Child Health Research Institute

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Children's NEBRASKA

Bioactive Polyunsaturated Fatty Acid Metabolites in Placental Samples and their Association with Infant Growth

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Background: Omega-3 and omega-6 fatty polyunsaturated fatty acids (PUFAs) are essential for brain development and maintaining a balanced inflammatory response during pregnancy through their enzymatic breakdown into bioactive metabolites. The placenta regulates nutrient transfer to the fetus and is the site of both necessary and pathologic inflammatory processes. However, our understanding of bioactive PUFA metabolite concentrations and their activity at the placental interface remains limited.

Significance of the Problem: Our limited comprehension of bioactive PUFA metabolites within the placental chorionic and basal layers hinders our capacity to decipher the regulation of nutrition, thereby impeding our understanding of its ramifications on fetal growth during gestation.

Question: Are there differences in n-3 and n-6 PUFA metabolite concentrations in basal (maternal) and chorionic (fetal) placental sections, and do these metabolites' have a relationship with infant growth?

Design/Methods: We enrolled 66 mother-infant pairs, and placental tissue samples were collected at delivery with IRB approval. Placental cross-sections were divided into basal and chorionic sections at the midpoint. PUFA metabolites were analyzed using liquid chromatography-tandem mass spectrometry. Spearman correlation coefficients were utilized to assess correlations between metabolite concentrations and gestational age (GA), birth length, head circumference, and weight percentiles, while the Kruskal-Wallis test compared PUFA metabolite concentrations across birth weight percentile groups (< 10th, 10-90th, and >90th). Statistical significance was set at $p< 0.05$.

Results: The median GA at delivery was 39 weeks (IQR: 36.40 – 39.50). Analysis revealed basal and chorionic PUFA metabolites had significant moderate to strong negative correlations with gestational age. Fewer metabolites from multiple enzymatic pathways also demonstrated significant negative correlations with growth parameters. Comparing metabolite levels between birth weight percentile groups revealed small for gestational age (SGA) infant placentas had higher metabolite levels than all other groups.

Conclusion: As GA increases, there is a corresponding increase in fetal demand for PUFAs, particularly during the third trimester when rapid fetal growth occurs. Our study showed a consistent inverse relationship with infant growth, regardless of metabolite. Furthermore, significant variations were observed when comparing metabolite levels in basal and chorionic samples across different birth weight percentiles. Increased placental PUFA metabolites in SGA infants may indicate the presence of inflammatory processes with up-regulation of metabolism or dysregulation in metabolite transfer for this at-risk group.