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Assessment of Total Protein, Calcium, Albumin and Glucose in Pregnant Women attending a Tertiary Health Facility in Southern Nigeria

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Abstract

Pregnancy refers to the fertilization and development of one or more offspring, known as a fetus or embryo, in a woman's uterus. Micronutrients are trace elements and vitamins obtained from our diet that are essential to sustain life and optimal physiological function. The aim of this study is to assess some micronutrients (total protein, calcium, albumin and glucose) in pregnant subjects attending Federal Medical Center, Asaba, Delta State. The subjects in this study comprise of pregnant women attending Federal Medical Centre, Asaba, Delta State. A total of one hundred and sixty (160) samples were recruited for this study which consist 120 pregnant women, 40 for each trimester and 40 non-pregnant women which serve as control. The results showed that total protein levels were lower ($p>0.05$) in the pregnant subjects (63.70±14.29 g/dl) when compared with the control (68.95±25.61 g/dl) but was not statistically significant. Albumin levels were significantly lower ($p<0.05$) in the pregnant subjects (35.00±10.80 g/dl) when compared with the control (40.05±14.56 g/dl). Calcium levels were also significantly higher ($p<0.05$) in the pregnant subjects (3.01±2.05 mmol/l) when compared with the control (1.82±0.33 mmol/l). Furthermore, Glucose levels were significantly lower ($p<0.05$) in the pregnant subjects (4.12±1.40 mg/dl) when compared with the control (6.16±4.25 mg/dl). Total protein levels were significantly lower ($p<0.05$) in 2nd trimesters (57.95±7.95 g/dl) when compared with 3rd trimesters (60.73±9.90 g/dl), control (68.95±25.61 g/dl) and 1st trimester (72.43±18.63 g/dl). Albumin levels were significantly lower ($p<0.05$) in 3rd trimesters (29.13±5.72 g/dl) when compared with 2nd trimesters (30.13±7.33 g/dl), control (40.05±14.56 g/dl) and 1st trimester (45.75±9.54 g/dl). Furthermore, calcium levels were significantly higher ($p<0.05$) in 3rd trimesters (4.54±2.52 mmol/l) when compared with 2nd trimesters (2.87±1.39 mmol/l), control (1.82±0.33 mmol/l) and 1st trimester (1.62±0.38 mmol/l). glucose levels were significantly higher ($p<0.05$) in control (6.16±4.25 mg/dl) when compared with 1st trimesters (4.41±2.03 mg/dl), 2nd trimesters (4.41±1.03 mg/dl) and 3rd trimester (3.77±0.77 mg/dl). The deficiencies in micronutrients that affect many women of reproductive age are now known to be associated with adverse maternal and perinatal outcomes. However, it is more beneficial to consume adequate micronutrients before conception to minimize the likely risks associated with their deficiencies in both the mother and the fetus. Also, consume it while being pregnant to meet the adequate levels of the micronutrients that the mother and fetus need.

Key words: total protein; calcium; albumin; glucose; pregnant;women

Introduction

Pregnancy refers to the fertilization and development of one or more offspring, known as a fetus or embryo, in a woman's uterus (Kalhan, 2000). The term embryo is used to describe the developing offspring during the first 8 weeks following conception, and the term fetus is used from about 2 months of development until birth (Kalhan, 2000). Adaptation to pregnancy in humans involves anatomic, physiologic and metabolic changes in the mother to support and provide her with nutritional and metabolic needs and those of growing conceptus (Kalhan, 2000). In a pregnancy, there can be multiple gestations, as in the case of twins or triplets. Childbirth usually occurs about 38 weeks after conception; in women who have a menstrual cycle length of four weeks, this is approximately 40 weeks from the last normal menstrual period. The World Health Organization (WHO) defines normal term for delivery as between 37 weeks and 42 weeks (WHO, 2006).

Pregnancy is typically divided into three periods, or trimesters, each of about three months. The first 12 weeks of pregnancy are considered to make up the first trimester. Weeks 13 to 28 of the pregnancy are called the second trimester. The third trimester of pregnancy spans from week 28 to the birth. Between the interval of 37 to 42 weeks, normal labour, rhythmic uterine contractions and birth occur and this is called **Term.** Pregnancy is associated with normal physiological changes that assist the nurturing and survival of the fetus. Pregnancy represents a period of major physiological and metabolic change, in order to ensure proper fetal growth and development, as well as maternal preservation and survival (King, 2000). Adequate pregestational nutritional status, as well as proper gestational weight gain and dietary intakes are mandatory to promote these processes and to avoid potentially adverse maternal and pregnancy outcomes (Ramakrishnan *et al.,* 2012; American College of Obstetricians and Gynecologists (ACOG), 2013; Feodor *et al.,* 2014; Parisi *et al.,* 2014; Shaw *et al.,* 2014; Marangoni *et al.,* 2016). Therefore, it is important to evaluate, monitor, and if appropriate, make changes to improve maternal nutritional status both before and during pregnancy. Moreover, inadequate and excessive dietary intakes have been associated with long-term effects and noncommunicable diseases in the offspring (developmental model for the origins of disease, Barker Hypothesis). Particularly, fetal development in obesogenic intrauterine environments can permanently modify individual biological and metabolic pathways, leading to adaptive pathophysiological alterations in the offspring and to increased risks of non-communicable diseases in adulthood (Luyckx *et al.,* 2017). This gives a critical role to preconception and pregnancy care in order to improve health of future generations and prevent transmission of obesity and non-communicable diseases in the offspring.

Biochemical parameters reflect these adaptive changes in most organ system and are clearly distinct from the non-pregnant state (Tran, 2005). However, these changes become very important in the event of complications. Micronutrients are trace elements and vitamins obtained from our diet that are essential to sustain life and optimal physiological function (Bailey *et al.,* 2015; McMillan *et al.,* 2019). Deficiencies affect over 2 billion people and are largely associated with malnutrition or poor diet (Bailey *et al*., 2015). Many micronutrients are necessary to elicit an effective immune response to viral infections but are also utilized by viruses such as the hepatitis C virus (HCV) and hepatitis B virus (HBV) to propagate infections (Rashed, 2011). Essential micronutrients are involved in many metabolic pathways in the liver, such as enzymatic functions and protein synthesis, immunological competence, interferon therapy response regulations, and alterations of the virus genomes (Bhaskaram, 2002).

Despite a small change in caloric and macronutrient requirements compared to the non-pregnant state, the need for micronutrient supply exponentially increases during pregnancy, particularly for key elements including iron, folate, iodine, calcium and vitamin D (King, 2000). Together with a limited availability of nutrients and fortified foods in low-income countries and with an alarming decline of appropriate nutritional habits in high-income countries, this explains why micronutrient deficiencies are extremely common during pregnancy (World Health Organization, 2008). This raises the question whether dietary intake is enough to cover the increased micronutrient requirements of pregnancy. The World Health Organization (WHO) currently recommends to provide multiple micronutrient supplements to pregnant women from populations with a high prevalence of maternal nutritional deficiencies, thus reducing the risks of low birth weight (LBW) and small for gestational age (SGA) compared to iron-folic acid supplementation alone (Moos *et al.,* 2008; Haider & Bhutta, 2017). Conversely, discordant results question the efficacy of routine multivitamin supplementation among well-nourished women from high-income countries (Wolf *et al.,* 2017).

Of interest however is the fact that pregnant women has shown some association with various diseases (Armelle *et al*., 2006). In fact, marked differences in plasma or serum concentration of some liver and intestinal enzymes (Adamo, 2010) leading to marked differences in nutritional benefit from a diet, enhances susceptibility to diseases. Pregnant women are particularly susceptible to various infections such as ascending pyelonephritis as a result of bladder infections (Epstein & Karumanchi, 2005). Therefore, the evaluation of some micronutrients in pregnant women is of major importance in monitoring the successful outcome of pregnancy.

Pregnancy is a normal physiological condition which shows many changes in the maternal environment. Many changes in renal function are associated with pregnancy and without a proper understanding of these changes, routine clinical investigations may be easily misinterpreted (Brown & Whitworth, 1992). A Norwegian study on 40,108 women showed that the nutrient contribution of dietary supplements among users varied from 65% for folate and vitamin D to 1% for potassium, with total intakes of vitamin D, folate, iodine and iron still lower than the national recommendations for pregnant women (Haugen *et al*., 2008). During pregnancy, micronutrient requirements increase more than those of macronutrients, and inadequate intakes (and, thus, a low nutritional quality of the diet) can have significant consequences for both the mother and the developing fetus. In particular, there is evidence to support the physiologic role played by selected minerals and vitamins. A recent meta-analysis also provided evidences that fetal gender, pregestational maternal nutritional status and adherence to supplementation represent important factors influencing the effect of multivitamin supplementation on pregnancy outcomes, showing improved survival and outcomes in case of female newborn and undernourished/anaemic pregnant women (Smith, Shankar & Wu, 2017). Hence this study is designed to evaluate some micronutrients of pregnant women attending Federal Medical Center, Asaba, Delta State.

Materials and Methods

Area of Study

This study was carried out among pregnant women visiting Federal Medical Centre, Asaba, Delta State, Nigeria. Asaba, the capital city of Delta State, Nigeria is situated within geographical co-ordinates 6°11′52.23″N6°43′42.48″E. It is situated on a terrace of the lower Niger River, overlooking the point where the Anambra River flows into it. Beyond the river banks, on the high plains which are far more extensive than the river basins, secondary forest vegetation flourishes (APU, 2016). The historic Niger River is a trans-African link beginning from West Africa and down into the Atlantic Ocean. Asaba forms a connector between western, eastern and northern Nigeria through the Niger River from the north and via the Asaba Niger Bridge, an east-west link and a Nigerian landmark. The analysis was carried out in the Chemical Pathology department of the Federal Medical Centre, Asaba, Delta State (World Gazetter, 2015).

Population of the Study

The subjects in this study comprise of pregnant women attending Federal Medical Centre, Asaba, Delta State. A total of one hundred and sixty (160) samples were recruited for this study which consist 120 pregnant women, 40 for each trimester and 40 non-pregnant women which serve as control. Subject data such as name, age, months of pregnancy were also obtained. The sample size (N) is calculated from the formula below using prevalence from previous studies (Ekejindu *et al.,* 2002).

Samples size (**N**) = $\frac{Z^2 Pq}{d^2}$ **,** where

N = the desired size

Z = 1.96 (standard score)

P = Prevalence (12%) (0.12)

q. = 1- P (0.88)

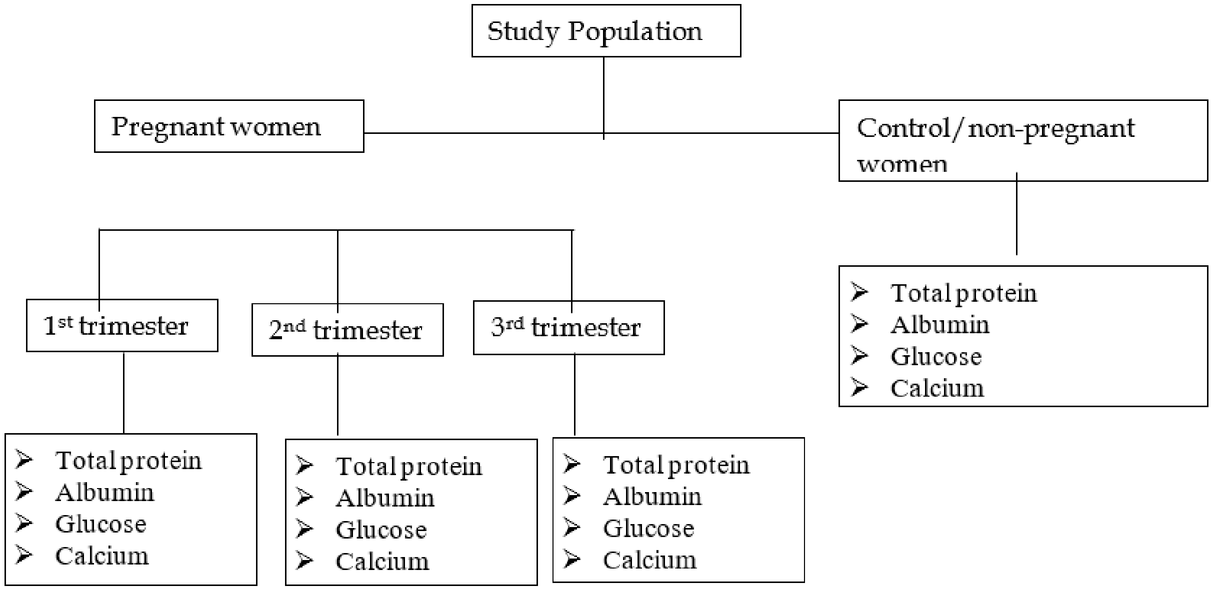
d = sample error tolerated (0.05)

$$N=\frac{1.96^2\times0.12\times0.88}{0.05^2}=162.2 \text{ approximately}= 160$$

Research Design

This study was designed as a prospective and cross-sectional study to assess some micronutrients (total protein, calcium, albumin and glucose) in pregnant subjects attending Federal Medical Center, Asaba, Delta State and make comparison with that of the control group. This study was carried out within three (3) months. A complete record of medical history was obtained for each subject, including name, age, and duration of pregnancy. The overall results of the study obtained was compared with the control using appropriate statistical methods.

Research Design Chat



Ethical Considerations

Ethical permission for this study was obtained from the Health Research Ethics Committee of Federal Medical Center, Asaba, Delta State, Nigeria. Also, informed consent was sought and obtained from the patients prior to the collection of samples for this study. The purpose of the study was exhaustively explained to the patients and assured of the confidentiality of the information obtained from them.

Sample Collection

Blood samples (5mls) was collected by vene-puncture into an accurately labelled lithium heparin containers for both subjects and control individuals. The blood samples were centrifuged with a laboratory centrifuge at 4000rpm for 10minutes at room temperature within two hours of collection and the serum separated into clean plain containers which are labelled corresponding to the initial blood samples containers. The serum was then stored at -20°C pending the analysis of the samples.

Sample Analysis

Serum Calcium Estimation: Calcium shall be estimated using the method described by Robertson and Mashall, (1979).

Principle: Calcium ion reacts with O-cresophthalene-complexono in an alkaline medium to form a purple coloured complex. The absorbance of this complex is proportional to the calcium concentration in the sample.

Estimation of Total Protein: The Total protein in the sample was determined using the method described by Gomall *et al.*, (1949).

Principle: In the biuret reaction, a chelate is formed between the CU^{2+} and the peptide bonds of the protein in alkaline solution to form a violet coloured complex whose absorbance is measured colorimetrically. The intensity of the colour is proportional to the concentration of protein in the sample.

Estimation of Albumin: The Albumin in the sample was determined using the method described by Doumas *et al.*, (1971).

Principle: This method is based on the specific binding of bromo- cresol green (BCG), an anion dye and the protein at acid PH with the resulting shift in absorption wavelength of the complex. The intensity of the colour formed is proportional to the concentration of albumin in the sample.

Estimation of Globulin: Plasma Globulin was estimated indirectly by subtracting the albumin concentration from total protein concentration as described by Ochie and Kolhatkar, (2000).

Plasma globulin (g/dL) = Total protein (g/dL)   Plasma Albumin (g/dL)

Determination of Glucose: The Glucose in the sample was determined using the method described by Doumas *et al.*, (1971)

Principle: Glucose oxidase (GOD) catalyzes the oxidation of glucose to give hydrogen peroxide (H_2O_2) and gluconic acid. In the presence of the enzyme peroxidase (POD), the hydrogen peroxide is broken down and the oxygen released reacts with 4-aminophenazone (4-aminoantipyrine) and phenol to give a pink colour. The absorbance of the colour produced is measured in a colorimeter using a green filter 520 nm (Ilford No. 604) or in a spectrophotometer at 515 nm (Cheesebrough, 2000).

Statistical Analysis

The Mean and standard deviation of the results obtained was calculated. ANOVA (LSD) was used for the analysis using SPSS package version 21. Values with $p< 0.05$ shall be considered statistically significant in this study.

Results

The results of this study are presented in this chapter and comparisons were made between the control and micronutrients of pregnant subjects according to their trimesters. Socio demographic profiles and the history of the subjects were also presented.

Table 1 revealed the socio-demographic characteristics of the study population. The subjects were categorized into four age groups; <21-25; 26-30; 31-35; and >35. The result for age showed that majority of the subjects were within the age range of 26-30 years; 38(31.7%), this was followed by <21-25 years, 35(29.2%), 31-35 years; 29(24.1%) and >35 years; 18(15.0%). Regrading religion, the results also showed that 117(97.5%) of the subjects were Christian and 3(2.5%) of the subjects were Muslim. As regards tribe, the result showed that majority of the subject were from Igbo; 81(67.5%), this was followed by subjects who were from other tribes; 32(26.7%), Urhobo; 5(4.2%) and Hausa, 2(1.7%). As regards occupation, the result showed that majority of the subjects were traders; 74(61.7%), this was followed by others; 24(20.0%), Teachers; 18(15.0%) and Civil Servants, 4(3.3%). As regards trimesters, the frequency of the subjects were equal among all the trimesters; 40(33.3%) The Age (Mean ±SD) were (28.99±5.96).

The results in table 2 showed the comparison of TP, ALB, CAL and GLU levels between the subjects and the control. The results showed that TP levels were not significantly lower ($p>0.05$) in the subjects (63.70±14.29 g/dl) when compared with the control (68.95±25.61 g/dl). On the contrary, ALB levels were significantly lower ($p<0.05$) in the subjects (35.00±10.80 g/dl) when compared with the control (40.05±14.56 g/dl). CAL levels were also significantly higher ($p<0.05$) in the subjects (3.01±2.05 mmol/l) when compared with the control (1.82±0.33 mmol/l). Furthermore, Glucose levels were significantly lower ($p<0.05$) in the subjects (4.12±1.40 mg/dl) when compared with the control (6.16±4.25 mg/dl).

The results in table 3 showed the comparison of TP, ALB, CAL and GLU levels between the controls and the various trimesters of the subjects. The results showed that TP levels were significantly lower ($p<0.05$) in 2nd trimesters (57.95±7.95 g/dl) when compared with 3rd trimesters (60.73±9.90 g/dl), control (68.95±25.61 g/dl) and 1st trimester (72.43±18.63 g/dl). ALB levels were significantly lower ($p<0.05$) in 3rd trimesters (29.13±5.72 g/dl) when compared with 2nd trimesters (30.13±7.33 g/dl), control (40.05±14.56 g/dl) and 1st trimester (45.75±9.54 g/dl). Furthermore, CAL levels were significantly higher ($p<0.05$) in 3rd trimesters (4.54±2.52 mmol/l) when compared with 2nd trimesters (2.87±1.39 mmol/l), control (1.82±0.33 mmol/l) and 1st trimester (1.62±0.38 mmol/l). GLU levels were significantly higher ($p<0.05$) in control (6.16±4.25 mg/dl) when compared with 1st trimesters (4.41±2.03 mg/dl), 2nd trimesters (4.41±1.03 mg/dl) and 3rd trimester (3.77±0.77 mg/dl).

Variables		Frequency	Percentage (%)
Age (Years)	<21-25	35	29.2
	26-30	38	31.7
	31-35	29	24.1
	>35	18	15.0
	TOTAL	**120**	**100**
Religion	Christian	117	97.5
	Muslim	3	2.5
	TOTAL	**120**	**100**
Tribe	Igbo	81	67.5
	Urhobo	5	4.2
	Hausa	2	1.7
	Others	32	26.7
	TOTAL	**120**	**100**
Occupation	Traders	74	61.7
	Teachers	18	15.0
	Civil Servants	4	3.3
	Others	24	20.0
	TOTAL	**120**	**100**
Trimesters	1st Trimesters	40	33.3
	2nd Trimesters	40	33.3
	3rd Trimesters	40	33.3
	TOTAL	**120**	**100**
Age (Mean ±SD)	28.99±5.96		

Table 1: Socio-Demographic Characteristics of the Study Population

Parameters	Control (n=40)	Subjects (n=120)	t value	P value
TP (g/dl)	68.95±25.61	63.70±14.29	1.618	0.108
ALB (g/dl)	40.05±14.56	35.00±10.80	2.336	0.021
CAL (mmol/l)	1.82±0.33	3.01±2.05	3.661	0.000
GLU (mg/dl)	6.16±4.25	4.12±1.40	4.597	0.000

Table 2: Comparison of TP, ALB, CAL and GLU levels between the Subjects and the Control.

KEYS: n=Sample size; p>0.05= Not significant; p<0.05= Significant

TP=Total Protein; ALB=Albumin; CAL=Calcium; GLU=Glucose

Parameters	Control (n=40)	1st Trimesters (n=40)	2nd Trimesters (n=40)	3rd Trimesters (n=40)	F value	P value
TP (g/dl)	68.95±25.61 a	72.43±18.63 a	57.95±7.95 b	60.73±9.90 b	6.388	0.000
ALB (g/dl)	40.05±14.56 a	45.75±9.54 b	30.13±7.33 ab	29.13±5.72 ab	26.420	0.000
CAL (mmol/l)	1.82±0.33 a	1.62±0.38 a	2.87±1.39 b	4.54±2.52 ab	33.612	0.000
GLU (mg/dl)	6.16±4.25 a	4.41±2.03 b	4.41±1.03 b	3.77±0.77 b	7.475	0.000

Table 3: Comparison of TP, ALB, CAL and GLU Levels between Control and subjects according to their various trimesters

KEYS: n=Sample size; p>0.05= Not significant; p<0.05= Significant

TP=Total Protein; ALB=Albumin; CAL=Calcium; GLU=Glucose

Values in a row with different superscripts is significantly different at p<0.05.

The results in table 4 showed the comparison of TP, ALB, CAL and GLU levels of the subjects according to trimesters. The results showed that TP levels were significantly lower (p<0.05) in subjects in 2nd trimesters (57.95±7.95 g/dl) when compared subjects in 3rd trimesters (60.73±9.90 g/dl) and 1st trimesters (72.43±18.63 g/dl). ALB levels were significantly lower (p<0.05) in subjects in 3rd trimesters (29.13±5.72 g/dl) when compared subjects in 2nd trimesters (30.13±7.33 g/dl) and 1st trimesters (45.75±9.54 g/dl). CAL levels were significantly higher (p<0.05) in subjects in 3rd trimesters (4.54±2.52 mmol/l) when compared subjects in 2nd trimesters (2.87±1.39 mmol/l) and 1st trimesters (1.62±0.38 mmol/l). On the contrary, GLU levels were not significantly higher (p>0.05) in subjects in 1st trimesters (4.41±2.03 mg/dl) when compared with subjects in 2nd trimesters (4.41±1.03 mg/dl) and 3rd trimesters (3.77±0.77 mg/dl).

The results in table 5 showed the comparison of TP, ALB, CAL and GLU of subjects according to age. The results showed that TP levels were not significantly higher (p>0.05) in within the age range of <21-25 years (65.37±13.64 g/dl) when compared subjects within the age range of 26-30 years (64.03±15.32 g/dl), 31-35 years (63.55±14.78 g/dl) and >35 (60.00±12.90 g/dl). ALB levels were not significantly lower (p>0.05) within the age range of 26-30 years (36.66±10.53 g/dl) when compared with subjects within the age range of >35 years (35.22±10.69 g/dl), 31-35 years (35.03±11.32 g/dl) and <21-25 years (33.06±10.85 g/dl). Furthermore, CAL levels were not significantly higher (p>0.05) in subjects within the age range of <21-25 years (3.37±2.33 mmol/l) when compared with subjects within the age range of 31-35 years (2.99±1.99 mmol/l), 26-30 years (2.59±1.82 mmol/l) and >35 years (2.23±2.04 mmol/l). GLU levels were not significantly higher (p>0.05) in subjects within the age range of 31-35 years (4.33±1.78 mg/dl) when compared with subjects within the age range of 26-30 years (4.19±1.51 mg/dl), <21-25 years (4.09±1.11 mg/dl) and >35 years (3.67±0.95 mg/dl).

Parameters	<21-25 Years (n=35)	26-30 Years (n=38)	31-35 Years (n=29)	>35 Years (n=18)	F value	P value
TP (g/dl)	65.37±13.64 a	64.03±15.32 a	63.55±14.78 a	60.00±12.90 a	0.563	0.640
ALB (g/dl)	33.06±10.85 a	36.66±10.53 a	35.03±11.32 a	35.22±10.69 a	0.673	0.570
CAL (mmol/l)	3.37±2.33 a	2.59±1.82 a	2.99±1.99 a	2.23±2.04 a	0.955	0.416
GLU (mg/dl)	4.09±1.11 a	4.19±1.51 a	4.33±1.78 a	3.67±0.95 a	0.867	0.460

Table 4: Comparison of TP, ALB, CAL and GLU Levels of subjects according to trimesters

KEYS: n=Sample size; p>0.05= Not significant; p<0.05= Significant

Values in a row with different superscripts is significantly different at p<0.05.

Parameters	1st Trimesters (n=40)	2nd Trimesters (n=40)	3rd Trimesters (n=40)	F value	P value
TP (g/dl)	72.43±18.63 a	57.95±7.95 b	60.73±9.90 b	14.103	0.000
ALB (g/dl)	45.75±9.54 a	30.13±7.33 b	29.13±5.72 b	58.783	0.000
CAL (mmol/l)	1.62±0.38 a	2.87±1.39 b	4.54±2.52 ab	30.682	0.000
GLU (mg/dl)	4.41±2.03 a	4.41±1.03 a	3.77±0.77 ab	2.123	0.124

Table 5: Comparison of TP, ALB, CAL and GLU Levels of the Subjects according to Age

KEYS: n=Sample size; p>0.05= Not significant; p<0.05= Significant

TP=Total Protein; ALB=Albumin; CAL=Calcium; GLU=Glucose

Values in a row with different superscripts is significantly different at p<0.05.

Discussion

Adaptation to pregnancy involves major changes in maternal metabolism in order to satisfy growing demands of the pregnancy outcome. The continuous physiologic adjustments affect the metabolism of all nutrients. The adjustments vary depending on the pre-pregnancy nutrition of the women, genetic determinants of the fetal size and maternal lifestyle. Thresholds in the capacity to adjust nutrient metabolism depending on the amount supplied exist for all nutrients (King, 2000). In pregnancy, the levels of different parameters generally decrease because of haemodilution and of increased needs.

The results from this study showed that TP levels were lower ($p>0.05$) in the pregnant subjects (63.70±14.29 g/dl) when compared with the control (68.95±25.61 g/dl) but was not statistically significantly. TP levels were significantly lower ($p<0.05$) in 2nd trimesters (57.95±7.95 g/dl) when compared with 3rd trimesters (60.73±9.90 g/dl), control (68.95±25.61 g/dl) and 1st trimester (72.43±18.63 g/dl). This result is in accordance with that of other studies (Bacq *et al.*, 1996; Iqbal *et al.*, 2003; Noor *et al.*, 2011). The decrease in serum protein profile concentration maybe explained by the hemodilution phenomenon (Bacq, 2000). Another explanation of such decrease is probably due to progressive rise in glomerular permeability to albumin during pregnancy (Iqbal *et al*., 2003).

ALB levels were significantly lower ($p<0.05$) in the pregnant subjects (35.00±10.80 g/dl) when compared with the control (40.05±14.56 g/dl). ALB levels were significantly lower ($p<0.05$) in 3rd trimesters (29.13±5.72 g/dl) when compared with 2nd trimesters (30.13±7.33 g/dl), control (40.05±14.56 g/dl) and 1st trimester (45.75±9.54 g/dl). Albumin, the major protein in plasma, is known as an important extracellular antioxidant and was shown to be a good target for oxidation in newborn plasma (Marzocchi *et al.*, 2005). Due to lower albumin the antioxidant capacity may be reduced which can lead to higher PrCarb observed in preterms.

Calcium is essential for fetal development. Calcium levels were significantly higher ($p<0.05$) in the subjects (3.01±2.05 mmol/l) when compared with the control (1.82±0.33 mmol/l). Calcium levels were significantly higher ($p<0.05$) in 3rd trimesters (4.54±2.52 mmol/l) when compared with 2nd trimesters (2.87±1.39 mmol/l), control (1.82±0.33 mmol/l) and 1st trimester (1.62±0.38 mmol/l). Calcium supplementation is associated with a reduction in pre-eclampsia as well as LBW and pre-term birth (Bhutta *et al*., 2013). Gestational hypertensive disorders are the second main causes of maternal morbidity and mortality, as well as being associated with an increased risk of pre-term birth and foetal growth restriction (Phillips *et al.*, 2014). As calcium supplementation during pregnancy reduces the incidence of gestational hypertension by 35%, pre-eclampsia by 52%–55% and pre-term births by 24% (Imdad & Bhutta, 2012), the World Health Organization (WHO) now recommends 1.5 g to 2.0 g of elemental calcium per day for pregnant women with low dietary calcium intakes. The recommended dietary allowance (RDA) for elemental calcium in pregnant and lactating women is 1000 mg/day, unchanged compared to the non-pregnant state and depending on maternal age (Hacker *et al*., 2012). Calcium intake amongst pregnant women often does not meet the recommendation even in developed countries, with low calcium intake thought to occur in 24% of pregnant women in the United States and more than 30% in some northern European populations.48 Calcium intake is essential for fetal skeletal development, primarily in the third trimester. Moreover, supplementation is a promising intervention for the prevention of pre-eclampsia in women with low baseline dietary calcium intake and at high risk of hypertensive disorders. This led to the WHO recommendation to supplement pregnant women at risk with 1.5–2.0 g/day of elemental calcium starting from 20 weeks of gestation onwards (Heppe *et al.*, 2013).

Glucose levels were significantly lower ($p<0.05$) in the pregnant women (4.12±1.40 mg/dl) when compared with the control (6.16±4.25 mg/dl). Glucose levels were significantly higher ($p<0.05$) in control (6.16±4.25 mg/dl) when compared with 1st trimesters (4.41±2.03 mg/dl), 2nd trimesters (4.41±1.03 mg/dl) and 3rd trimester (3.77±0.77 mg/dl). Similar result was obtained by Afolayan & Tella (2009). This could be due to metabolic factors whereby the metabolism of glucose increased due to increase demand by fetus. During pregnancy serum glucose level falls by about 15-20% as a result of the energy requirements of the foetus, which are almost exclusively met by the maternal glucose (Documenta, 1977). In addition, the women with low fasting blood sugar level could be in their early part of first trimester and second trimester as suggested by Green & Stephen (2002). From the beginning of the third trimester, fetal growth slowly peaks leading to a corresponding decrease in plasma concentration of maternal and fetal hormonal factors that stimulate and regulate glucose mobilization.

Conclusion

This study showed that serum glucose levels, albumin and calcium levels are all influenced by pregnancy. Specifically, glucose and calcium levels were significantly lower in pregnant women than non-pregnant women. Furthermore, total protein and albumin were decreased in pregnancy when compared to non-pregnant women. The variations in these parameters resulted as a result of haemodilution and of increased needs. The deficiencies in micronutrients that affect many women of reproductive age are now known to be associated with adverse maternal and perinatal outcomes. These adverse outcomes can have longer-term impacts into adulthood. Maternal undernutrition has been described as one of the most neglected aspects of nutrition in public health globally. Existing and emerging research connecting micronutrient deficiencies in pregnancy state with adverse birth outcomes is a stimulating development. Strategies for correcting the deficiency of these micronutrients in pregnant women have gone a long way in improving pregnancy outcomes over the years. However, it is more beneficial to consume adequate micronutrients before conception to minimize the likely risks associated with their deficiencies in both the mother and the fetus. Also, consume it while being pregnant to meet the adequate levels of the micronutrients that the mother and fetus need.

Based on the results of this study, the following are hereby recommended;

i. Regular monitoring of glucose and calcium should be done on pregnancy to prevent any underlying onset of diseases related to glucose and calcium.
ii. Albumin and total protein assessment should be encouraged in pregnancy to prevent any onset of neonatal and maternal diseases.
iii. Furthermore, further research should be done to determine other abnormalities associated with pregnancy and hence provide necessary information on the possible reasons for variations of the parameters in pregnancy.

Availability of Data and Materials

The authors declare consent for all available data present in this study.

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Authors' Contributions

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Competing Interests

The authors declare no conflicts of interest

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