ORIGINAL ARTICLE

FASTING BLOOD GLUCOSE AND URINARY KETONE IN THE THREE TRIMESTERS OF NORMAL PREGNANCY

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Background: Normal pregnancy is a physiological condition in which there is a balanced feto-maternal homeostasis with overall aim of achieving a successful period of gestation. Increase in blood glucose with increasing trimester of pregnancy and use of fatty acid as an alternative source of energy is well documented. However, the progressive increase in blood glucose as pregnancy advances has not been related to urinary ketone. This study was designed to examine the blood glucose and urine of apparently healthy non-pregnant and pregnant women in the three trimesters of pregnancy. **Methods:** This cross-sectional study involved 200 volunteers (50 non-pregnant women and 50 pregnant women in each of the three trimesters of pregnancy. Blood samples were collected from the thumb by a lancet prick and examined using a glucometer. Urine samples were collected from each subject into a sterile universal bottle and analysed for Ketone among other parameters such as Blood, Protein, Nitrite, Glucose, Urobilinogen, Ascorbic acid, and *p*H. **Results:** Fasting blood glucose increased as pregnancy advanced; 97.27±3.06 (third trimester) >92.03±3.01 (second trimester) >86.10±2.83 (first trimester). The fasting blood sugar for the non-pregnant control subjects (84.07±1.36) was significantly lower ($p<0.05$) than that of the pregnant women. The 24% of the subjects in the third trimester had ketonuria, none of the other group of subjects had ketone in their urine. **Conclusion:** The increased blood glucose concentration in the third trimester of pregnancy was associated with acompensatory source of energy from fatty acid metabolism as evidenced by ketonuria.

Keywords: Blood glucose, pregnancy, trimester, ketonuria.

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INTRODUCTION

Pregnancy or gestation is a maternal condition of having a developing foetus in the body. It is a physiological condition in which there is a balanced feto-maternal homeostasis with the overall aim of achieving a successful period of gestation. It is divided into three trimesters of about thirteen weeks each. Each trimester bring about new anatomic, physiologic, biochemical and emotional changes.[1] These changes occur at different rates throughout the whole body to allow the pregnant woman to accumulate additional energy in preparation for gestation and labour.[2] Glucose is an energy giving food substrate gotten majorly from all carbohydrate foods. Its metabolism and regulation involves two major hormones; glucagon and insulin secreted by the pancreas and some organs of the body such as the liver.[3,4] The normal blood glucose concentration in person who has not eaten a meal within the past 3 or 4 hours is about 90 mg/dl, after meal containing large amount of carbohydrate this level seldom rise above 140 mg/dl unless the person has diabetes mellitus.[5] In pregnancy, there are significant alterations in glucose metabolism.[6] Placental hormones and other factors are thought to reprogram maternal physiology as they interfere with the action of insulin as it binds to the insulin receptor.[7] Thus insulin is prevented from stimulating the transport of glucose from the blood to tissues and cells of the body. This empirical increase in blood glucose advantageously provides the foetus with a constant glucose environment that is ideal for development and which makes no demands on its control mechanisms until it is separated from the mother.[8] However, the apparent unavailability of glucose to tissues as a result of insulin resistance from placenta and other hormones causes a paradigm to fatty acid metabolism for energy production. The shift to fatty acid metabolism for energy production may cause appearance of urinary ketone as pregnancy advances. This study is aimed at assessing glucose levels and urinary ketone as pregnancy traverses its trimesters.

MATERIAL AND METHODS

One hundred and fifty pregnant women attending ante natal clinic at the St. Philomena's Hospital Benin, Benin City, Edo state, volunteered for the study. Each trimester of pregnancy had fifty volunteers each. While fifty non-pregnant apparently healthy volunteers who are staff of the hospital served as the control**.** All subjects were between the ages of 23–27 years and their characteristics will be obtained a questionnaire.

The subject who attended their antenatal clinic regularly, and who were on typical Nigerian diet i.e., 60% carbohydrate were included in the study.

Subjects with Positive family history of diabetes, Positive family history of hypertension, Positive history of gestational diabetes in previous pregnancies, Positive history of hyperemesis gravidarum in index pregnancy, multiplegestations, or

Pregnancy from assisted reproductive technique were excluded from the study.

The test was performed in the morning between 8 AM–10 AM after an overnight fast. With the subject sitting in a chair, a lancet was used to prick the thumb on either of the palms of the hand to draw out blood, after the thumb had been cleaned with cotton wool and methylated spirit. Little pressure was applied to the thumb to further aid the outlet of blood which was allowed to drop on a glucose sensitive strip that was inserted into a glucometer (Accu-check®, model: GU 04310654, Roche, Mannheim, Germany). Within seconds the blood glucose concentration was generates on the screen of the glucometer. The reading on the screen was noted and recorded as fasting blood sugar in mg/dl for each subject.

Urine samples were also collected into a universal container and were assayed within 30 minutes of collection using the Combi 9 biochemical test strips (Macherey-Nagel BP. 135, 67722 Hoerdt, France), which are impregnated with a reagent that changes colour immediately after it is dipped into the universal container containing urine. The shade of the colour is compared to a standard colour chart to determine urinary pH and ketonuria.

Results were presented in tables. Appropriate statistical comparisons were made using ANOVA test and $p<0.05$ was considered statistically significant.

RESULTS

The characteristics of the subjects in terms of age, menstrual and obstetric history is shown in Table-1. The mean fasting blood glucose for control and test subjects is shown in Table-2 and there was a progressive rise of fasting blood sugar from the control group to the 3rd trimester group. The blood glucose in each trimester of pregnancy was significantly higher ($p<0.05$) than the control value. Furthermore was a significant difference ($p<0.05$) between the four groups used for the study; 24% of the subjects had ketonuria in the third trimester of pregnancy.

Table-1: Subjects' characteristics

SUBJECTS	Age (years)	Age at Menarche (years)	Menstruation Period (days)	Menstrual cycle (days)	Parity	Gravidity
Control	24.21±0.47	11–13	3–5	26–30	2–4	3–6
1st trimester	25.22±0.58	10–13	3–5	25–29	1–2	3–5
2nd trimester	24.68±0.29	11–14	3–5	26–30	1–3	1–7
3rd trimester	24.00±0.81	11–13	3–5	27–31	1–3	2–5

Values are in Mean±SEM or Range

Table-2: Fasting blood glucose concentration (mg/dl), percentage of subjects with ketonuria and *p*H ranges

Subjects	Fasting Blood glucose (mg/dl)	Subjects with urinary ketone (%)	*p*H
Control	81.07±1.36	0.0	5–8
1st trimester	86.10±2.83*	0.0	5–7
2nd trimester	92.03±3.01*	0.0	5–8
3rd trimester	99.27±3.06*	24.0%	5–7

Values are Mean±SEM, range and percentages. *indicates that there was a significant difference ($p< .05$) between control and test subjects

DISCUSSION

Skeletal muscle is the principal site of whole-body glucose disposal, and along with adipose tissue, becomes severely insulin resistant during the latter half of pregnancy. The study revealed a progressive increase in blood glucose concentration as pregnancy advanced (Table-2). The increase in blood glucose is due to an alteration in the cell signaling pathway for insulin mediated glucose transport.[9]However, this progressive increase in blood glucose as pregnancy advanced did not exceed the normal range as the fasting blood glucose concentration in the third trimester was normal (Table-2). The relatively high blood glucose levels in the third trimester of pregnancy corroborate with another study done by Perkins and his team.[10]Although previous study[11, 12]has shown a 200 - 250 % increase in insulin secretion as against a 50% decrease in insulin secretion there was still a rise in glucose concentration in the third trimester of pregnancy. Placental-derived hormones are believed to be a major factor in reprogramming maternal physiology to achieve an insulin-resistant state.[13] Placental hormones such as cortisol, progesterone, prolactin, estrogen, human placental lactogen and human placental growth hormones, amongst others can indirectly cause an increased blood glucose level[14] by interfering with the action of insulin as it binds to the insulin receptor. For instance, Human placental growth hormone (hPGH)increases six- to eightfold during gestation and replaces normal pituitary growth hormone in the maternal circulation by approximately 20 weeks of gestation.[15] Adipokines have also been implicated in causing insulin resistance. Facilitated lipolysis in late pregnancy further compounds the problem resulting in an even higher blood glucose level.[11]

In this study, 24% of the subjects in the 3rd trimester group had ketones in their urine indicative of a gluconeogenic metabolic state that can occur with pregnancy, starvation or insulin deficiency.[16]The gluconeogenic state is probably due to lack of glucose transport to tissues for utilization. The highly insulin resistant state in the 3rd trimester as evidenced by the relatively high glucose blood glucose concentration,

probably heightens the appearance of gluconeogenesis with concomitant ketonuria as the body relies more on the metabolism of fats for energy. This theory is seconded by a study where it was stated that in late gestation, rising concentrations of Human chorionic Somatomammotropin, prolactin, cortisol and glucagon exert anti-insulinogenic and lipolytic effects that promote greater use of alternative fuels, especially fatty acid, by the peripheral tissues.[17]

CONCLUSION

Although fasting blood glucose concentration increased progressively in the three trimesters of pregnancy; that of the third trimester of pregnancy was associated with a compensatory source of energy from fatty acid metabolism as evidenced by the ketonuria.

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