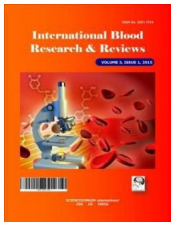

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Enzymatic and Non-enzymatic Biomarkers Levels in Pregnancy Trimesters in Ilesa South Western Nigeria

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Aims: The aim of this study was to see the effect of pregnancy on some selected enzymatic and non-enzymatic biomarkers based on trimesters.
Study Design: One-factor, one control - three test group quasi - experimental design.
Place and Duration of Study: Department of Chemical Pathology, Obafemi Awolowo University Teaching Hospitals Complex, Wesley Guild Hospital Unit, Ilesa, Osun State, Nigeria, between September 2015 and April 2016.
Methodology: A total of eighty (80) subjects were recruited for the study, and were grouped into 1st trimester pregnant women (n=20), 2nd trimester pregnant women (n=20), 3rd trimester pregnant women (n=20), and non-pregnant women (n=20). Blood samples (10 mL venous blood) were collected, centrifuged and stored as plasma before subjection to biochemical analysis. Blood plasma was analyzed for enzymatic and non-enzymatic biomarkers using standard approved methods.
Results: This study revealed that from first to third trimester, the following biomarkers: CK (creatine-kinase), LDH (lactate dehydrogenase), GGT (gamma-glutamyl transferase), AMY (amylase), TRP (troponin), CRP (c-reactive protein), MYO (myoglobin), AFP (alphafetoprotein), CB (conjugated bilirubin), and UR (urea) progressively increased while AST (aspartate

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aminotransferase), ALT (alanine aminotransferase), ALP (alkaline phosphatase), TB (total bilirubin), CR (creatinine), Na+ (sodium),and K+ (potassium) gradually decreases respectively. TP (total protein), and ALB (albumin), decreases in first and second trimester before rising in the third trimester of pregnancy. Moreover, in statistical analysis of the pregnancy trimesters with non pregnant women, ALP, AMY, TRP, MYO, and AFP were significantly increased while UR was significantly decreased in first trimester comparison with control subjects. In second trimester of pregnancy, CK, LDH, ALP, AMY, TRP, CRP, MYO, and AFP, were significantly elevated while UR was significantly decreased when compared to non pregnant subjects. In third trimester of pregnancy, CK, LDH, ALP, GGT, AMY, TRP, CRP, MYO, AFP, and CB were significantly raised while Na+ was significantly reduced when compared to the non pregnant women. Other biomarkers investigated with controls has differences that were statistically non significant.

Conclusion: Pregnancy irrespective of the trimester exerts positive influence on both enzymatic and non enzymatic biomarkers, which when investigated during pregnancy prevent pregnancy associated medical complications and gives improved antenatal care for safe delivery of a healthy baby by healthy mother.

Keywords: Plasma; enzymatic biomarkers; non-enzymatic biomarkers; pregnancy; trimesters.

1. INTRODUCTION

Pregnancy is a unique state where the physiology of a woman is greatly altered to accommodate the foetus. It occurs during ovulation, within which the ovum is fertilised (conception) in the fallopian tube and becomes zygote, which is then carried into the uterus [1-2]. Normal pregnancy in human being lasts for about 280 days (40 weeks), and has a large impact on the well being of a woman without any underlying medical disorder and at the same time makes the foetus vulnerable to the changes in the mother's internal and external physiological status [3]. As pregnancy trimester advances, great changes occur in physiology of the mother which is designed to supply the foetus needed nutrients required for growth, and the mother additional energy that she requires for labour [4]. Among several other causes of maternal mortality, haemorrhage has been reported to be the major cause in the West Africa sub-regions with 34.6% in the North Central Nigeria and 32.2% in Benin Republic [5-6].

Biomarkers are substances produced by a cell, tissue and organ as a characteristic that is objectively measured and evaluated as an indicator of normal biologic processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention [7]. This study is found necessary to assess the influence of normal human pregnancy on enzymatic biomarkers (creatine-kinase, lactate dehydrogenase, apartate and alanine aminotransferase, alkaline phosphatase, gamma-glutamyl transferase, and amylase) and non-enzymatic biomarkers (troponin, c-reactive protein, myoglobin, total protein, albumin, alphafetoprotein, total and conjugated bilirubin, creatinine, urea, sodium and potassium) in our society.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Reagents and chemicals

The reagents and chemicals used for this work were of analytical grade from sigma, and they include: urea acid reagent [$Fecl_3.6H_2o$ (5 g), phosphoric acid (85%), H_2so_4 (200 ml)], urea colour reagent (diacetylmonoxime (20g), thiosemicarbazide (5 g)], creatinine reagent [picric acid (9.3 g), Naoh (30 g), H_2so_4 (18.8 ml), sodium tungstate (50 g)], total protein biuret reagent [Naoh (8 g), alkaline tartrate (9g), $Cuso_4.5H_2o$ (3 g), potassium iodide (5 g)], albumin bromocresol green reagent [sodium citrate (10.16 g), citric acid (13.7 g), sodium azide (0.2 g), bromocresol green dye (0.698 g), solid brij 35 (25 g)], and bilirubin reagent [sodium benzoate (75 g), caffeine (50 g), hydrated sodium acetate (125 g) ethylene di-thymic acid (1 g), sulphanilic acid (5 g), H_2so_4 (15 ml), sodium nitrite (5 g), Naoh (50 g), sodium potassium tartrate (175 g), ascorbic acid (200 mg)], to mention a few.

2.2 Methods

2.2.1 Experimental design and grouping of subjects

Quasi-experimental design method was utilized in this study and subjects were divided into four (4) groups:

i. Group 1 was 1st Trimester Pregnant Women;
ii. Group 2 was 2nd Trimester Pregnant Women;
iii. Group 3 was 3rd Trimester Pregnant Women;
iv. Group 4 was Non-pregnant Women.

2.2.2 Sampling areas

The hospital selected for the purpose of this research in ilesa metropolis was Obafemi Awolowo University Teaching Hospitals Complex, Wesley Guild Hospital Unit, Ilesa, Osun State, Nigeria. This hospital is recognised as referral centre for best antenatal care in ilesa metropolis.

2.2.3 Recruitment of subjects

A total of eighty (80) subjects were recruited for the study, and were grouped into 1st trimester pregnant women (n=20), 2nd trimester pregnant women (n=20), 3rd trimester pregnant women (n=20), and non-pregnant women (n=20). Their blood samples were processed for analysis within 72 hours of collection employing standard approved methods.

2.2.4 Selection of subjects

The subjects for this project were selected according to the following criteria:

i. Visiting antenatal clinic to seek consent of the pregnant women and obtaining brief clinical history from them using questionnaire to take care of personal data, gestational age and other health informations;
ii. Visiting out-patient clinic to seek consent of the non-pregnant women and obtaining brief clinical history from them using questionnaire to take care of personal data, and other health informations;
iii. Ensuring that the pregnant subjects were free from all pregnancy associated complications while the non-pregnant subjects were healthy.

2.2.5 Collection of blood samples

2.2.5.1 Blood sample

About 10 mL of venous blood was collected from each subject into lithium heparin bottle.

2.2.5.2 Preparation of blood plasma

The blood samples (10 mL venous blood) were collected, centrifuged at 4,000 rpm for 20 min and stored as plasma before subjection to biochemical analysis. Blood plasma was analyzed for enzymatic and non-enzymatic biomarkers using standard approved methods.

2.2.6 Determination of concentration of plasma total protein

Plasma total protein concentration was determined spectrophotometrically using biuret method [8].

2.2.7 Determination of concentration of plasma albumin

Plasma albumin concentration was determined spectrophotometrically using dye binding method [8].

2.2.8 Estimation of plasma creatinine concentration

Plasma concentration of creatinine was estimated spectrophotometrically according to Jaffe's reaction method [8].

2.2.9 Estimation of plasma urea concentration

The concentration of plasma urea was estimated spectrophotometrically using diacetylmonoxime method [8].

2.2.10 Estimation of plasma levels of bilirubin [total and conjugated]

Plasma bilirubin concentration was estimated spectrophotometrically according to Jendrassik's method [8].

2.2.11 Estimation of plasma alphafetoprotein (AFP) concentration

Concentration of alpha-fetoprotein was estimated using enzyme linked immunosorbent assay (ELISA) method [9].

2.2.12 Assay of plasma gamma-glutamyl transferase (GGT) activity

This was assayed using enzymatic method [9].

2.2.13 Estimation of plasma myoglobin concentration

Concentration of myoglobin was estimated using enzyme linked Immunosorbent assay (ELISA) method [9].

2.2.14 Determination of plasma C- reactive protein (CRP) concentration

Plasma C - reactive protein concentration was determined spectrophotometrically using turbidimetric method [9].

2.2.15 Assay of plasma lactate dehydrogenase (LDH) activity

Lactate dehydrogenase (LDH) activity was assayed using enzymatic method [9].

2.2.16 Estimation of plasma troponin concentration

Concentration of troponin was estimated using enzyme linked Immunosorbent assay (ELISA) method [9].

2.2.17 Assay of plasma creatine-kinase (CK) activity

Creatine-kinase activity was assayed according to reflotron analytical method [9].

2.2.18 Determination of plasma sodium and potassium concentrations

Plasma concentrations of sodium and potassium were determined using the flame photometry method [9].

2.2.19 Assay of plasma aspartate aminotransferase (AST) activity

This was assayed spectrophotometrically using enzymatic method [10].

2.2.20 Assay of plasma alanine aminotransferase (ALT) activity

This was assayed spectrophotometrically using enzymatic method [10].

2.2.21 Assay of plasma alkaline phosphatase (ALP) activity

Alkaline phosphatase activity was assayed spectrophotometrically according to enzymatic method of Henry [11].

2.2.22 Assay of plasma amylase activity

This was assayed using enzymatic method [12].

2.3 Statistical Analysis

Results are expressed as mean ± SEM. Statistical difference was determined by one-way analysis of variance (ANOVA) followed by a post hoc test (Student Newman-Keuls Test (SNK)). Difference was considered statistically significant with $p < 0.05$. Computer software Graph pad PRISM® version 3.00 was used for the analysis.

3. RESULTS

The results of this study showed for each trimester together with non-pregnant women (control) are summarized in Tables 1-3. Tables 4-6 show the results of comparison of the three trimesters.

Also Tables 7-9 show the results for each trimester together with non-pregnant women (control) while Tables 10-12 show the results of comparison of the three trimesters.

4. DISCUSSION

Results obtained from this study showed an increased creatine-kinase activity in pregnancy from first to third trimester with a significant level seen at second and third trimesters. This is in line with previous studies [13]. Moreover, creatine-kinase was increased in pregnancy as compared to non-pregnant subjects.

Table 1. Enzymatic biomarkers in 1st trimester pregnant and non-pregnant (control) women

Enzymatic biomarkers	1st trimester (n=20)	Control (n=20)	P
CK (U/L)	117.30±8.63	95.40±9.46	P > 0.05
LDH (U/L)	192.70±5.91	174.90±7.72	P > 0.05
AST (IU/L)	19.70±2.43	18.30±1.75	P > 0.05
ALT (IU/L)	20.30±2.70	15.00±2.06	P > 0.05
ALP (IU/L)	194.80±7.20	67.00±4.01	P < 0.001
GGT (U/L)	30.90±2.38	28.70±1.57	P > 0.05
AMY (IU/L)	168.10±14.79	101.30±8.01	P < 0.01

Table 2. Enzymatic biomarkers in 2nd trimester pregnant and non-pregnant (control) women

Enzymatic biomarkers	2nd trimester (n=20)	Control (n=20)	P
CK (U/L)	127.50±10.63	95.40±9.46	P < 0.05
LDH (U/L)	213.60±7.97	174.90±7.72	P < 0.001
AST (IU/L)	15.70±0.79	18.30±1.75	P > 0.05
ALT (IU/L)	18.60±1.80	15.00±2.06	P > 0.05
ALP (IU/L)	171.10±6.20	67.00±4.01	P < 0.001
GGT (U/L)	34.50±2.53	28.70±1.57	P > 0.05
AMY (IU/L)	195.40±18.72	101.30±8.01	P < 0.001

Table 3. Enzymatic biomarkers in 3rd trimester pregnant and non-pregnant (control) women

Enzymatic biomarkers	3rd trimester (n=20)	Control (n=20)	P
CK (U/L)	154.40±7.94	95.40±9.46	P < 0.001
LDH (U/L)	235.90±5.47	174.90±7.72	P < 0.001
AST (IU/L)	13.60±1.36	18.30±1.75	P > 0.05
ALT (IU/L)	17.10±2.15	15.00±2.06	P > 0.05
ALP (IU/L)	150.30±8.76	67.00±4.01	P < 0.001
GGT (U/L)	42.20±3.42	28.70±1.57	P < 0.01
AMY (IU/L)	217.40±24.79	101.30±8.01	P < 0.001

Table 4. Comparison of Enzymatic biomarkers in 1st trimester pregnant and 2nd trimester pregnant women

Enzymatic biomarkers	1st trimester (n=20)	2nd trimester (n=20)	P
CK (U/L)	117.30±8.63	127.50±10.63	P > 0.05
LDH (U/L)	192.70±5.91	213.60±7.97	P < 0.05
AST (IU/L)	19.70±2.43	15.70±0.79	P > 0.05
ALT (IU/L)	20.30±2.70	18.60±1.80	P > 0.05
ALP (IU/L)	194.80±7.20	171.10±6.20	P < 0.05
GGT (U/L)	30.90±2.38	34.50±2.53	P > 0.05
AMY (IU/L)	168.10±14.79	195.40±18.72	P > 0.05

Table 5. Comparison of enzymatic biomarkers in 1st trimester pregnant and 3rd trimester pregnant women

Enzymatic biomarkers	1st Trimester (n=20)	3rd Trimester (n=20)	P
CK (U/L)	117.30±8.63	154.40±7.94	P < 0.05
LDH (U/L)	192.70±5.91	235.90±5.47	P < 0.001
AST (IU/L)	19.70±2.43	13.60±1.36	P > 0.05
ALT (IU/L)	20.30±2.70	17.10±2.15	P > 0.05
ALP (IU/L)	194.80±7.20	150.30±8.76	P < 0.001
GGT (U/L)	30.90±2.38	42.20±3.42	P < 0.01
AMY (IU/L)	168.10±14.79	217.40±24.79	P > 0.05

The elevated activities of creatine-kinase might be the resultant effect of response of cardiac muscle to cardiovascular changes for increased cardiac output and plasma volume in normal human pregnancy [13].

However, Lactate dehydrogenase activity increased gradually from first to third trimester when compared to control, and was significant at second and third trimesters. When all trimesters were compared to each other, statistically significant increase was also observed in Lactate dehydrogenase activity. The highest value was associated with the third trimester. This is in line with the previous work [14] where elevated plasma Lactate dehydrogenase activity was observed in normal human pregnancy. The elevated Lactate dehydrogenase activity

observed during pregnancy might be due to increased lactate dehydrogenase release from cellular components especially red blood cells enhanced by relative anaemia seen in pregnancy, as this is in accordance with the previous report [14].

Table 6. Comparison of enzymatic biomarkers in 2nd trimester pregnant and 3rd trimester pregnant women

Enzymatic biomarkers	2nd trimester (n=20)	3rd trimester (n=20)	P
CK (U/L)	127.50±10.63	154.40±7.94	P < 0.05
LDH (U/L)	213.60±7.97	235.90±5.47	P < 0.05
AST (IU/L)	15.70±0.79	13.60±1.36	P > 0.05
ALT (IU/L)	18.60±1.80	17.10±2.15	P > 0.05
ALP (IU/L)	171.10±6.20	150.30±8.76	P < 0.05
GGT (U/L)	34.50±2.53	42.20±3.42	P < 0.05
AMY (IU/L)	195.40±18.72	217.40±24.79	P > 0.05

Table showed Means ± Standard error of mean (SEM), Differences between means and the levels of significance (P<0.001 and P<0.05). CK= Creatine-kinase, LDH = Lactate dehydrogenase, AST= Aspartate aminotransferase, ALT= Alanine aminotransferase, ALP= Alkaline phosphatase, GGT= Gamma-glutamyl transferase, AMY= Amylase

Table 7. Non-enzymatic biomarkers in 1st trimester pregnant and non-pregnant (control) women

Non-enzymatic biomarkers	1st trimester (n=20)	Control (n=20)	P
TRP (ng/mL)	0.40±0.02	0.30±0.05	P < 0.05
CRP (mg/L)	5.90±0.42	4.90±0.38	P > 0.05
MYO (ng/mL)	96.20±4.64	68.50±5.80	P < 0.001
TP (g/L)	77.00±1.18	77.20±1.82	P > 0.05
ALB (g/L)	36.10±0.05	36.50±1.12	P > 0.05
AFP (IU/mL)	29.60±1.96	7.40±0.67	P < 0.001
TB (umol/L)	37.00±5.01	27.90±1.55	P > 0.05
CB (umol/L)	6.50±0.61	5.50±0.43	P > 0.05
CR (umol/L)	88.51±6.08	81.20±5.04	P > 0.05
UR (mmol/L)	2.63±0.16	3.50±0.21	P < 0.01
Na+ (mmol/L)	136.30±0.48	136.50±0.99	P > 0.05
K+ (mmol/L)	3.80±0.04	3.60±0.07	P > 0.05

Table 8. Non-enzymatic biomarkers in 2nd trimester pregnant and non-pregnant (control) women

Non-enzymatic biomarkers	2nd trimester (n=20)	Control (n=20)	P
TRP (ng/mL)	0.60±0.03	0.30±0.05	P < 0.001
CRP (mg/L)	7.70±0.51	4.90±0.38	P < 0.001
MYO (ng/mL)	101.30±3.98	68.50±5.80	P < 0.001
TP (g/L)	76.20±2.69	77.20±1.82	P > 0.05
ALB (g/L)	35.30±1.04	36.50±1.12	P > 0.05
AFP (IU/mL)	41.60±2.06	7.40±0.67	P < 0.001
TB (umol/L)	36.20±4.21	27.90±1.55	P > 0.05
CB (umol/L)	7.90±0.98	5.50±0.43	P > 0.05
CR (umol/L)	87.30±5.82	81.20±5.04	P > 0.05
UR (mmol/L)	2.80±0.19	3.50±0.21	P < 0.05
Na+ (mmol/L)	134.30±1.45	136.50±0.99	P > 0.05
K+ (mmol/L)	3.70±0.09	3.60±0.07	P > 0.05

Table 9. Non-enzymatic biomarkers in 3rd trimester pregnant and non-pregnant (control) women

Non-enzymatic biomarkers	3rd trimester (n=20)	Control (n=20)	P
TRP (ng/mL)	0.70±0.03	0.30±0.05	P < 0.001
CRP (mg/L)	9.10±0.70	4.90±0.38	P < 0.001
MYO (ng/mL)	118.40±4.40	68.50±5.80	P < 0.001
TP (g/L)	79.70±1.26	77.20±1.82	P > 0.05
ALB (g/L)	36.70±0.92	36.50±1.12	P > 0.05
AFP (IU/mL)	48.00±3.42	7.40±0.67	P < 0.001
TB (umol/L)	34.40±3.67	27.90±1.55	P > 0.05
CB (umol/L)	8.50±0.85	5.50±0.43	P < 0.05
CR (umol/L)	86.70±5.57	81.20±5.04	P > 0.05
UR (mmol/L)	3.10±0.19	3.50±0.21	P > 0.05
Na+ (mmol/L)	130.50±1.26	136.50±0.99	P < 0.01
K+ (mmol/L)	3.50±0.13	3.60±0.07	P > 0.05

Table 10. Comparison of non-enzymatic biomarkers in 1st trimester pregnant and 2nd trimester pregnant women

Non-enzymatic biomarkers	1st trimester (n=20)	2nd trimester (n=20)	P
TRP (ng/mL)	0.40±0.02	0.60±0.03	P < 0.001
CRP (mg/L)	5.90±0.42	7.70±0.51	P < 0.05
MYO (ng/mL)	96.20±4.64	101.30±3.98	P > 0.05
TP (g/L)	77.00±1.18	76.20±2.69	P > 0.05
ALB (g/L)	36.10±0.05	35.30±1.04	P > 0.05
AFP (IU/mL)	29.60±1.96	41.60±2.06	P < 0.001
TB (umol/L)	37.00±5.01	36.20±4.21	P > 0.05
CB (umol/L)	6.50±0.61	7.90±0.98	P > 0.05
CR (umol/L)	88.51±6.08	87.30±5.82	P > 0.05
UR (mmol/L)	2.63±0.16	2.80±0.19	P > 0.05
Na+ (mmol/L)	136.30±0.48	134.30±1.45	P > 0.05
K+ (mmol/L)	3.80±0.04	3.70±0.09	P > 0.05

Table 11. Comparison of non-enzymatic biomarkers in 1st trimester pregnant and 3rd trimester pregnant women

Non-enzymatic biomarkers	1st trimester (n=20)	3rd trimester (n=20)	P
TRP (ng/mL)	0.40±0.02	0.70±0.03	P < 0.001
CRP (mg/L)	5.90±0.42	9.10±0.70	P < 0.001
MYO (ng/mL)	96.20±4.64	118.40±4.40	P < 0.01
TP (g/L)	77.00±1.18	79.70±1.26	P > 0.05
ALB (g/L)	36.10±0.05	36.70±0.92	P > 0.05
AFP (IU/mL)	29.60±1.96	48.00±3.42	P < 0.001
TB (umol/L)	37.00±5.01	34.40±3.67	P > 0.05
CB (umol/L)	6.50±0.61	8.50±0.85	P > 0.05
CR (umol/L)	88.51±6.08	86.70±5.57	P > 0.05
UR (mmol/L)	2.63±0.16	3.10±0.19	P > 0.05
Na+ (mmol/L)	136.30±0.48	130.50±1.26	P < 0.01
K+ (mmol/L)	3.80±0.04	3.50±0.13	P > 0.05

The result of this study showed that pregnant women had a non significant and reduced aspartate aminotransferase enzyme activity levels from first to third trimester when compared to control groups and when all trimesters were compared to each other. The gradual reduction might be the resultant effect of hormonal changes in pregnancy. It is known that in pregnancy, various hormones are secreted e.g oestrogen. This hormonal stimulation causes imbalances and appetite changes for reduced vitamin intake (vitamin B_6) in pregnancy.

Table 12. Comparison of non-enzymatic biomarkers in 2nd trimester pregnant and 3rd trimester pregnant women

Non-enzymatic biomarkers	2nd trimester (n=20)	3rd trimester (n=20)	P
TRP (ng/mL)	0.60±0.03	0.70±0.03	P < 0.05
CRP (mg/L)	7.70±0.51	9.10±0.70	P > 0.05
MYO (ng/mL)	101.30±3.98	118.40±4.40	P < 0.05
TP (g/L)	76.20±2.69	79.70±1.26	P > 0.05
ALB (g/L)	35.30±1.04	36.70±0.92	P > 0.05
AFP (IU/mL)	41.60±2.06	48.00±3.42	P < 0.05
TB (umol/L)	36.20±4.21	34.40±3.67	P > 0.05
CB (umol/L)	7.90±0.98	8.50±0.85	P > 0.05
CR (umol/L)	87.30±5.82	86.70±5.57	P > 0.05
UR (mmol/L)	2.80±0.19	3.10±0.19	P > 0.05
Na+ (mmol/L)	134.30±1.45	130.50±1.26	P < 0.05
K+ (mmol/L)	3.70±0.09	3.50±0.13	P > 0.05

Table showed Means ± Standard error of mean (SEM), Differences between means and the levels of significance (P<0.001 and P<0.05). TRP= Troponin, CRP = C-reactive protein, MYO= Myoglobin, TP= Total protein, ALB= Albumin, AFP= Alphafetoprotein, TB= Total bilirubin, CB= Conjugated bilirubin, CR= Creatinine, UR= Urea, Na+= Sodium, K+= Potassium

Vitamin B_6 being required as cofactor for aspartate aminotransferase production, its reduced intake brings about decreased aspartate aminotransferase enzyme activity, as this was reported in previous report [15].

Result obtained for alanine aminotransferase activity shows a non significantly increased activity similar to that of aspartate aminotransferase enzyme activity when compared to controls and when all trimesters were compared to each other as its activity reduced gradually from first to third trimester. Factor responsible for this decrease in alanine aminotransferase activity might not be far from same previous findings responsible for aspartate aminotransferase [15]. This is because both enzymes belong to same group of aminotransferases [15].

The gamma glutamyltransferase activity increased progressively from first to third trimester when compared to control, and a significant difference was noted alone at third trimester. When all trimesters were compared to each other, statistically significant increase was seen in the gamma glutamyltransferase activity in Tables 5 and 6. This is in line with the previous work [16] where elevated plasma gamma glutamyltransferase activity was observed to be parrallel with alkaline phosphatase in normal human pregnancy. The elevated gamma glutamyltransferase activity observed during pregnancy might be as a result of increased release from the placenta into plasma, since placenta is one of the clinical source of gamma glutamyltransferase [16].

Total bilirubin and conjugated bilirubin concentrations from this study showed a non significant increase than the non pregnant subjects.This is in line with previous studies [16]. The hyperbilirubinemia than the non pregnant subjects might be due to relative anaemia in pregnancy making the hepatic reticuloendothelial system (kupffer cells) to digest little haemoglobin for bilirubin synthesis. In contrast, comparison of the trimesters with each other revealed gradual decrease in total bilirubin concentrations and progressive increase in conjugated bilirubin concentrations, though they were statistically non significant. This is also as previously reported [16] as there is a gradual response by the liver in pregnant individual to increase the binding of bilirubin to albumin and being conjugated to result in decreased total bilirubin and increased conjugated bilirubin concentrations.

Alkaline phosphatase activity from this study showed significant increase in all the three trimesters of pregnancy than the non pregnant subjects. This is in line with previous studies [16]. This hyperphosphatasia might have occured in pregnant individuals as a result of increased release from the placenta into plasma, since placenta is one of the clinical source of alkaline phosphatase. Nevertheless, there exists a gradual reduction in the alkaline phosphatase activity from first to third trimester. This reduction could be associated to the increased need of phosphates by foetus for development to bring hypophosphatasia [17].

Total protein and albumin concentrations from this study showed a non significant decrease in

first and second trimesters with an elevation in third trimester of pregnancy than the non pregnant subjects. This was also observed when comparing the trimesters with each other. This is in line with previous studies [18]. The reduced total protein and albumin in first and second trimesters might have occurred as a result of hormonal stimulation in pregnant individuals to cause imbalances and appetite changes for reduced dietary intake (of proteins) in pregnancy. Nevertheless, there exists a gradual elevation in the total protein and albumin concentrations in third trimester. This finding could be due to increased plasma protein synthesis into bloodstream by liver in pregnancy from the same influence of hormonal changes to cope with high need of protein by the mother and developing foetus in pregnancy [18].

The activity of amylase from this study increased progressively from first to third trimester at a significant level in pregnant women when compared to non-pregnant women. This was in line with the previous work [18] where they recorded increased level of amylase activity as the age of pregnancy increased which was evident when the trimesters were compared to each other, though statistically non significant. The hyperamylasemia in pregnancy might be due to hormonal changes that necessitates increase secretions of amylase from both salivary gland and pancrease into plasma [18].

The result of this study showed that pregnant women had a non significantly increased creatinine concentration than the controls. This finding could be due to increased plasma and endogenous protein synthesis into bloodstream by liver in pregnancy from the influence of hormonal changes to cope with high need of protein by the mother and developing foetus in pregnancy [18]. Furthermore, as the pregnancy advances from first to third trimester, the creatinine concentration gradually decreases. This finding could be due to increased plasma volume in pregnancy that necessitated creatinine haemodilution. Similar observation has been reported previously [19].

Plasma concentration of urea from this study was reduced in all three trimesters when compared with control, as significant level was observed in first and second trimesters. This is in line with previous studies [19]. The decrease might be due to the increased plasma volume in pregnancy that necessitated urea haemodilution. Furthermore, as the pregnancy advances from first to third trimester, the urea concentration gradually increases. This finding might have occurred as a result of improved hormonal stimulation in pregnant individuals for appetite changes that brings about improved dietary intake (of proteins) in pregnancy, since urea is influenced by dietary intake [19].

Results obtained from this study for the non enzymatic biomarkers in pregnancy revealed significantly elevated troponin concentrations in pregnancy in all three trimesters. This is in line with previous studies [20]. This elevations of troponin may be deduced to occur due to the need that troponin as cardiac regulatory protein in pregnant individual, sees pregnancy mimicking growing tumour that needed to be inhibited from advancing, thus produced and released to interfere with the development of new blood vessel needed for pregnancy growth. The increased troponin concentrations in pregnancy as compared to non-pregnant subject could also be due to this factor [20].

C-reactive protein concentrations increased gradually from first to third trimester when compared to control, and was significant at second and third trimesters. When all trimesters were compared to each other, statistically significant increase was also observed for C-reactive protein concentrations in tables 10 and 11. This is in line with the previous work [21] where an elevated plasma C - reactive protein concentration was observed in normal human pregnancy. The elevated C-reactive protein concentrations observed during pregnancy might be due to increased release from cellular components as a result of openness to infection enhanced by reduced immunity in pregnancy, that is c-reactive protein increases due to its role in innate immunity, as an early defense system against infections [21].

Moreover, Myoglobin concentrations increased progressively and significantly from first to third trimester when compared to control. When all trimesters were compared to each other, statistically significant increase was also observed for Myoglobin concentrations in Tables 10 and 11. This is in line with the previous work [22]. The elevated Myoglobin concentrations observed during pregnancy might be due to the resultant effect of response of cardiac muscle to cardiovascular changes for increased cardiac output in coping with the needed increased blood plasma volume and blood flow in normal human pregnancy, hence demanding for more myoglobin to supply oxygen for this function [22].

Plasma concentration of alphafetoprotein from this study was significantly elevated in all three trimesters when compared with control and each other. This is in line with previous studies [23]. The elevations might be due to the increased production of alphafetoprotein in pregnancy as a response to foetal and neonatal development by liver, yolk-sac and in small concentrations by gastrointestinal tract [23].

Sodium ion concentration in plasma decreased gradually from first to third trimester when compared to control, and was significant at third trimester. When all trimesters were compared to each other, statistically significant decrease was also observed for sodium concentration in Tables 11 and 12. This is in line with the previous work [24] where the findings could be due to increased plasma volume in pregnancy that necessitated sodium ion haemodilution [24].

However, plasma potassium ion concentration decreased gradually and non significantly from first to third trimester when compared with each other, but when compared to non pregnant subjects, an elevation that was non significant was observed at first and second trimesters than the controls while at third trimester, it was opposite. This is in line with the previous work [24]. The hyperkalaemia at first and second trimesters than the controls might be due dietary gain of potassium. Nevertheless, the gradual decrease of plasma potassium ion concentration as pregnancy advances with hypokalaemia seen at third trimester could have occurred from increased plasma volume in pregnancy that necessitated potassium ion haemodilution [24].

5. CONCLUSION

Pregnancy irrespective of the trimester as expressed in this study exerts positive influence on both enzymatic and non enzymatic biomarkers, which when investigated during pregnancy prevents pregnancy associated medical complications and gives improved antenatal care for safe delivery of a healthy baby by healthy mother.

CONSENT

Author declared that written informed consent was obtained from all the subjects studied in this work.

ETHICAL APPROVAL

Author hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 declaration of Helsinki.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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