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Biochemical profiles of pregnant women attending Gambo Sawaba General Hospital, Zaria, Kaduna State, Nigeria.

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Abstract

The hormonal and metabolic changes that occur during pregnancy promote the development and survival of the foetus. Pregnancy problems, however, might result from an imbalance in metabolic profiles. Biochemical profile assessments may be useful for both identification and treatment of some underlining causes of pregnancy complications. The biochemical profiles of pregnant and non-pregnant women attending the prenatal clinic at the Gambo Sawaba General Hospital in Zaria were examined in this study. Pregnant women in various stages (First trimester, second trimester, third trimester), and non-pregnant women were divided into four groups of thirty women each at random from a total of 90 pregnant and 30 non-pregnant women. Standard techniques were used to measure serum glucose, cholesterol, total protein, albumin, globulin, urea, uric acid, creatinine, alanine transaminase, aspartate transaminase, alkaline phosphatase, and body mass index. The findings demonstrate that, in comparison with non-pregnant women, women in the first, second, and third trimesters of pregnancy showed a significantly ($P < 0.05$) higher levels of blood glucose, serum cholesterol, and body mass index. But serum protein, urea, uric acid, albumin, globulin, and creatinine levels among pregnant women in the three trimesters were not significantly different ($P > 0.05$) however, the difference was significant ($P < 0.05$) when compared to non-pregnant women. While there was no difference in the levels of ALT and AST between pregnant and non-pregnant women (there was a significant difference in the levels of ALP ($P < 0.05$) between pregnant and non-pregnant women. This study shows that assessing the metabolic profile of pregnant women may be important in managing pregnancy-related complications and prepare the mother for safe delivery. It is recommended that specific biochemical parameters, particularly serum glucose, serum cholesterol, and BMI be monitored during prenatal visits to prevent life threatening complications.

Keywords: Pregnancy, Women, Profile, Biochemical, Trimester

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INTRODUCTION

Pregnancy is linked to common physiological changes that help the foetus to grow and survive. When compared to the non-pregnant state, biochemical parameters clearly show these adaptive modifications in the majority of organ systems (Usman *et al*., 2018). Pregnancy is a dynamic process associated with significant physiological changes in the cardiovascular system (Agholor, 2016). These changes are mechanisms that the body has adapted to meet the increased metabolic demands of the mother and fetus and to ensure adequate uteroplacental circulation for fetal growth and development (Grindheim, 2012).

Some of the changes in maternal physiology during pregnancy include, for example, increased maternal fat and total body water, decreased plasma protein concentrations, especially albumin, increased maternal blood volume, cardiac output, and blood flow to the kidneys and decreased blood pressure (Ayandis,2018). In the event of complications, these adjustments, however, become crucial. Anemia, hyperlipidemia, hypertension, diabetes, and preeclampsia are some of the potential problems of pregnancy (Shehata, 2011 and Okojie *et al.,* 2011). According to the WHO, more than 20 million women worldwide face pregnancy-related poor health each year, often for the rest of their lives. Additionally, "about 500,000 women are believed to have died from pregnancy and childbirth-related causes, and the lives of eight million women are at risk" (WHO, 2016). Regardless of the gestational age and location of the pregnancy, maternal mortality which is the death of a woman , during pregnancy and within 42 days of delivery remains , a source of public health concern, particularly in developing nations where maternal mortality indices show a high prevalence of these pregnancy-related deaths (WHO, 2016). The importance of ensuring excellent maternal health cannot be overstated, especially given the crucial role that women play in determining the welfare of the family (Berk, 2011). Mortality of a mother may mark the beginning of poverty, child undernutrition, lack of education, and a host of other negative socioeconomic impacts that have an impact on her family and society as a whole (Ogunjemie and Ikoro 2012., Mojekwu and Ibekwe, 2012).

Globally there has been an increase in antenatal services, but pregnancy-related complications resulting in maternal deaths is still on the increase particularly in Sub-Saharan Africa, whose annual rate needed to achieve the Sustainable Development global goal of 70 maternal deaths per 100,000 live births is very low (WHO, UNICE; and UNFPA 2021). Nigeria has an average maternal mortality ratio of (814/100,000) and it's ranked second globally, after India with a global contribution of 19% to global pregnancy-related maternal mortality ratio (MMR) (NDHS, 2018). In north-west zone, Kaduna State contributes 10% of the total maternal mortality ratio. Zaria LGA in Kaduna State has MMR of (1400 maternal deaths/ 100,000 live births) which is >10% of total pregnancy-related maternal death in Kaduna State (NDHS, 2018). All other studies have focused on indirect methods of assessing maternal mortality ratio. The indirect methods for estimating maternal mortality simply rely on survey where women are asked questions about the socio-economic status of their fellow sisters who are living or death, it relies on retrospective evidence (Hadiza *et al*, 2010).

Pregnancy-related biochemical measures to prevent development of complications have not been seen in Zaria (WHO, 2020). The primary goal of this study was to evaluate differences in blood levels of biochemical parameters among healthy pregnant women at Gambo Sawaba General Hospital in Zaria and to give reference data

MATERIALS AND METHODS

Description of Study Area

The city of Zaria, situated in the Centre of northern Nigeria, was established as the seat of the throne of Zazzau Emirate more than 700 years ago, and is currently the Emirate's administrative headquarters. Zaria is situated on Latitude: 11° 06' 40.61" N Longitude: 7° 43' 21.72" E. According to the 2016 National Population Commissions, projection, Zaria has a population of 549,400. Hausa/Fulani are the dominant groups in the city and the state, and the Hausa language serves as the lingua franca. Most of the city's inhabitants are Muslims. There are 4 State- Owned Secondary facilities, and two Federally owned Teaching Hospitals. Gambo Sawaba General Hospital in Zaria Local Government is one of the state-owned secondary health facility where the study was conducted. The Kaduna State Government have implemented various interventions to reduce maternal and child mortality among which are; Bi-annual maternal child health week, Vitamin A supplementation, Deworming tablets, Iron and Folic acid supplementation and nutrition education. These interventions have been able to reduce maternal and child deaths significantly and more still need to be done.

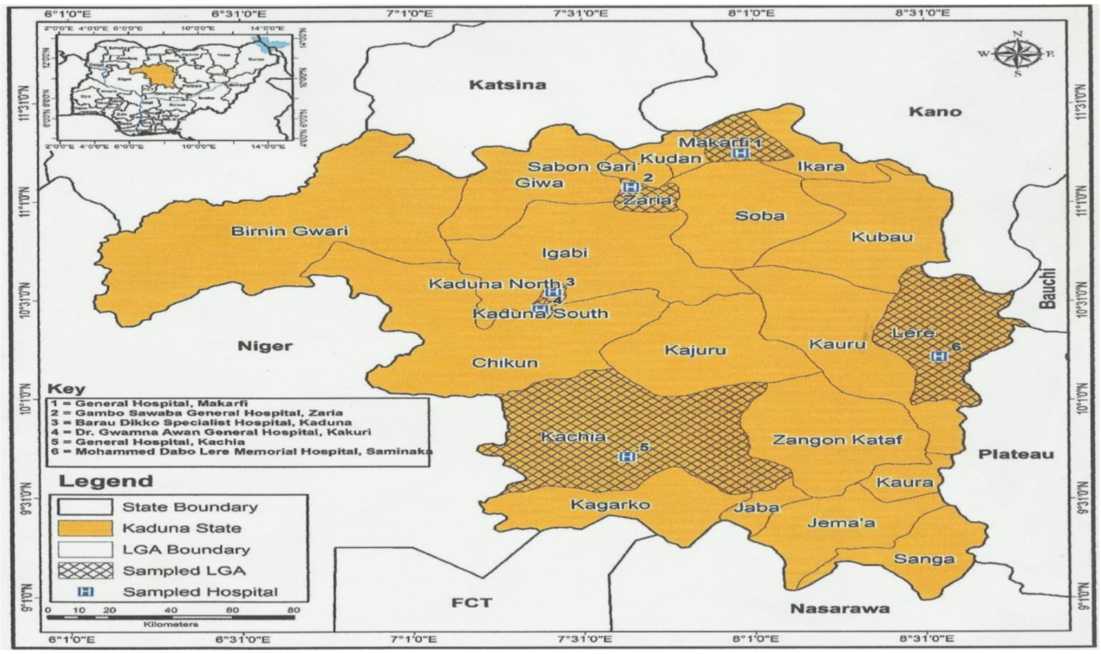

Figure 1: Map of Nigeria and Zaria LGA showing the study area.
Source: Kaduna Geographical Information System, 2017

Study design

This is a case-control study involving 120 pregnant mothers in their first, second and third trimesters and 30 non-pregnant mothers attending antenatal clinic at Gambo Sawaba General Hospital in Zaria Local Government Area (LGA) of Kaduna State.

Study population

The sample comprised 120 women aged 18-40 years; 90 apparently healthy pregnant women and 30 healthy non pregnant age-matched controls.

Sampling and sample size

Overall, 120 pregnant women were chosen randomly, and were divided into four groups of 30 each, representing the first, second, and third trimesters of pregnancy thirty subjects each in the first, second and third trimesters were chosen] Thirty (30) apparently healthy, non-pregnant women were chosen from the general community to serve as controls. Age matching was done for pregnant and non-pregnant women.

Sample size calculation

The sample size was determined using the method described by Naing *et al*., (2006) as defined below,

Sample Size= $\frac{Z^2P(1-p)}{C^2}$

Where;

Z=1.96 at 95%

P=percentage prevalence of Pregnancy Maternal Mortality in Zaria LGA 10.3 % (WHO, 2016).

C=confidence Level. (5%).

Inclusion criteria

Women between the ages of 18 and 40 who were healthy, not-pregnant, or pregnant and who do not suffer from any liver disorder and who visit the Gambo Sawaba General Hospital.

Exclusion criteria

Expectant mothers who have gestational diabetes, hypertension, obesity, or other chronic illnesses as well as women above the age of 40, (as pregnancy at this age is thought to be high risk).

Ethical consideration

The Ethics and Research Committee of the Kaduna State Ministry of Health approved the study's protocol. The study was conducted in conformity with the ethical guidelines for medical research involving human beings as stated in the 1964 Helsinki declaration. Prior to enrollment, all study participants provided a written, informed permission.

METHODS

Socio-demographic and clinical information

Socio-Demographic and Clinical Information were collected using a semi-structured questionnaire that asked about sociodemographic data (age, education, employment, and family income per month), medical history (previous pregnancies, complications from those pregnancies, and pregnancy avoidance) and clinical data (complications during this pregnancy, treatment, and blood pressure).

Measurement of anthropometric parameters

Using accepted methods, anthropometric characteristics were assessed throughout each trimester of pregnancy. A regularly calibrated weighing scale (ZT 120 Seca Gmbh and Co., Germany) was used to weigh subjects while wearing the bare minimum of clothes, and a calibrated stadiometer (model 220; Seca Gmbh and Co., Germany) was used to measure their heights. BMI was computed as follows: BMI = Weight (kg)/Height (m^2). The method was carried out in triplicate after which the value was determined

Specimen collection and biochemical analyses

Biochemical analysis

A volume of 8 ml of 12 h-fasted venous blood samples were collected from all the study participants; 6 ml into EDTA-containing tube and 2 ml into plain tubes. The blood in plain tubes were centrifuged at room temperature for 10 minutes at a speed of 4000 rpm to obtain sera that was used for calcium, zinc, uric acid, urea, creatinine, Alanine transaminase, Aspartate transaminase, total protein, albumin tests, while blood in EDTA tubes were used for glucose and cholesterol tests. All measurements were done in triplicate.

Determination of serum glucose

Serum blood glucose was determined by the method described by international Federation of clinical chemistry (IFCC, 1998). Using Thomas reagent kit

Determination of total serum cholesterol

Utilizing Daisy's Diagnostic Reagent Kit Systems from Germany, an enzymatic colorimetric approach is used to quantify total cholesterol levels in blood or plasma.

Determination of serum total protein

Using Daisy's reagent kits, the serum total protein was measured using a photometric assay in accordance with the Thomas technique (Thomas, 1998).

Determination of albumin

According to the procedure outlined by Johnson and his colleagues, serum albumin was measured using a photometric assay (Johnson et al., 1999)

Determination of globulin

Globulin will be calculated according the following formula described by IFCC (1998)

Estimation of alanine transaminase

The determination of Alanine Transaminase (ALT) was carried according to the method described by Reitman and Frankel using RANDOX reagent Kit (1957). The determination of Aspartate Transaminase (AST) was carried out as described by Reitman and Frankel using RANDOX reagent Kit. (1957).

Determination of alkaline phosphatase

According to the International Federation of Clinical Chemistry and Laboratory Medicine

(IFCC), serum alkaline phosphatase (ALP) activity was assessed using a kinetic photometric test with Daisy's reagent kits, following the procedure outlined by Thomas (Thomas, 1998).

Determination of serum urea and creatinine: Serum creatinine was measured using the method described by IFCC (1998)

Determination of serum uric acid: By employing Daisy's reagent kits and TBHBA (2, 4, 6-tribromo-3-hydroxybenzoic acid) in an enzymatic photometric assay, serum uric acid may be measured (Fossati et al., 1980).

Data analysis

Statistical package for social sciences (SPSS), version 20.0 a product of International Business Machine (IBM) was used for data analysis, two-way analysis of variance (ANOVA) with Turkey A post-hoc test was employed to examine differences both within and between groups, while Pearson's moment correlation was employed to establish links between BMI, blood glucose, and serum cholesterol. When the P-value was less than 0.05, the difference was deemed statistically significant.

RESULTS

Figure 1I shows the Sociodemographic characteristics of pregnant women in various trimesters and non-pregnant women. 40(33.3%) of the pregnant women are between 18-24 years are in their second trimester of pregnancy, while 60(50%) within the age of 25-31 years are in their first trimester respectively. 30 (25.1%) of the non-pregnant women were above 38 years of age. Figure III demonstrates that 36(30%) of pregnant women in their third trimester of pregnancy had no formal education while 22(18.3%) of non-pregnant women who had no formal education. Also 31(25.8%) and 29(24.2%) of pregnant women in their third trimester had primary, secondary and tertiary education, when compared to3(27.5%), 41(34.1%) and 35(29.2%) of non-pregnant women who attended primary, secondary and tertiary education respectively. Figure V demonstrates that 18.3% of non-pregnant women have average monthly earnings of <10,000 naira, while 23.3% of pregnant women in their first trimester earn averagely <10,000 monthly. Figure V also demonstrates that 29.2% on non-pregnant women had an average monthly income of 30,000-40,000 naira when compared to 25.5% of pregnant women in their first and third trimesters with an average monthly income of 30,000-40,000 respectively. Figure IV demonstrates that 36(30%) of pregnant women in their third trimester of pregnancy have no formal education while 22(18.3%) of non- pregnant women have no formal education. Also 31(25.8%) and 29(24.2%) of pregnant women in their third trimester have primary, secondary and tertiary education, when compared to 3(27.5%), 41(34.1%) and 35(29.2%) of non-pregnant women who attended primary, secondary and tertiary education respectively. Figure V presents the employment status of pregnant and non-pregnant women. Twenty-six (31.7%) of the pregnant women in their third trimester and 21(17.5%) non-pregnant women were not employed, 34.1% of the pregnant women are self-employed while 18.3% of the non-pregnant women were self-employed. Table 1 presents the results for serum glucose, serum cholesterol and body mass index of pregnant and non-pregnant women attending Gambo Sawaba General Hospital, Zaria. From the table serum glucose increased significantly (P<0.05) from (81.4±7.32 - 90.7±4.32 mg/dl) in pregnant women, this difference was also significant (P<0.05) when compared to serum glucose among non-pregnant women 77.6±7.32 mg/dl respectively. Although the results indicate that the serum glucose for all the study population is within the normal range (60 -110mg/dl) respectively. Also, serum cholesterol increases significantly (P<0.05) from (152±11.33 - 188±14.33 mg/dl) as against non-pregnant women (146±10.23 mg/dl), this difference was significant (P<0.05) when compared to non-pregnant women. The body mass index (BMI), showed an increase (P<0.05), (22.22±1.22 - 26.35±2.33 kg/m^2) among the pregnant women in different trimesters of pregnancy, this difference was also significant (P<0.05) when compared to non- pregnant women (22.22±1.22 kg/m^2). The results clearly demonstrated that the BMI for pregnant and non-pregnant women remain within the normal range (18.5 – 24.9 kg/m^2).

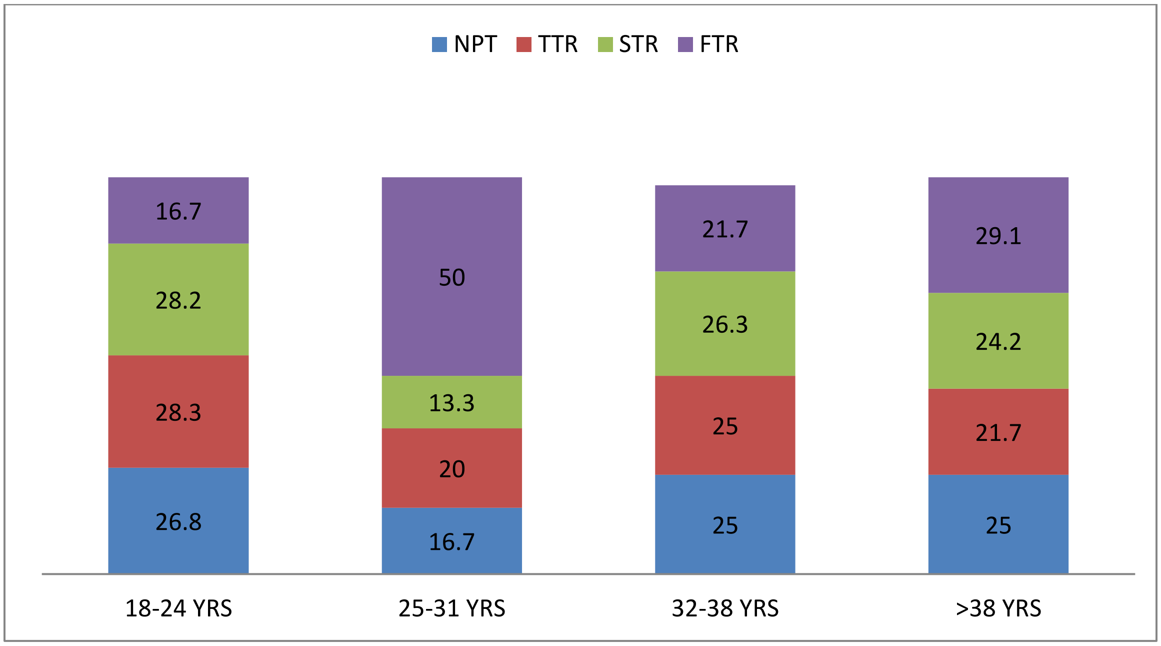

Figure II: percentage age ranges of pregnant and non-pregnant women attending ANC at Gambo Sawaba General Hospital, Zaria.

Key: FTR= First trimesters= Second trimester, TTR= Third trimester= non-pregnant

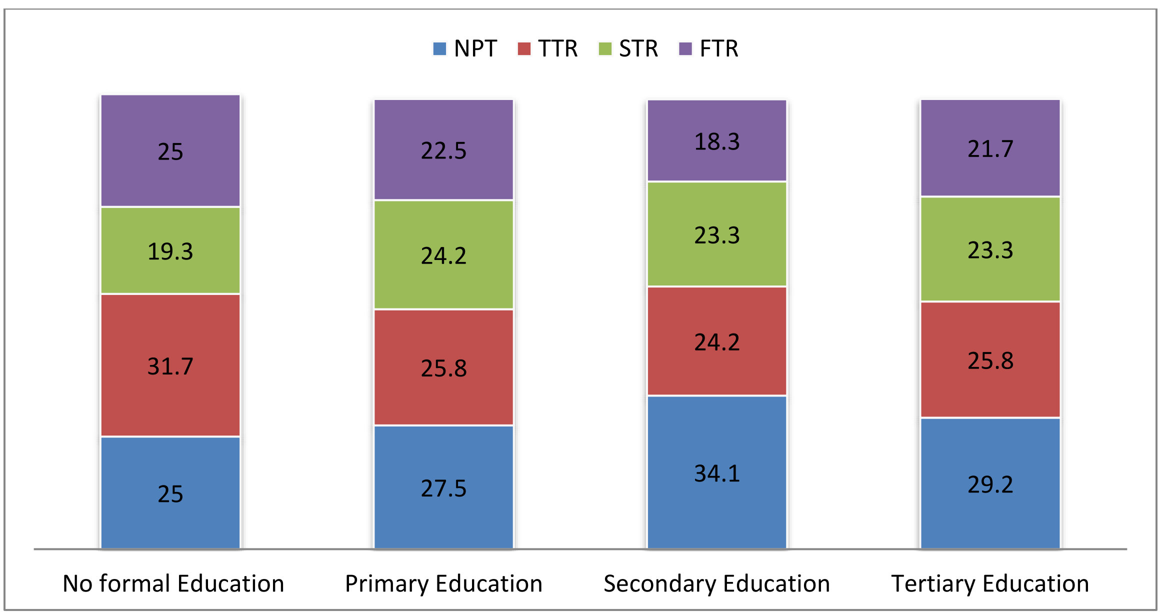

Figure III: Educational status of pregnant and non-pregnant women attending ANC at Gambo Sawaba General hospital, Zaria.

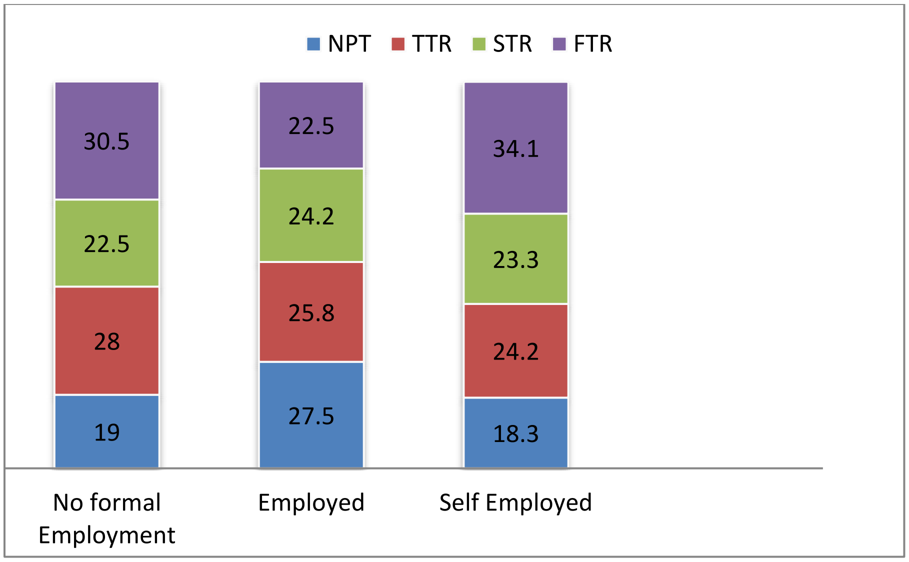

Figure1V: Employment status of pregnant and non-pregnant women attending ANC at Gambo Sawaba General hospital, Zaria.

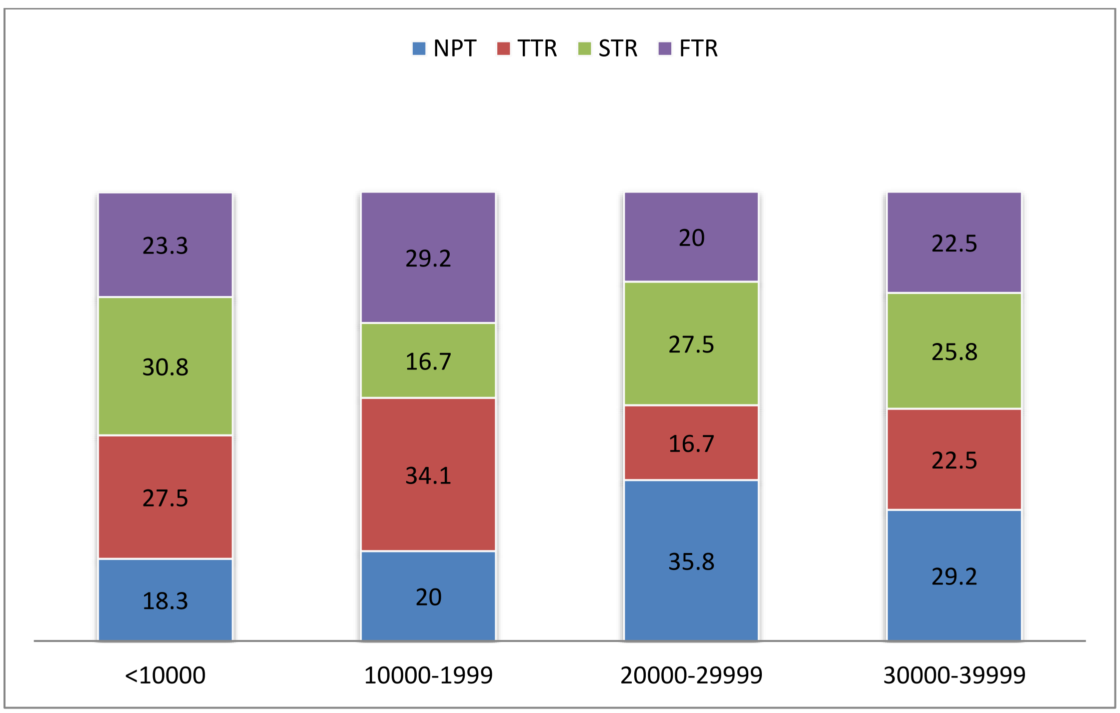

Figure V: Income levels (in naira) of pregnant and non-pregnant women attending ANC in Gambo Sawaba General hospital, Zaria.

Table 1: Serum glucose, cholesterol and body mass index (BMI) of pregnant and non-pregnant women.

Parameters	Non pregnant Controls (n=30)	Pregnancy			Trimesters
		1st (n=30)	2nd (n=30)	3rd (n=30)	Normal Range *(min-max)*
Glucose(mg/dl)	77.6±7.32[a]	81.4±7.32[b]	87.3 ±7.32[c]	90.7±4.32[d]	60-110
Cholesterol(mg/dl)	146±10.23[a]	152±11.33[b]	174±11.33[c]	188±14.33[d]	120-190
BMI (Kg/m^2)	22.22±1.22[a]	22.97±1.22[a]	24.24±2.11[b]	26.35±2.33[c]	18.5 – 24.9

Results are expressed as Means ± S.D, n = number of subjects in groups. Values in the same Rows having the same superscript do not differ significantly (P>0.05)

Results for the Protein Profile of Pregnant and Non-Pregnant Women receiving antenatal Care at Gambo Sawaba General Hospital, Zaria, are shown in Table 2. Pregnant women's urea, creatinine, and uric acid concentrations are significantly (P>0.05) lower in the first, second, and third trimesters than those of non-pregnant women. When compared to non-pregnant women, these results reveal a significant increase (P<0.05). Table 4.3 shows the study population's protein profile, (total protein, albumin, and globulin). In comparison to non-pregnant women, pregnant women had significantly reduced levels of total protein and albumin in the second and third trimesters (P>0.05). When compared to the second trimester, these values were likewise significant (p<0.05) lower in the third trimester. For total protein and albumin among different groups, however, this decline was significant (P<0.05).

Table 3 lists the study population's ALT, AST, and ALP enzyme activities. Between pregnant and non-pregnant women, there was no significant difference in the activities of the ALT and AST enzymes (P>0.05). However, compared to non-pregnant women, ALP enzyme activities were significantly reduced (P<0.05) in the first trimester. ALP was, however, significantly greater (P<0.05) in the third trimester compared to the first and second trimesters. Additionally, all of the groups' ALP activity differed significantly (P>0.05) from one another.

Table 2: Serum protein, albumin, globulin, uric acid, urea and creatinine for pregnant and non-pregnant women.

Parameters protein profile	Non pregnant controls (n=30)	Pregnant		Trimesters	
		1st (n=30)	2nd (n=30)	3rd (n=30)	Normal range *(min-max)*
Total protein (g/dl)	7.6±0.31[a]	7.2±0.55[a]	6.6±0.55[b]	6.2±0.55[c]	6.0 -8.3
Albumin (g/dl)	4.8±0.43[a]	4.4±0.90[a]	4.1±0.37a	3.7±0.7[b]	3.5 - 5.0
Globulin (g/dl)	2.92±0.39[a]	2.62±0.75[a]	2.55±0.41[a]	2.42±0.67[a]	2.0 - 3.5
Uric acid (mg/dl)	3.90±1.01[a]	2.60±1.5[b]	3.22±1.4[c]	3.70±1.6[c]	2.7-7.3[d]
Urea(mg/dl)	26.14±4.6[a]	22.3±6.2[b]	18.3±5.2[c]	16.3±6.4[d]	14-23
Creatinine(mg/dl)	0.84±0.13[a]	0.73±0.12[a]	0.69±0.11[b]	0.70±0.098[a]	0.7-1.1

Results are expressed as Means ± S.D, n = number of subjects in groups. Values in the same Rows having the same superscript do not differ significantly (P<0.05)

Table 3: Serum ALT, AST and ALP for pregnant and non-pregnant women ((IU/L))

Parameters Liver Enzymes (IU/L)	Non pregnant Controls (n=30)	Pregnancy Trimesters			
		1st (n=30)	2nd (n=30)	3rd (n=30)	Normal Range *(min-max)*
ALT	13.1±6.5[a]	12.3±5.6[a]	11.3±4.5[a]	10.2±4.2[b]	19 - 25
AST	18.2±7.0[a]	17.1±6.4[a]	17.3±6.5[a]	17.1±5.5[a]	8 - 33
ALP	98.8±50.3[a]	68.4±26.9[b]	74.2±25.3[c]	120.7±32.5[d]	(44–174)

Results are expressed as Means ± S.D, n= number of subjects in groups. Values in the same Row having the same superscript do not differ significantly (P>0.05).

DISCUSSION

Socioeconomic status (SES), (level of education, income and unemployment status) is one of the most significant factors connected with medical outcomes (Ikhioya, 2014; Nafiu, 2016). Once SES is low, medical care is insufficient and this has been credited to adverse consequences. In pregnant women, low SES can increase the risk of adverse pregnancy complications (Lee *et al.*, 2016). The results from the current study showed that pregnant women have low SES (Education, income and unemployment) compared to non-pregnant women. Low SES can increase the risk of adverse pregnancy complications such as abortion, preterm delivery, preeclampsia, eclampsia, and gestational diabetes Kim *et al*., (2018). Findings from this study support that reported by Russell and Banks (2011), who reported pregnancy complications among pregnant women with low SES.

In line with research from Kano State, Nigeria, this study found that pregnant women's blood glucose levels were considerably greater than those of non-pregnant women (Salisu and Atiku, 2009). Higher serum glucose levels in pregnant women are caused by a well-integrated metabolic shift that occurs as pregnancy progresses in order to provide an adequate amount of nutrients to a fetus that is constantly feeding from an intermittently fasting and feeding mother (Ayandis *et al*., 2018). Additionally, pregnancy is linked to an insulin-resistant condition that is comparable to type 2 diabetes. Early in pregnancy, rising estrogen and progesterone levels affect the mother's carbohydrate metabolism by promoting pancreatic cell hypertrophy and insulin excretion (Ephraim *et al*., 2014). Insulin resistance is brought about by the secretion of additional hormones such prolactin, cortisol, estrogen, and progesterone, as well as human placental lactogen. It has been shown that pregnant women have much higher amounts of these hormones (Okhiai., Faith and Magdalene, 2011). Our study found that pregnant women had higher cholesterol levels than non-pregnant pregnant women. However, first-trimester pregnant women had reduced cholesterol levels. In the first, second, and third trimesters, there was a considerable difference between pregnant and non-pregnant women. Our results corroborate those of Salisu and Atiku (2009), Mankuta *et al.* (2010), and Parchwani and Patel (2012). In the third trimester, this might increase by as much as double compared to levels in women who are not pregnant (Imoru, 2010; Okojie *et al.,* 2011). This observation is valid for the current investigation as well. The development of atherosclerosis, ischemic heart disease, intrauterine growth disorder, intrauterine growth retardation, and hypertension has therefore been implicated by several studies as being influenced by aberrant lipid metabolism during pregnancy (Pillay *et al.,* 2016; Nazli, 2010). Our findings therefore suggest that lipid profile be monitored during your pregnancy.

The majority of the steroids discovered in greater concentrations in pregnant women's blood come from cholesterol, which plays a big part in lipid metabolism during pregnancy. The growth of the zygote in the uterine lining in the first trimester in response to the mother's switch from carbohydrate to fat metabolism, which is an alternative pathway for energy generation due to high energy demand in the second trimester and development of foetal organ in the third trimester, may be the cause of the lipid change during pregnancy (Garg *et al*., 2012).

During the first trimester, the protein profile, which includes total protein, albumin, and globulin, typically decreased (Jamil, 2013). As the pregnancy moves closer to the second and third trimesters, this drop is increasingly noticeable. This outcome is consistent with findings from previous investigations (Noor *et al.,*2011) and is referred to as haemodilution. The haemodilution phenomenon provides an explanation for the drop in serum protein profile concentration (FMOH, 2010). The gradual increase in glomerular permeability to albumin during pregnancy provides another possible explanation for such a drop (Kana *et al*., 2015). One of the key determinants of embryonic survival, growth, and development is maternal nutrition during gestation, particularly dietary protein consumption (Jamil *et al.,* 2013). Due to a lack of certain amino acids that are essential for cell metabolism and function, low maternal dietary protein consumption can result in embryonic losses (Chandra, 2012), Intrauterine growth restriction, and lower postnatal growth (Jamil *et al*., 2010). Increased dietary protein intake during pregnancy is likely to increase amino acid catabolism and if not checked could lead to ammonia toxicity leading to intrauterine growth restriction and fetal death (Lee *et al*., 2016).

In the first, second, and third trimesters, pregnant women's uric acid, creatinine, and uric acid concentrations were all considerably lower than those of non-pregnant women. Williams, and Davison (2008); Iqbal *et al.* (2003) both had similar outcomes. An increase in glomerular filtration rate of more than 50% results during early pregnancy due to increased renal blood flow. A reduction in serum creatinine and urea concentrations is associated with gestational hyper filtration (Okonofua, 2018., Williams and Davison 2008). Additionally, the overt decrease in uric acid level in the first trimester may also be caused by heamodilution as a result of the pregnancy's increased plasma volume, which mostly happens at this time (Iqbal *et al.,* 2003 and Anantharaman *et al.,* 2011).

The study subjects evaluated in the present study do not have any liver disorders. The most helpful test for the regular diagnosis of liver disorders is the measurement of serum ALT and AST activities (Joshi *et al.,* 2010). The results from this study indicate that the pregnant women who were evaluated in this situation do not have any liver disorders. Several earlier published studies show that serum ALT and AST activities do not vary or stay within the normal range determined in women who are not pregnant during pregnancy (Joshi *et al.,* 2010). However, the observed increase in ALP activity during the third trimester is consistent with reports of Loganathan *et al.,* (2005); Joshi *et al.,* (2010) and Jamjute et al., (2010). The rise in ALP is mostly linked to increased placental secretion or increased bone isoenzyme synthesis (Bacq, 2000; Joshi *et al*., 2010). The observed variations in some biochemical profiles reported in this study as against other studies might be due to change in race, gestational age, environmental, socio-cultural and socio-economic factors between the study populations.

CONCLUSION

Based on the results from the current study it can be concluded that biochemical profiles can contribute to complications during pregnancy. Findings from the study clearly demonstrate a significant increase in serum glucose, cholesterol and BMI from first to third trimester. The alterations in the metabolic profiles during pregnancy may have a negative impact on the pregnancy's outcome. In order to prevent unfavorable pregnancy outcomes and irrespective of their pregnancy trimesters biochemical profiles should be monitored to avoid adverse pregnancy complications that can pose health treats to the mother and her unborn foetus. However other study can focus on measuring hematological profile in pregnant women.

Author contribution

JZP conceived and performed data analysis the study. JZP, AG and AN performed the literature search while SIM, ASF, ZYS wrote the draft of the manuscript. AAM made technical corrections. All authors read and approved the final draft of the manuscript.

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