

Evaluation of anthropometric and lipid profile changes at different trimesters among pregnant women attending antenatal care in Nnewi, Anambra State, Nigeria

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Abstract

Background: Regular physiological changes in pregnancy pose a metabolic challenge to individuals due to modifications the body makes for fetal growth and development, resulting in increased insulin resistance, inflammation and alterations in body composition, lipid levels and haemodynamic factors.

Objective: This study evaluates the lipid profile changes at different trimesters of pregnancy in pregnant women with proteinuria and glycosuria in Nnewi Anambra State.

Methods: A cross-sectional comparative study was conducted involving two hundred and fifty-two pregnant women categorized by trimester. Anthropometric and biochemical parameters including triglyceride (TG) and high-density lipoprotein cholesterol (HDL-C) were measured. TG/HDL was calculated.

Results: Significant trimester-dependent changes were observed in TG ($p < 0.001$), HDL-C ($p = 0.017$), and TG/HDL-C ratio ($p < 0.001$). Post-hoc analysis indicated elevated TG and TG/HDL-C ratio in third trimester and peak HDL-C in second trimester.

Conclusion: TG, HDL-C, and TG/HDL-C ratio may serve as early biomarkers for identifying at-risk pregnancies. Monitoring these may aid in reducing adverse outcomes and long-term maternal morbidity.

Keywords: Pregnancy; Triglyceride; HDL-C; TG/HDL-C Ratio

1. Introduction

The perinatal period is a sensitive window for long-term parental health due to the rapid and extensive changes across multiple organ systems, both during pregnancy and postpartum [1]. Pregnancy presents a unique physiological state characterized by metabolic and inflammatory shifts. These changes, while adaptive, can unmask or exacerbate underlying pathologies such as insulin resistance, dyslipidemia, and oxidative stress, contributing to gestational diabetes, preeclampsia, and long-term cardiovascular risk [1–4]. In Southeastern Nigeria, rising incidences of adverse pregnancy outcomes (APOs) like preterm delivery and intrauterine growth restriction have been linked to dysregulated

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lipid metabolism [5]. As such, pregnancy often represents a stress test for longer-term cardiometabolic health [3], with individuals experiencing certain complications being at much higher risk for later-life cardiovascular disease (CVD). Epidemiological evidence has consistently shown that among mothers with prior history of GDM, 30–84% of them had GDM recurrence in subsequent pregnancies [6], 20–40% developed metabolic syndrome (MetS) within 2–20 years [7] and 17–63% developed type 2 diabetes mellitus (T2DM) and obesity within 5–16 years [4]. Longitudinal studies have shown that women with prior GDM and obesity were at higher risk to develop MetS compared with those without such metabolic history, and these women with prior GDM and obesity had relatively higher values of anthropometric parameters (such as BMI and waist circumference), blood pressure, glucose, homeostatic model assessment, insulin, C-peptide and fibrinogen, together with lower HDL-C levels [8]. Significant changes in Triglyceride, total cholesterol and HDL-C were associated with pre-eclampsia in these Southeastern Nigerian women [5]. This study focuses on evaluating TG, HDL-C, TG/HDL-C ratio in identifying high-risk pregnancies since analysis of this parameter offers an opportunity for early diagnosis and proactive management of cardiometabolic risks during pregnancy.

2. Material and methods

2.1. Study area and Population

The study was conducted at the antenatal clinics of Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Anambra State, Nigeria. Participants included 252 pregnant women (25–40 years). The biochemical analysis was performed at the facilities of Chemical Pathology Laboratory of NAUTH, Nnewi, Anambra State, Nigeria.

2.2. Study design

This study was a cross-sectional comparative study.

2.3. Sample Size and recruitment

Using Fisher's formula [9] for population >1000 with a 5.8% prevalence, the calculated minimum sample size was 84 per group (n=252 total). Participants were randomly selected, with written informed consent obtained.

2.4. Inclusion/Exclusion Criteria

- Inclusion: Apparently healthy pregnant women, aged 25–40 years.
- Exclusion: Those with diabetes, hypertension, renal, hepatic or haematological diseases and any other chronic metabolic diseases.

2.5. Ethical Approval and Consent

Ethical approval was obtained from Nnamdi Azikiwe University Teaching Hospital (NAUTH) ethical committee. Informed consent was secured from all participants.

2.6. Sample Collection, Preservation, and analysis:

Five (5) ml of blood was collected from the participants using vacutainer needles into plain tube and EDTA tube. The samples were processed and stored at -20°C before analysis. Basic anthropometric measurements of height and weight were measured, BMI calculated.

2.7. Methods of determination of Triglyceride and HDL-C.

Triglyceride and HDL-C were analyzed using spectrophotometric method.

2.8. Statistical Evaluation

Data generated from this study were analysed using IBM SPSS Statistics for Windows version 23.0 (IBM Corp, Armonk, NY, USA). Variables were normally distributed and were expressed as mean \pm standard deviation ($M \pm SD$). Analysis of variance (ANOVA) was used to compare the mean differences between the groups studied. Post-hoc analysis was done to ascertain the exact point of significant difference observed in the ANOVA.

3. Result

Table 1 Anthropometric parameters of the subjects

Variables	1 st trimester Mean±SD	2 nd trimester Mean±SD	3 rd trimester Mean±SD	F-value	P-value
Age	31±0.60	34±1.47	29±4.82	8.31	< 0.001
Weight	68±0.00	77.5±2.66	74.75±8.12	11.75	<0.001
Height	1.61±0.00	1.66±0.04	1.67±0.48	10.54	<0.001
BMI	26.23±0.00	28.21±2.34	26.58±3.46	2.29	0.11

Table 1 shows that age, weight, and height significantly varied across trimesters ($p < 0.001$) while BMI differences were not significant ($p = 0.11$), suggesting weight gain was proportional to height across groups.

Table 2 Comparative evaluation of TG, HDL and TG/HDL in Pregnant Women at first trimester, second trimester and third trimester

Variables	1 st trimester Mean±SD	2 nd trimester Mean±SD	3 rd trimester Mean±SD	F-value	P-value
Triglyceride	1.07±0.39	1.48±0.29	1.82±0.53	9.815	<0.001
HDL	1.16±0.47	1.60±0.30	1.27±0.29	4.623	0.017
TG/HDL	0.94±0.07	0.92±0.01	1.46±0.42	18.156	<0.001

As shown in Table 2, TG levels increased significantly across trimesters (1st: 1.07 ± 0.39 , 2nd: 1.48 ± 0.29 , 3rd: 1.82 ± 0.53 mmol/L; $p < 0.001$), supporting the notion of hyperlipidemia as a hallmark of advancing gestation. HDL-C peaked in the second trimester (1.60 ± 0.30 mmol/L), followed by a decline (3rd trimester: 1.27 ± 0.29 ; $p = 0.017$). The TG/HDL ratio was highest in the third trimester (1.46 ± 0.42), indicating elevated atherogenic risk ($p < 0.001$).

Table 3 LSD Post Hoc analysis for the significant ANOVA test for TG, HDL AND TG/HDL

Variable		Mean difference	P-value
1st trimester TG	2nd trimester TG	-0.41	0.02
	3rd trimester TG	-0.75	<0.001
2nd trimester TG	3rd trimester TG	-0.33	0.057
1st trimester HDL	2nd trimester HDL	-0.43	0.006
	3rd trimester HDL	-0.10	0.478
2nd trimester HDL	3rd trimester HDL	0.32	0.035
1st trimester TG/HDL	2nd trimester TG/ HDL	0.01	0.872
	3rd trimester TG/HDL	-0.51	<0.001
2nd trimester TG/ HDL	3rd trimester TG/ HDL	-0.53	<0.001

Table 3 shows the LSD tests, the tests confirmed significant differences between 1st and 3rd trimester TG levels ($p < 0.001$), 2nd and 3rd trimester HDL ($p = 0.035$), and TG/HDL ratios between 3rd and earlier trimesters ($p < 0.001$).

4. Discussion

This study examined trimester-specific alterations in anthropometric and lipid profile parameters among pregnant women attending antenatal care in Nnewi, Anambra State, Nigeria. The results discovered statistically significant variations in several anthropometric indices (age, weight, and height) and biochemical markers (triglycerides [TG], high-density lipoprotein [HDL], and TG/HDL ratio), providing understanding into the dynamic metabolic changes occurring during pregnancy. These findings emphasize the physiological adaptations to pregnancy and their implications for maternal cardiometabolic risk.

The observed significant variation in maternal age ($p < 0.001$) between trimesters could reflect differences in the distribution of study participants across trimesters rather than biological progression. However, weight showed a consistent and statistically significant increase from the first trimester (68.00 ± 0.00 kg) to the third trimester (74.75 ± 8.12 kg, $p < 0.001$), which is in line with the expected gestational weight gain. This gain supports increased energy requirements and fetal growth, a normal physiological occurrence reported across diverse populations [10]. Height measurements also showed significant differences ($p < 0.001$), although height typically remains constant throughout adult life. This discrepancy may result from methodological differences in measurement or selection bias. Body Mass Index (BMI), calculated using weight and height, showed no statistically significant variation ($p = 0.11$), though it tended to increase in the second trimester. This is consistent with the nonlinear pattern of weight gain in pregnancy, where fat accumulation is more prominent in mid-gestation [2].

The most outstanding finding was the progressive and significant rise in serum triglycerides from the first (1.07 ± 0.39 mmol/L) to the third trimester (1.82 ± 0.53 mmol/L, $p < 0.001$). This hypertriglyceridemia is consistent with the well-documented effect of gestational hormones such as estrogen and human placental lactogen, which stimulate hepatic lipogenesis and inhibit lipoprotein lipase activity, leading to elevated circulating TG levels [1-2].

Triglyceride elevation is a physiologic adaptation designed to ensure an adequate energy supply to the fetus, especially in the third trimester. However, excessively increased TG levels have been associated with adverse pregnancy outcomes such as gestational diabetes mellitus (GDM), preeclampsia, and preterm delivery [11]. The results of the post hoc analysis confirmed that the differences in TG levels between trimesters, particularly between the first and third ($p < 0.001$), and second and third ($p = 0.057$), were statistically and clinically meaningful.

HDL levels exhibited a biphasic trend, peaking in the second trimester (1.60 ± 0.30 mmol/L) and subsequently declining in the third trimester (1.27 ± 0.29 mmol/L, $p = 0.017$). The transient rise may reflect enhanced reverse cholesterol transport in early to mid-pregnancy, which helps maintain vascular integrity and reduce oxidative stress. The later decline in HDL levels could signify reduced protective lipoprotein activity and a shift toward a more atherogenic profile, particularly as pregnancy advances [8].

The significance of the changes in HDL levels was further validated by post hoc tests, with significant differences observed between the first and second trimester ($p = 0.006$) and between the second and third trimester ($p = 0.035$). Decreased HDL in late pregnancy may be a marker for endothelial dysfunction and increased cardiovascular risk postpartum, particularly in women with other predisposing factors [3,12].

The TG/HDL ratio, a surrogate marker for insulin resistance and cardiovascular disease (CVD) risk, significantly increased by the third trimester (1.46 ± 0.42 , $p < 0.001$). In early pregnancy, the ratio was relatively stable (0.94–0.92), indicating minimal metabolic disturbance. The sharp rise in late gestation suggests increased insulin resistance and lipoprotein metabolism dysregulation, hallmarks of gestational metabolic syndrome [6].

Post hoc analysis showed significant differences between the third trimester and both the first and second trimesters ($p < 0.001$), confirming the third trimester as a critical window of heightened cardiometabolic stress. This reinforces the importance of monitoring the TG/HDL ratio during pregnancy, not only as a diagnostic tool for gestational dyslipidemia but also as a predictor of postpartum metabolic disorders [13].

5. Conclusion

This study demonstrates significant trimester-specific variations in triglycerides, HDL, and TG/HDL ratio among pregnant women. The third trimester is characterized by pronounced hypertriglyceridemia and a higher TG/HDL ratio, indicating increased cardiometabolic stress. Monitoring these lipid parameters during pregnancy could serve as a valuable tool for early identification of at-risk pregnant women, enabling timely intervention to alleviate adverse

maternal and fetal outcomes. These findings support the inclusion of lipid profiling in routine antenatal care, particularly in regions like Nigeria with rising burdens of metabolic disease.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

Ethical approval for this study was obtained from the Ethical Committee of NAUTH.

Statement of informed consent

Informed consent was obtained from all participants.

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