred into plain dry test tubes, separated by centrifugation, and the serum was stored at -20°C until analysis.

2.7. Laboratory Procedure

The levels of DHA, EPA, AA, ALA, and LA in the serum were analysed using GC-MS. The identification of the fatty acid components was conducted using the National Institute of Standards and Technology (NIST) database, which contains over 62,000 patterns. The spectra of the unknown components were compared with known components stored in the NIST library for accurate identification.

2.8. Data Analysis

The normality of the data was assessed using the Shapiro-Wilk test, which indicated that the data did not follow a normal distribution. Descriptive statistics, including mean, standard deviation, median, minimum, and maximum values, were calculated to summarise the serum levels of each fatty acid in the second trimester and at delivery for both mothers and their newborns. Comparisons of serum fatty acid levels between the second trimester and delivery were conducted using Wilcoxon signed-rank tests for paired samples. This test was also used to compare maternal and newborn serum levels at delivery. Independent samples t-tests were performed to compare fatty acid levels between male and female newborns at delivery. Spearman's rank correlation coefficients were calculated to examine the associations between birth weight, head circumference, crown-heel length, and the serum levels of each fatty acid. Correlation coefficients (r) and p -values were reported to indicate the strength and significance of these associations. All statistical analyses were performed using Stata version 17.0 [BE (Basic Edition), Stata Corp LLC, Texas, USA]. The significance level was set at $p = 0.05$, and Bonferroni adjustments were made for multiple comparisons to maintain the overall type I error rate.

2.9. Ethical Consideration

Approval for this research was obtained from the University of Ibadan/University College Hospital (UI/UCH) Joint Ethics Committee (UI/EC/22/0388). The study was conducted in strict compliance with the guidelines of the Nigerian Code for Health Research Ethics.

3. Results

3.1. Demographic Characteristics

One hundred and seventy-three (173) pregnant women were enrolled on the study in the second trimester, but data from 96 mothers available at delivery were utilised while cord blood samples were obtainable in 73 newborns. The demographic characteristics of the women were as shown in Table 1. The study found that most pregnant women (89.6%) were from the Yoruba tribe. The study also revealed that 60% of the women were multiparous, having multiple children. Educational attainment among the pregnant women varied, with 60% being university graduates or postgraduates, while only 25% had post-secondary education. The occupational distribution was diverse.

Table 1. Demographic Characteristics of the Pregnant Women (n = 173)

Characteristic	n (%)
Family structure	
Polygamous	16 (9.2)
Monogamous	157 (90.8)
Parity	
Primiparous	69 (39.9)
Multiparous	104 (60.1)
Tribe	
Others	18 (10.4)
Yoruba	155 (89.6)
Mothers' level of education	
University graduate and Postgraduate	104 (60.1)
Post-Secondary certificate, not University	43 (24.8)
Secondary School or grade II certificate	22 (12.7)
Modern 3 and Primary 6 certificate	2 (1.2)
Less than primary 6 education and no formal education	2 (1.2)
Mothers' occupation	
Senior public servant, professional, contractor, large scale trader	56 (32.3)
Intermediate grade, public servant, senior schoolteachers	46 (26.6)
Junior schoolteacher, driver, artisan	20 (11.6)
Petty trader, labourer, messenger, similar grades	32 (18.5)
Unemployed, fulltime housewife, student, subsistence farmer	19 (11.0)

n= Total number of subjects, % = Percentage

3.2. Gestational Age and Anthropometric Indices of the Newborns

Table 2 shows that male newborns had a mean birth weight of 3.3 kg, while female newborns had a slightly higher mean birth weight of 3.8 kg. The mean crown-heel length for male newborns was 49.3 cm, while for female newborns it was 47.4 cm. The mean head circumference for male newborns was 35.5 cm, while for female newborns it was 34.8 cm. The mean gestational age for both male and female newborns was 38.7 weeks, with

males having a median gestational age of 38.5 weeks and females having a median gestational age of 39.0 weeks. All the newborns were delivered at term (gestational age >37 weeks).

Table 2. Descriptive Statistics for Gestational Age and Anthropometric Indices of the 73 Newborns

Parameter	Sex	Mean	Median	SD	Min	Max
Birth weight (kg)	Male	3.3	3.2	0.6	1.6	4.6
	Female	3.8	3.1	0.5	1.6	3.5
Crown-heel length (cm)	Male	49.3	50.0	3.9	43.0	57.0
	Female	47.4	48.0	4.5	35.5	58.0
Head circumference (cm)	Male	35.5	35.0	1.8	30.4	39.0
	Female	34.8	34.5	2.9	28.0	44.0
Gestational Age (weeks)	Male	38.7	38.5	1.4	35.0	41.0
	Female	38.7	39.0	1.8	34.0	41.0

SD: Standard Deviation

3.3. Levels of Fatty Acids in the Newborns at Delivery

The comparisons of the levels of various fatty acids in male and female newborns are displayed in Table 3. The mean ALA level for males was 1.9 mg/L, while the overall mean was 1.5 mg/L. The difference between male and female newborns was not statistically significant. The EPA levels were 0.8 mg/L for males and 0.4 mg/L for females, with no significant difference. DHA levels were 2.6 mg/L for males and 1.3 mg/L for females, with no significant difference between genders. LA levels were 0.5 mg/L for males and 0.5 mg/L for females, with no significant difference. Informed consent was obtained from those who met the inclusion criteria.

Table 3. Comparison of Fatty Acid Levels Between Male and Female Newborns

Parameter	Male (n = 35)	Female (n = 38)	Total	p value
ALA				
Mean (SD)	1.9 (1.3)	1.4 (1.5)	1.5 (1.4)	0.619
Interquartile range	0.7 – 2.5	0.6 – 0.9	0.7 – 1.9	
EPA				
Mean (SD)	0.8 (1.3)	0.4 (0.2)	0.6 (1.0)	0.290
Interquartile range	0.2 – 1.0	0.2 – 0.4	0.2 – 0.5	
DHA				
Mean (SD)	2.6 (2.8)	1.3 (1.4)	2.0 (2.3)	0.191
Interquartile range	0.3 – 4.8	0.2 – 2.3	0.3 – 2.6	
LA				
Mean (SD)	0.5 (0.4)	0.5 (0.8)	0.5 (0.6)	0.435
Interquartile range	0.1 – 0.9	0.0 – 1.2	0.1 – 0.9	
AA				
Mean (SD)	2.0 (1.9)	0.7 (0.4)	1.4 (1.5)	0.048*
Interquartile range	0.5 – 4.4	0.5 – 1.0	0.5 – 1.4	

SD: Standard Deviation; ALA: Alpha-Linolenic Acid; EPA: Eicosapentaenoic Acid; DHA: Docosahexaenoic Acid; LA: Linoleic Acid; AA: Arachidonic Acid.

The mean AA level in males (2.0 mg/L) was significantly higher than in females (0.7 mg/L). The overall mean AA level was 1.4 mg/L.

3.4. Levels of Maternal Fatty Acids in Second Trimester and Delivery

Table 4 shows the pairwise comparison of the mean levels of various maternal fatty acids between the second trimester and delivery, using the Wilcoxon Rank test to assess statistical significance. The mean difference in ALA levels between the second trimester and delivery was -0.17 mg/L, with a 95% confidence interval ranging from -0.48 to 0.07 mg/L ($p = 0.207$). This indicates that the difference in ALA levels was not statistically significant. For EPA, the mean difference was 0.27 mg/L, with a 95% confidence interval of 0.06 to 0.47 mg/L ($p = 0.027$) indicating a statistically significant increase in EPA levels from the second trimester to delivery. The mean difference in DHA levels was 1.02 mg/L, with a confidence interval ranging from 0.34 to 1.82 mg/L ($p = 0.005$), indicating a significant increase in DHA levels between the second trimester and delivery. The mean difference for LA was -0.08 mg/L, with a confidence interval of -0.32 to 0.04 mg/L and the p-value was 0.236, showing no significant change in LA levels. The mean difference in AA levels was 0.60 mg/L, with a confidence interval of 0.28 to 0.95 mg/L ($p < 0.001$), indicating a significant increase in AA levels from the second trimester to delivery.

Table 4. Pairwise Comparison of the Mean Levels of Maternal Fatty Acids at Second Trimester and Delivery

Parameter	Mean difference	95% Confidence Interval		Wilcoxon Rank Test	
		Lower	Upper	Statistic	P
ALA (mg/L)	-0.17	-0.48	0.07	299	0.207
EPA (mg/L)	0.27	0.06	0.47	549	0.027*
DHA (mg/L)	1.02	0.34	1.82	592	0.005*
LA (mg/L)	-0.08	-0.32	0.04	305	0.236
AA (mg/L)	0.60	0.28	0.95	667	<0.001*

* $p < 0.05$ indicates statistical significance. SD: Standard Deviation; ALA: Alpha-Linolenic Acid; EPA: Eicosapentaenoic Acid; DHA: Docosahexaenoic Acid; LA: Linoleic Acid; AA: Arachidonic Acid.

3.5. Levels of Maternal Fatty Acids and Neonatal Fatty Acids at Delivery

Table 5. Pairwise Comparison of the Mean Levels of Maternal and Neonatal Fatty Acids at Delivery

Parameter	Mean difference	95% confidence interval		Wilcoxon Rank test	
		Lower	Upper	Statistic	P
ALA (mg/L)	0.65	0.32	0.95	614.00	0.001*
EPA (mg/L)	-0.08	-0.24	0.21	73.00	0.391
DHA (mg/L)	0.07	-0.54	0.45	119.00	0.612
LA (mg/L)	-0.12	-0.54	0.24	72.00	0.373
AA (mg/L)	-0.12	-0.90	0.11	82.50	0.263

* $p < 0.05$ indicates statistical significance. SD: Standard Deviation; ALA: Alpha-Linolenic Acid; EPA: Eicosapentaenoic Acid; DHA: Docosahexaenoic Acid; LA: Linoleic Acid; AA: Arachidonic Acid.

The results of the comparisons of the mean levels of various maternal fatty acids at delivery with those of neonatal fatty acids, using the Wilcoxon Rank test to determine statistical significance, are shown in Table 5. The results showed a significant difference in ALA levels (0.65 mg/L) between maternal delivery and neonatal levels ($p = 0.001$). However, we found no significant difference in DHA (0.07 mg/L; $p = 0.612$), LA (-0.12 mg/L; $p = 0.373$), and AA (-0.12 mg/L; $p = 0.263$) levels between maternal delivery and neonatal levels.

3.6. Correlation between Newborns' Anthropometrics and the Fatty Acid Levels

The results presented in Table 6 detail the correlation between newborns' anthropometric measurements, birth weight, head circumference, and length, and the blood fatty acid levels in their mothers at the time of delivery. There was no significant correlation between maternal ALA, EPA, DHA, LA and AA levels and newborn anthropometric measures (birth weight, head circumference, and length). Similarly, there was no significant correlation between ALA, EPA, DHA, LA and AA levels in the cord blood and any of the newborn anthropometric measures (birth weight, head circumference, and length).

Table 6. Correlation Between Maternal Blood Fatty Acid Levels and Newborn Anthropometrics at Delivery

Parameter	Birth Weight		Head Circumference		Length	
	r	p	r	p	r	P
ALA (mg/L)	-0.11	0.516	0.13	0.464	-0.001	0.995
EPA (mg/L)	-0.29	0.076	0.03	0.838	-0.03	0.877
DHA (mg/L)	-0.15	0.376	0.11	0.520	0.12	0.497
LA (mg/L)	-0.23	0.154	-0.19	0.289	-0.10	0.559
AA (mg/L)	-0.05	0.760	0.12	0.499	0.216	0.234

r: Correlation Coefficient; CI: Confidence Interval; DHA: Docosahexaenoic Acid; EPA: Eicosapentaenoic Acid; ALA: Alpha-Linolenic Acid; LA: Linoleic Acid; AA: Arachidonic Acid.

4. Discussion

The findings of this study provide remarkable insights into the changes in fatty acid profiles during pregnancy and their associations with neonatal birth weight and other anthropometric measures. Despite the dynamic changes observed in levels of DHA, EPA, and AA from the second trimester to delivery, we did not find correlations between these fatty acids and newborn anthropometrics. The demographic profile of the study participants reflects a socio-culturally homogeneous group with diverse educational and occupational backgrounds. This demographic consistency helps to minimise potential confounding variables related to ethnic and socio-economic diversity, thereby strengthening the reliability of the findings within this population context.

The significant increases in DHA and EPA levels from

the second trimester to delivery highlight their critical roles in fetal neurodevelopment and the anti-inflammatory processes essential for pregnancy progression. The DHA is known for its importance in brain and retinal development, while EPA serves as a precursor to DHA and exhibits anti-inflammatory properties [21]. The rise in AA levels, despite its pro-inflammatory potential, underscores its necessity in cell signalling and tissue growth during fetal development [22].

The lack of significant correlations between fatty acids and newborn anthropometrics suggests that the relationship between maternal fatty acid levels and fetal growth is complex and influenced by multiple factors. This finding aligns with previous studies that reported inconsistent results regarding the impact of maternal DHA supplementation on birth weight and gestational age [23]. The variability in findings across different populations and study designs buttress the need for further research to elucidate the mechanisms underlying these associations.

Several studies have investigated the relationship between maternal fatty acid status and birth outcomes. Angoa and colleagues found a positive correlation between higher maternal DHA levels and increased birth weight, length, and head circumference, suggesting that DHA plays a role in promoting fetal growth [13]. However, our study did not find significant correlations between DHA levels and these anthropometric measures, which may be due to differences in study populations, sample sizes, or methodologies. Research by Brenna and Carlson emphasises the importance of DHA for optimal brain development, indicating that adequate maternal DHA intake is crucial for fetal neurodevelopment [24].

Similarly, another author noted that dietary omega-3 fatty acids, particularly DHA, are essential for brain development [25]. While our findings support the importance of DHA, they also suggest that its impact on birth weight and other growth parameters may not be as straightforward, necessitating further investigation. The observed increases in DHA, EPA, and AA levels from the second trimester to delivery likely reflect the body's adaptation to meet the growing demands of the developing fetus. The significant difference in ALA levels between the maternal and neonatal stages indicates metabolic changes during the perinatal period, possibly due to the conversion of ALA into longer-chain fatty acids like EPA and DHA.

One potential explanation for the lack of significant correlations between fatty acid levels and newborn anthropometrics is the concept of fetal programming. Barker proposed that the intrauterine environment, including nutrient availability, has long-term effects on offspring health and development [6]. While fatty acids are crucial for immediate fetal growth, their long-term impacts on cognitive function and metabolic health may be more pronounced and require longitudinal studies to fully understand. Some genetic factors, like variations in the fatty acid desaturase (FADS) genes, can also affect how fatty acids are used and may help explain why the results of different studies are not always the same [26]. Future research should consider genetic variations to better understand individual responses to maternal fatty acid intake and their effects on fetal development.

Several factors may explain the lack of significant associations observed in this study. The relatively small

sample size of 73 newborns might have limited the ability to detect subtle effects of fatty acids on fetal growth, highlighting the need for larger studies to draw more definitive conclusions. Additionally, the cross-sectional design, which assessed fatty acid levels only at delivery, may not fully capture fluctuations and cumulative effects throughout pregnancy. A longitudinal approach, tracking fatty acid levels at multiple gestational stages, would provide a more comprehensive understanding of their role in fetal development.

These findings have important clinical implications. Ensuring adequate maternal intake of omega-3 fatty acids, particularly DHA, is essential for fetal neurodevelopment. Healthcare providers should emphasise the importance of a balanced diet rich in essential fatty acids during pregnancy. Personalized nutrition strategies considering genetic, environmental, and lifestyle factors, may offer more effective approaches for optimizing maternal and fetal health.

However, the study has notable limitations. The cross-sectional design restricts causal inference between maternal fatty acid levels and fetal growth. Future longitudinal studies, incorporating multiple time points for fatty acid assessment, would better capture dynamic changes and their potential influence on pregnancy outcomes [27]. Additionally, integrating detailed dietary assessments and biomarkers such as erythrocyte membrane fatty acids could provide a more accurate reflection of long-term fatty acid status [27]. Expanding research to diverse populations will also help uncover potential variations in associations between fatty acid levels and fetal growth.

5. Conclusion

This study offers valuable insights into maternal and umbilical cord blood levels of DHA, EPA, AA, ALA, and LA and their relationship with newborn birth weight, length, and head circumference. The findings highlight the complex interplay of fatty acid metabolism during pregnancy and reinforce the significance of maternal nutrition in fetal development. The absence of significant correlations with newborn anthropometric measures suggests that genetics, maternal health, and other physiological factors may have a greater influence on pregnancy outcomes. Future research should prioritize longitudinal studies across diverse populations to better understand the long-term effects of maternal fatty acid status on fetal growth and overall health.

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Authors' Contributions

BEO conceived the study, review of the literature and wrote the first draft of the manuscript, POO contributed to review of literature, study design and collection of data, and OAA identified the participants and coordinated the care of the participants. BEO supervised all activities. All the authors contributed to the writing, edited and approved the final version of the manuscript.

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