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Assessment Of Body Mass Index, Glucose-6-Phosphate Dehydrogenase And Uric Acid Among Pregnant Women

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Abstract: ***Pregnancy involves various physiologic, metabolic and anatomic changes in the maternal environment. This study was designed to assess the Body Mass Index (BMI), activities of G6PD and uric acid levels in different trimesters of pregnancy. A total of eighty (80) subjects were used for this study which consist of sixty (60) pregnant women, 20 for each trimester and 20 non-pregnant women which served as control. Five milliliters (5mls) of blood samples were collected aseptically by vene puncture and dispensed into accurately labeled sterile EDTA containers for G6PD and Lithium heparin containers for Uric acid. The weight and height of the subjects were collected for the determination of the Body Mass Index (BMI). The results of this study revealed that the levels of BMI were significantly higher ($p<0.05$) in the first (26.09±2.92 kg/m^2), second (28.01±2.71 kg/m^2) and third trimesters (32.62±4.32 kg/m^2) as compared to the control (22.11±2.86 kg/m^2). The activities of G6PD were significantly higher ($p<0.05$) in the second (224.30± 9.47 u/g Hb) and third trimesters (236.80±5.59 u/g Hb) as compared to the first trimester (169.60±4.78 u/g Hb) and control (167.80±5.47 u/g Hb). The levels of uric acid were significantly lower ($p<0.05$) in the first (3.53±1.53 mg/dl), second (3.73±0.31 mg/dl) and third trimesters (3.84±0.67 mg/dl) as compared to the control (4.57±0.53 mg/dl). The results on BMI categorization showed that overweight and obesity occurred in the second and third trimesters respectively. Also, there was a significant positive correlation between BMI and G6PD (r=0.448; p value= 0.004) and a negative correlation between BMI and uric acid (r=-0.311; p value=0.051). The results of this study revealed that maternal changes in pregnancy contributed significantly in the alteration of BMI, G6PD and uric acid levels.***

Keywords: Pregnancy, Body Mass Index, Uric Acid, Glucose-6-Phosphate Dehydrogenase

I. INTRODUCTION

Pregnancy is the fertilization and development of fetus in a woman's uterus where the fetus develops within the first eight weeks after conception. [1] There are various anatomical and physiological changes attributed to pregnancy adaptation and these changes are geared towards supporting and providing metabolic and nutritional requirements for the mother and the fetus.[1] Pregnancy usually lasts for about thirty-eight weeks from the day of conception and normal term for delivery is defined to be between thirty seven to forty two weeks.[1] However, pregnancy is divided into three trimesters

of about three months each. The first trimester is said to be within the first 12 weeks, second trimester between 13 to 28 weeks and the third trimester between 28 weeks to delivery. [2]Biochemical parameters reflect these adaptive changes in most organ system and are clearly distinct from the non-pregnant state. [2]

Furthermore, Glucose-6-phosphate dehydrogenase (G6PD) is a cytosolic enzyme that catalyzes the conversion of D-glucose-6-phosphate and $NADP^+$ to -phospho-D-glucono-1,5-lactone and NADPH + H^+.[3] This enzyme plays a role in the pentose phosphate pathway by maintaining the level of the co-enzyme nicotinamide adenine dinucleotide phosphate (NADPH).[4] The NADPH in turn maintains the level of glutathione in these cells that helps protect the red blood cells against oxidative damage.[5, 6] G6PD deficiency is an X-linked recessive hereditary disease characterized by abnormally low levels of glucose-6-phosphate dehydrogenase, and it is regarded as the most common human enzyme defect. [7]Individuals with the disease may exhibit non immune hemolytic anemia in response to a number of causes, most commonly infection or exposure to certain medications or fava beans.[7, 8]

Moreover, uric acid is the end product of purine metabolism and its elevated level induces endothelial dysfunction and may induce hypertension and vascular disease.[9] It has been observed that there is a relationship between preeclampsia and higher levels of uric acid. In this case, the uric levels spikes within the first ten weeks of gestation where there is clinical presentation of the disorder. [10] Serum uric acid is known to decrease in early pregnancy but patients presenting with pregnancy induced hypertension shows elevated levels even in third trimester in association with relatively less urate excretion.[11]

One of the most significant public health concerns recently in the world has been the rate of increasing incidence of obesity among women of child bearing age.[12] Also, there is an association between high maternal body mass index and complicated pregnancy outcome such as pre and post term delivery, induction of labour, postpartum hemorrhage preeclampsia and caesarean section.[13, 14] Therefore, considering the information above with the fact that there is limited information on the assessment of Body Mass Index, activities of G6PD and uric acid levels among pregnant women within the study area; this study was embarked on to provide such information where it can be used to monitor the progression of pregnancy.

II. MATERIALS AND METHODS

A. AREA OF STUDY

This study was carried out in Ekpoma, Esan West Local Government area of Edo State. It is located at latitude 6^o 45^IN and longitude 6^o 08^IE. The University is situated in this region and it is moderately populated with the peoples' occupation being farming and trading. The main sources of water in the locality are rainfall and well. The well is augmented by irrigation scheme provided by the Government for public use. [15]

B. STUDY POPULATION

The subjects used in this study were from the Primary Health Care Centres in Ekpoma, Edo State. A total of eighty (80) subjects were recruited for this study which consist of sixty (60) pregnant women, 20 for each trimester and 20 non-pregnant women which served as the control.

C. RESEARCH DESIGNS

The research was designed to evaluate the BMI, activities of G6PD and uric acid level in pregnant women and make comparison with that of the control group. A complete medical history was obtained for each subject which included the name, age, duration of pregnancy, dietary habit, past medical, surgical and drug history.

D. INCLUSION AND EXCLUSION CRITERIA

Apparently healthy pregnant and non pregnant women within the age of 17-45 years and who gave consent to the study were recruited for the study. Pregnant and non pregnant women with clinical complications, who did not give consent and under any therapy were excluded from the study. However, pregnant and non pregnant woman beyond the age range of 17-45 years were also excluded.

E. ETHICAL APPROVAL

Ethical approval was obtained from the University Research and Ethics Committee. Also, informed consent was also obtained from the subjects after explaining the purpose of the study to them.

F. COLLECTION OF SAMPLES

Blood samples (5mls) were collected using sterile EDTA containers for G6PD and Lithium heparin containers for Uric acid. All samples were collected under aseptic conditions and labeled appropriately with name and dates. The blood samples were centrifuged at 1000rpm for 15minutes at room temperature to obtain plasma and transported to the laboratory within 2 hours of collection for appropriate analysis.

G. METHODS OF SAMPLE ANALYSIS

G6PD was analyzed using the enzymatic methods described by Kornberg and Horecker.[16] Enzymatic colorimeric method (Uricase) was employed for the estimation of uric acid as described by Cheesbrough.[17]

For the estimation of BMI, the weight was measured after removal of shoes while wearing light clothing. Height was measured without shoes in the standing position with the shoulders in relaxed position and arms hanging freely and then calculated as; weight (kg)/ height (m^2). Also BMI was also categorized according to World Health Organization,[18] as follows;

- ✓ Less than 18.5-Under weight
- ✓ 18.5-24.9 - Healthy weight range
- ✓ 25.0-29.9 - Over weight

✓ More than 30.0-Obese.

H. STATISTICAL ANALYSIS

Student's t-test and Analysis of Variance (ANOVA) were used to compare the results obtained in the study. All results were reported as mean ± standard deviation, using a computer program named Statistical Package for Social Sciences (SPSS) version 21. P values less than ($p<0.05$) was considered statistically significant.

III. RESULTS

The results showed that the levels of BMI were significantly higher ($p<0.05$) in the first (26.09±2.92 kg/m^2), second (28.01±2.71 kg/m^2) and third trimesters (32.62±4.32 kg/m^2) as compared to the control (22.11±2.86 kg/m^2). The activities of G6PD were significantly higher ($p<0.05$) in the second (224.30± 9.47 u/g Hb) and third trimesters (236.80±5.59 u/g Hb) as compared to the first trimester (169.60±4.78 u/g Hb) and control (167.80±5.47 u/g Hb). The levels of uric acid were significantly lower ($p<0.05$) in the first (3.53±1.53 mg/dl), second (3.73±0.31 mg/dl) and third trimesters (3.84±0.67 mg/dl) as compared to the control (4.57±0.53 mg/dl) (Table 1).

The results showed that the levels of BMI, uric acid and activities of G6PD were not significantly different ($p>0.05$) within the age 20-25 years, 26-30 years, 31-35 years and 36 years and above (Table 2).

The results revealed that none of the pregnant women within the trimesters were underweight as they all reported zero (0.0%) prevalence. In the first trimester, 10 (16.7%) were healthy, 8 (13.3%) were overweight while 2 (3.3%) were obese. For the second trimester, 6 (10.0%) were healthy, 10 (16.7%) were overweight while 4 (6.7%) were obese. In the third trimester, 2 (3.3%) were healthy, 2 (3.3%) were overweight while 16 (26.7%) were obese. The first trimester recorded the highest number of healthy pregnant women, the second trimester recorded the highest number of overweight women while the third trimester recorded the highest number of obese women (Table 3).

The results revealed that there was a significant positive relationship between BMI and G6PD (r=0.448; p value= 0.004). Also, there was a negative but non-significant ($p>0.05$) relationship between BMI and uric acid (r=-0.311; p value=0.051) (Table 4).

Table 1: Levels of BMI, G6PD and Uric acid in trimesters of pregnancy and control

Parameter	Control (n=20)	1st Trimester (n=20)	2nd Trimester (n=20)	3rd Trimester (n=20)	F value	P value
BMI (kg/m^2)	22.11±2.86^a	26.09±2.92^{ba}	28.01±2.71^b	32.62±4.32^{bc}	17.837	0.000
G6PD (u/gHb)	167.80±5.47^a	169.60±4.78^a	224.30±9.47^{ab}	236.80±5.59^b	3.000	0.043
Uric Acid (mg/dl)	4.57±0.53^a	3.53±1.53^b	3.73±0.31^b	3.84±0.67^b	2.598	0.049

Key: G6PD= Glucose-6-Phosphate Dehydrogenase, BMI= Body Mass Index, P<0.05= Significant, p>0.05=Not Significant, Tri=Trimester, n=Sample Size, Values in a row with different superscripts are significantly different at p<0.05.

Table 2: Levels of BMI, G6PD and Uric acid among pregnant women according to age

Parameter	20-25yrs (n=10)	26-30 yrs (n=30)	31-35yrs (n=12)	36 yrs and above (n=08)	F value	P value
BMI (kg/m^2)	30.16±3.41^a	28.33±3.89^a	26.32±3.64^a	33.40±6.56^a	2.882	0.055
G6PD(u/gHb)	204.20±5.28^a	226.00±8.57^a	184.67±5.46^a	197.00±7.63^a	0.505	0.682
Uric Acid (mg/dl)	3.02±3.41^a	3.64±0.95^a	4.12±1.02^a	4.15±0.45^a	1.640	0.204

Key: G6PD=Glucose-6-Phosphate Dehydrogenase, BMI= Body Mass Index, P<0.05=Significant, p>0.05=Not Significant, Yrs=years, n=Sample Size, Values in a row with different superscripts are significantly different at p<0.05.

Table 3: BMI categorization of pregnant women according to trimesters

Trimesters	Underweight	Healthy	Overweight	Obesity	Total
1st Trimester (n=20)	0 (0%)	10 (16.7%)	8 (13.3%)	2 (3.3%)	20
2nd Trimester (n=20)	0 (0%)	6 (10.0%)	10 (16.7%)	4 (6.7%)	20
3rd Trimester (n=20)	0 (0%)	2 (3.3%)	2 (3.3%)	16 (26.7%)	20
Total	0 (0%)	18 (30.0%)	20 (33.3%)	22 (36.7%)	60 (100.0%

Table 4: Correlation of BMI with G6PD and Uric Acid

1st Parameter	Mean ± SD		2nd Parameter	Mean ±SD	r	P value
BMI (kg/m^2)	28.91±4.30	vs	G6PD (u/gHb)	201.23±7.31	0.448	0.004
BMI (kg/m^2)	28.91±4.30	vs	Uric acid (mg/dl)	3.70±0.96	-0.311	0.051

Key: G6PD= Glucose 6 Phosphate Dehydrogenase, BMI= Body Mass Index, P<0.05=Significant, p>0.05=Not Significant, Yrs=years, n=Sample Size.

IV. DISCUSSION

According to Kalhan [1] and Waltzer [19], pregnancy has been described as a normal physiological condition which presents many changes in the maternal environment and involves anatomic, physiologic and metabolic changes in the mother to provide her with the basic nutritional requirements for the growing fetus. The most common health conditions that have been reported in women are obesity and overweight and this study evaluated over weight and obese pregnant women by body mass index and how it affects biochemical parameters.

The results of this study revealed that BMI levels of pregnant women were significantly increased when compared with the non-pregnant women. Another point to note is that as pregnancy increases, the BMI levels also increased concurrently. BMI has been described to be a maker of obesity and it has been a well-documented risk factor for morbidity and mortality. [20, 21] This study also revealed that majority of the pregnant women were either overweight or obese within the second and third trimesters. However, increased gestational weight gain has been reported to cause serious

complications to maternal health and increase child body size while a reduced weight gain will increase the likelihood of small gestational age.[22] However, the rate of the increasing prevalence of obesity among women has become one of the most striking public health challenges.[12, 23] Adverse maternal pregnancy outcomes such as labour induction, pre-eclampsia, eclampsia, macrosomia, postpartum hemorrhage and caesarean section have all resulted as a result of increased maternal body mass index.[14] This is in line with the study of Leonie *et al.* [23] where they reported similar trend of result and purported that obese women are at high risk for pre-eclampsia and other maternal health complications. Previous studies carried out by Berghoft *et al.* [14], demonstrated that in nulliparous women the chance of caesarean section increased with BMI. According to UshaKiran *et al*. [24], comparison of induction of labour in pregnant women showed that lower BMI was associated with lower induction of labour. It was reported that nulliparous women with increased levels of body mass index had the higher chance of having pre-term labour. [12] Therefore, pregnant mothers with high BMI values as observed in this study could be easily susceptible to obesity and cardiovascular risks and this corresponds with the study of Sukhpal.[25]

Furthermore, the results of this study showed that the activities of G6PD in pregnant women were significantly increased when compared to the control. This is not in line with the study of Vergnes *et al* [26], where they reported deficiency of G6PD in pregnant women. Also, decreased activities of G6PD were observed in the first trimester when compared with other trimesters. According to the study of Vergnes *et al.* [26], they reported that G6PD deficiency in pregnancy may manifest as increased urinary tract infections, preeclampsia, neonatal jaundice, hydrops fetalis and still birth. Alteration in neutriphil G6PD trafficking and oxidative stress has been greatly influenced by pregnancy.[27] Furthermore, increase in G6PD in adipocytes stimulates oxidative stress and inflammatory signals; therefore pregnant women are prone to oxidative stress which would have resulted to an increase in G6PD activities.[27] Also, increase in G6PD could also be as a result of obesity and gestational diabetes.[27]

Furthermore, there is a progressive but significant decrease in the levels of uric acid among the trimesters of pregnancy as compared to the control. Also, the results revealed that uric acid levels were decreased across the trimesters. The result of this study is in agreement with the study of Dunlop & Davison.[28] They attributed this decrease in the levels of uric acid to be due to the fact that plasma volume increase during the course of pregnancy coupled with a similar increase in glomerular filtration rate in early pregnancy. The initial increase in the clearance of uric acid is attributed to changes in the glomerular filtration and plasma volume.[28] In line with the above suggestions, the increased renal plasma flow, decreased serum albumin values and raised serum progestogen levels produce an increase in the glomerular filtration rate during pregnancy which is matched by markedly increased clearances of uric acid.[29] Also, serum uric acid levels have been shown to be decreased in early pregnancy and to have a tendency to rise towards term.[30] The positive protein and purine balance during growth of the foetus, and the increase of glomerular filtration rate, result in lowered maternal plasma uric acid levels.[31] In the third trimester, the glomerular filtration rate begin to decrease toward non-pregnant values and the decrease in plasma volume causes a decrease in renal plasma flow to the secretory site which leads to decrease in the secretion of uric acid from proximal and more distal parts of tubule.[28, 31]

V. CONCLUSION

This study revealed that there were high levels of BMI among the pregnant women studied. The BMI values increased as the pregnancy progresses resulting in overweight and obesity in the second and third trimesters respectively. Also, there were significant higher values of G6PD among pregnant women and it increases as the pregnancy progresses to term. Serum uric acid on the other hand was significantly lower in pregnant women. The results of this study however showed that maternal changes in pregnancy contributed significantly in the alteration of BMI, G6PD and uric acid.

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