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Research Article

# Correlation of Serum Uric Acid with Glycemic Indices of Diabetes Mellitus Subjects

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## ABSTRACT

Diabetes mellitus is a metabolic disease associated with hyperglycemia and patients are at an increased risk of nephropathy, retinopathy and other diabetic complications. The present study was carried out to evaluate the correlation of uric acid with glycemic indices and possibly as a surrogate glycemic biomarker in diabetes mellitus. A total of one hundred (100) individuals were recruited for the study comprising of eighty (80) known diabetic and twenty (20) apparently healthy individuals. After an overnight fast, blood samples were collected and separated. Fasting blood sugar, HbA1C and uric acid were estimated using standard methods. Diabetes mellitus subjects exhibit a significantly ($p<0.05$) higher fasting blood sugar level than apparently healthy subjects. Also, the diabetes mellitus subjects showed a significantly ($p<0.05$) higher glycosylated haemoglobin and serum uric acid when compared with apparently healthy subjects but there was no gender difference observed among the diabetes mellitus subjects. There was a positive association between serum uric acid and fasting blood sugar as well as glycosylated haemoglobin. Uric acid showed positive association and significant correlation with fasting blood sugar and glycosylated haemoglobin. Thus serum uric acid may be a potential surrogate glycemic biomarker in diabetes mellitus.

**Keywords**: *Type2 Diabetes Mellitus, Glycosylated haemoglobin, Cardiovascular risk, Fasting blood sugar, Uric acid*

## INTRODUCTION

Diabetes mellitus (DM) is a metabolic and endocrinological disease which is characterized by hyperglycemia (increased blood glucose level) that results from defects in insulin secretion, insulin action or both (Sarkar *et al*., 2010). It is also characterized by disturbances of carbohydrate, lipid and protein metabolism (Solano *et al*., 2006). The chronic hyperglycemia of diabetes is associated with damage of several body organs which could be as a result of microvascular and macrovascular complications (ECDCDM, 2003). Besides hyperosmolar coma and ketoacidosis, the microvascular complication in patients with type 2 diabetes mellitus include cardiovascular disease (CVD) such as heart disease and stroke which could be the cause of death in 50% of diabetics while the macrovascular complications of diabetes include diabetic neuropathy, nephropathy and retinopathy (Michael, 2008).

Hemoglobin A1C (HbA1c) is glycated hemoglobin which is formed by the non-enzymatic reaction of glucose with native hemoglobin. It is a suitable indicator for detecting the state of glycemic control, progress of disease, and disease complications in diabetes mellitus patients (Feldt- Rasmussen, 2006; Stolar, 2010). It is routinely measured to check the glycemic control over a preceding 8-12 weeks of time (Delamater, 2006). HbA1c concentrations predict cardiovascular disease risk in diabetic patients. A good blood glucose control measures are associated with reduction in cardiovascular disease and elevated HbA1c levels are associated with increasing cardiovascular disease risk (Khaw and Wareham, 2006) which is predicted to be increased by 18%.

Uric acid (UA), the prime end product of purine catabolism and the precursor of gout, has been implicated in diabetes mellitus as well as in hyperlipidemias. There is a possible role of insulin in nucleotide metabolism (Nakanishi

*et al*., 2003; Kertes, 2013). High uric acid is considered as an independent risk factor for developing diabetes, hypertension, stroke and cardiovascular diseases. The clearance of UA is being reduced with increase in insulin resistance (Adlija *et al*., 2010). There is evidence suggestive that hyperuricemia as an independent risk factor for impaired fasting glucose (IFG) and type 2 diabetes mellitus. Patients with hyperuricemia are at a significantly higher risk of progressing to type 2 diabetes mellitus (Lv *et al*., 2013; Xue *et al*., 2015). A large number of researchers have begun to consider uric acid as a serum indicator of glycometabolic disorders, because of a correlation between uric acid and glucose metabolism by earlier authors (Sluijs *et al.*, 2013; Qiu *et al*., 2015). There are different views whether uric acid can be used to determine glycemic control of diabetes mellitus subjects but no evidence had been found from literature search. Therefore, the aim of this study is to assess the correlation of uric acid with glycemic indices and possibly as a surrogate glycemic biomarker in diabetes mellitus subjects.

## MATERIALS AND METHODS

### Study population

This study was undertaken in Warri, the commercial epicentre of Delta State, Nigeria. A total of one hundred (100) individuals were recruited for the study comprising of eighty (80) known diabetic and twenty (20) apparently healthy individuals. Participants were informed of the study protocol and their consent obtained while ethical clearance was issued by ethical committee of the State Ministry of Health, Asaba with reference number DT/SMOH/PRS/17/654

### Collection of samples

Seven milliliters (7 ml) of blood was collected from respondents' after overnight fast using aseptic precaution. This was divided into fluoride oxalate for glucose estimation, ethylenediaminetetraacetic acid (EDTA) for HBA1C estimation and plain container for urate estimation. The blood in the plain container was allowed to clot, then retracted and spun at 2000rpm for 10minutes to obtain a clear serum, which was stored at -20$^0$C until used. Estimation of blood glucose and HbA1C were carried out immediately.

### Biochemical analysis

Glucose was estimated by glucose oxidase method of Trinider (1969), Uric acid by colorimetric method of Kageyama (1971) and HbA1C by immunoturbidometric method described by Hamwi *et al*. (1995). All procedures employed for determination were in accordance with the manufacturer's instructions.

### Statistical Analysis

Data were analysed statistically using Statistical Package for Social Sciences (SPSS) version 20. The results were presented as mean ± standard deviation and significant difference considered at $p \leq 0.05$ while Pearson correlation was considered at $\leq 0.001$

## RESULTS AND DISCUSSION

### Results

The results of the study are as shown in the tables and figures below. Figure 1 showed the anthropometric variables of diabetes mellitus (DM) subjects and the controls. There were not significant *(p>0.05)* difference in the ages of both diabetes mellitus subjects and apparently healthy individuals used for the study. The diabetes mellitus subjects had a significantly ($p<0.05$) higher systolic blood pressure (SBP mmHg), diastolic blood pressure (DBP mmHg) and body mass index (BMI) when compared with the apparently healthy control.

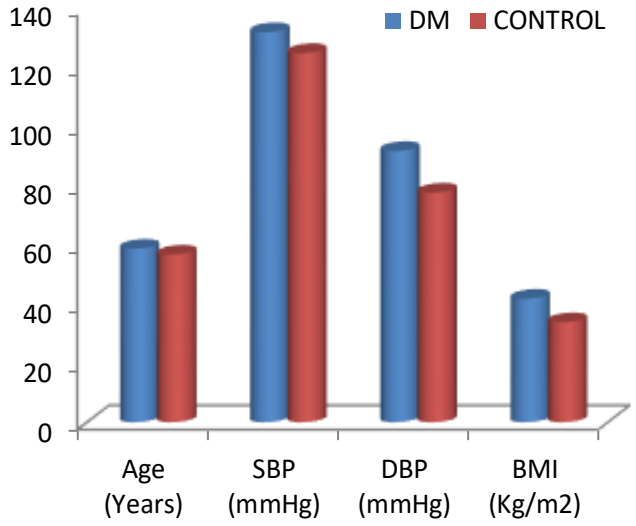


**Figure 1.** Anthropometric Variables of Diabetic Mellitus and Control.

Table 1 shows some biochemical parameters of diabetes mellitus (DM) and control subjects. The diabetes mellitus subjects shows a significantly ($p<0.05$) higher fasting blood sugar (FBS), glycosylated haemoglobin (HbA1C) and serum uric acid (SUA) when compared with apparently healthy control subjects.

Figure 2 shows the gender anthropometric variables of diabetes mellitus (DM) subjects. There were no significant ($p>0.05$) differences observed in age, systolic blood pressure (SBP), diastolic blood pressure (DBP), weight

(WT), height (HT) and body mass index (BMI) when male and female subjects were compared.

**Table 1.** Some Biochemical Variables of Diabetes Mellitus and Control Subjects

| Parameters | DM (n=80) | Control (n=20) | t - values | P values |
|---|---|---|---|---|
| **FBS (mg/dl)** | 221.53±15.92 | 91.90±16.83 | 32.189 | 0.000* |
| **HbA1C (%)** | 10.89±10.90 | 5.78±1.30 | 2.085 | 0.040* |
| **SUA (mg/dl)** | 7.14±1.20 | 4.14±0.88 | 10.505 | 0.000* |

***Significant**

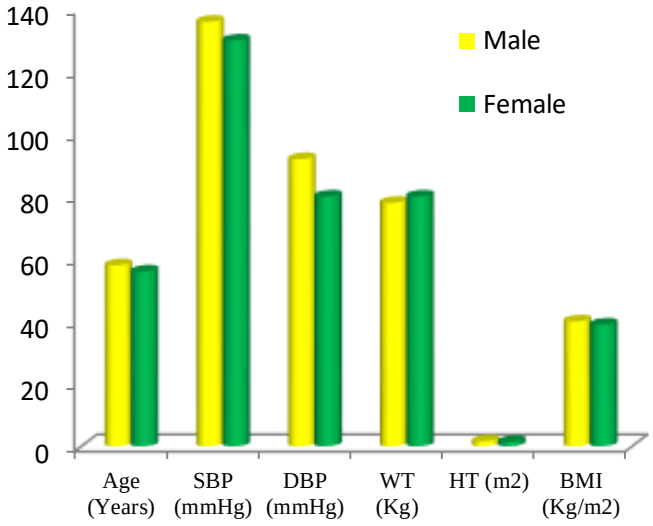


**Figure 2.** Anthropometric Variables of Male and Female Diabetes Mellitus Subjects.

**Key**: Age (Years), SBP (mmHg), DBP (mmHg), WT (Kg), HT (metres)

Table 2 shows some biochemical parameters of male and female diabetes mellitus subjects. There were no significant ($p>0.05$) differences observed when the mean ± SD of fasting blood sugar, glycosylated haemoglobin and serum uric acid (SUA) of male and female diabetes mellitus subjects were compared.

Figure 3 shows the correlation between uric acid and fasting blood sugar of diabetes mellitus subjects. There was a positive correlation ($R^2$=0.06024) between uric acid and fasting blood sugar.

Figure 4 shows the correlation between uric acid and glycosylated haemoglobin (HbA1C). There was a positive correlation ($R^2$=0.0646) between uric acid and glycosylated hemoglobin (HbA1C).

**Table 2.** Mean ±SD of Some Biochemical Parameters of Diabetics Subjects Based on Gender.

| Parameters | Male (n=30) | Female (n=80) | t - values | P values |
|---|---|---|---|---|
| **FBS (mg/dl)** | 227.72±15.05 | 217.40±15.28 | 2.978 | 0.004ǂ |
| **HbA1C (%)** | 13.03±17.10 | 9.46±1.30 | 1.446 | 0.152ǂ |
| **SUA (mg/dl)** | 7.34±1.27 | 7.00±1.14 | 1.240 | 0.219ǂ |

***Significant**

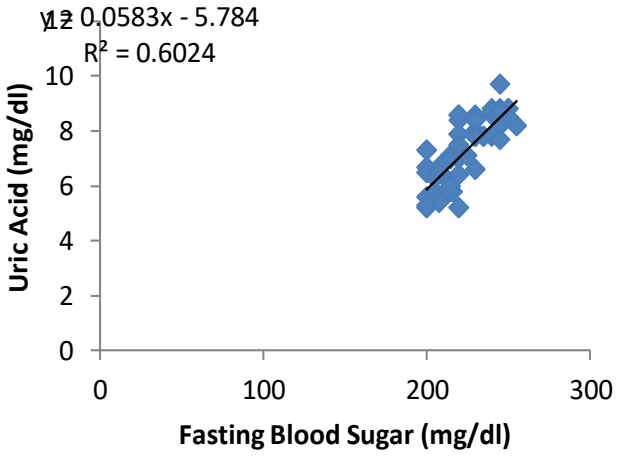


**Figure 3**. Positive Correlation of Uric Acid with Fasting Blood Sugar

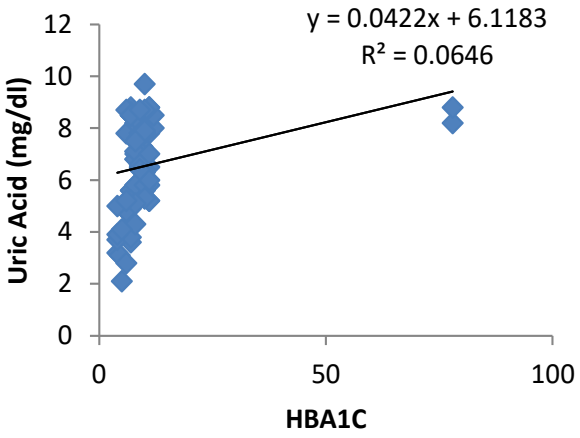


**Figure 4.** Positive Correlation of Uric acid with Glycosylated Haemoglobin.

**Discussion**

In Nigeria, diabetes mellitus is one of the most common non-communicable diseases known to have a multi-systemic effect. Screening for diabetes mellitus has involve fasting blood glucose and haemoglobin A1C as conventional biomarkers but there is need for additional biomarker hence this study. This study observed that diabetes mellitus subjects had a significantly ($p>0.05$) higher blood pressure which is in tandem with earlier report of Unadike *et al*. (2011). Hypertension has been identified as one of the risk factor of diabetes mellitus (Towfighi, 2011). Diabetes mellitus is said to affect the renin-angiotensin system which ultimately elevate the blood pressure of the individuals. Diabetes mellitus had a significantly ($p<0.05$) higher fasting blood sugar and haemoglobin A1C in diabetes mellitus subjects when compared with apparently healthy subjects. This is in tandem with the previous work by Momin *et al*. (2013) which reported similar results in their study. Glucose has been accepted as a standard biomarker of diabetes mellitus. The high HbA1c observed in diabetes mellitus show a poor glycemic control by diabetic subjects. On the other hand, there were no significant differences ($p>0.05$) observed between the male and female diabetes mellitus subjects.

The study observed that diabetes mellitus had significantly ($p<0.05$) higher uric acid when compared with apparently healthy subjects in this study. This is in line with earlier report by earlier authors (Dehghan *et al.*, 2008; Adebisi *et al*., 2009) that did similar work on diabetes mellitus subjects. The higher uric acid concentration observed among diabetes mellitus may be due to the presence of hyperinsulineamia as well as insulin resistance in diabetes mellitus subjects. Hyperinsulinemia has been observed to increase the activation of the hexose phosphate shunt, which promote the biosynthesis and transformation of purine, and ultimately increase the rate of uricogenesis (Modan *et al.*, 1987). However, there was no gender differences observed when fasting blood sugar, glycosylated haemoglobin (HbA1C) and uric acid of diabetes mellitus subjects were compared. There was a strong positive correlation between uric acid, fasting blood sugar and glycosylated haemoglobin. This is in agreement with the earlier work of Dehghan *et al*. (2008) Facchini *et al.* (1991), and Alam *et al*. (2015) which did similar study on uric acid. This implies that fasting blood sugar increases with concomitant increase in uric acid. Glycosylated haemoglobin has been identified as glycemic biomarker by earlier authors (Alam *et al.*, 2015). Thus, uric acid can be accorded similar function as glycosylated haemoglobin because they are directly proportional as elucidated above.

## CONCLUSION

In conclusion, it is imperative to note that; uric acid has shown to be directly proportional to both fasting blood sugar and glycosylated haemoglobin (HbA1C) as observed in this study. This therefore means that as fasting blood sugar and HbA1C increases, uric acid also increases. It is therefore pertinent to consider uric acid as additional biomarker in the evaluation of diabetes mellitus.

## FUNDING STATEMENT

None.

## CONFLICT OF INTEREST

None.

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