## ORIGINAL ARTICLE

# Role of Salivary Glucose in the Diagnosis and Monitoring of Type 2 Diabetes Mellitus

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## ABSTRACT

**Objectives**: To determine the correlation of fasting salivary glucose with fasting plasma glucose (FPG) and glycated hemoglobin A1c (HbA1c) for the diagnosis and monitoring of type 2 diabetes mellitus (T2DM).

**Methods:** A case - control study was carried out from 11th March to 30th August 2021, involving 88 participants out of which 44 were healthy controls and 44 participants were known T2DM who had FPG ≥ 126 mg/dl or 7.0 mmol/L. FPG was measured by Glucose oxidase method and HbA1c by National Glycohemoglobin Standardization Program (NGSP) certified chromatography.

**Results:** T2DM group had significantly higher FPG, HbA1c and salivary glucose values. Both diabetics and healthy controls showed a positive correlation of fasting salivary glucose with FPG. The correlation coefficient (r) was 0.689 and 0.477 for cases and control groups respectively. Similarly, a positive correlation of fasting salivary glucose with HbA1c was observed with the value of r 0.433 and 0.498 for diabetic and healthy control groups respectively, when measured separately. For both groups linear regression equations were derived and scatter dot plots were plotted. P value < 0.001

**Conclusion:** A positive correlation of fasting salivary glucose with FPG and HbA1c was found. As a result, fasting salivary glucose can be utilized instead of plasma glucose for T2DM patients' screening, diagnosis, and monitoring thereby eliminating the repeated pricks and mental trauma of patients.

**Keywords:** Blood glucose, glycemia, glycated hemoglobin, salivary glucose, Type 2 diabetes mellitus

## INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one the most frequent types of diabetes mellitus.[1] In Pakistan T2DM was reported to affect 16.9% of population in 2018.[2] T2DM is relative rather than absolute insulin insufficiency that affects 90 – 95 percent of person with insulin resistance. Insulin therapy is rarely necessary for these people. Because hyperglycemia develops slowly and is not particularly bothersome in the initial stages, most patients go undetected and are not aware of any of the hallmark symptoms of T2DM. These people, on the other hand, are vulnerable to cardiac, cerebral, renal, retinal, and peripheral vascular problems.[3]

Blood is currently collected by venipuncture and fingerstick procedures for the diagnosis and monitoring of diabetes mellitus but these are invasive procedures which cause physical and mental stress to patients, as most of the patients are needle phobic.[4,5] As a result, saliva can be utilized as an alternative diagnostic tool for type 2 diabetes mellitus screening, diagnosis, and monitoring, particularly in infants, children, and adults.[6] Because saliva collection is noninvasive and simple to collect, handle, store, and transport.[7]

Various studies with conflicting results have been conducted in T2DM, salivary glucose, fasting plasma glucose, and glycated haemoglobin A1c: a study of their relationships.[7,8,9,10]

This investigation sought to compare fasting salivary glucose (FSG) levels to those of fasting plasma glucose (FPG) and glycated haemoglobin A1c in people with type 2 diabetes so that the usefulness and efficacy of this noninvasive method to determine the glycemic state of patients in our population can be assessed.

## METHODOLGY

A descriptive case-control study was carried out at Pakistan Railway Hospital (PRH) Islamic international medical college trust (IIMCT) Rawalpindi from March 2021 to August 2021 as part of MPhil research project. Riphah International University's Institutional Review Committee granted ethical approval (Appl.# Riphah/ IRC/20/241. October 19, 2020) andWritten informed permission was acquired from all individuals. The sampling strategy relied on convenience rather than statistical probability. There were a total of 88 people, who were randomly assigned to one of two groups. Group 1 had 44 people with T2DM, and Group 2 included 44 people who were not diabetic but served as controls. Cochran's formula for determining the optimal size of a research sample was used to determine the sample population. Fasting plasma glucose (FPG) 126 mg/dl or 7.0 mmol/L was required for inclusion in the trial, and 11 patients with T2DM who visited the PRH diabetes clinic met these criteria. The patients with systemic diseases or chronic illnesses, smokers, pregnant women, Sjogren syndrome, medications affecting salivation, oral lesions, chemotherapy, or radiotherapy and those who had positive history of salivary gland surgery were not included in the study.

Participants who fulfilled the inclusion criteria were then called after an overnight fasting of 8-10 hours. 5ml of venous blood was drawn by aseptic measures in sodium fluoride tube (NaF) and EDTA tube for plasma glucose and HbA1c estimation respectively. The spitting method was used to collect 3 mL of saliva in a sterile, labelled container. Saliva and blood samples were centrifuged for 5 minutes at 3000 revolutions per minute (rpm). Saliva samples were stored at – 80 ˚C to be analyzed collectively.

Plasma glucose was estimated by glucose oxidase method on automated analyzer Selectra Pro M by using the reagent by Merck. Glycated hemoglobin A1c was measured by NGSP certified chromatographic separation of glycohemoglobin A1c in blood by using the reagent supplied by AMS company. HbA1c was estimated on Microlab 300. Similarly, salivary glucose was estimated collectively on HUMA reader HS by Elisa using the reagent provided by Abcam® ab65333 Glucose assay kit.

**Statistical Analysis:** The information was analysed using SPSS 21. Chi-square tests were run on categorical data. The independent t test was employed to compare biochemical characteristics between diabetic and control groups. The level of correlation of biochemical variables was determined using Pearson correlation and regression analysis. Statistical significance was defined as a P value < 0.05.

## RESULTS

The average age of 88 study subjects was 47.44 ± 9.45 years. The mean age of control and type 2 diabetes mellitus group was 43.09 ± 6.24 years and 51.79 ± 10.15 years respectively. The difference in mean ages between the two groups was not statistically significant.

Gender distribution of both study groups expressed in terms of percentages. In the diabetic group there were 22 males (53.7%) and 22 (46.8%) females whereas control group comprised 19 (46.3%) males and females were 25 (53.2%). The age and gender distribution are shown in table 1.

Mean FSG of diabetic group was found to be 13.1 mg/dl ± 4.3, mean FPG and HbA1c of T2DM group was 196.3 mg/dl ± 44.0 and 7.2 % ± 0.89 respectively. Mean FSG of control group was 1.35 mg/dl ± 0.54, mean FPG and HbA1c of control group was found to be 92.50 mg/dl ± 6.74 and 5.18% ± 0.55 respectively. In the T2DM group, these outcomes were statistically considerably greater than in the control group. As stated in table 1, the P value was 0.001.

Table 1: Comparison of demographic and biochemical parameters of Diabetic and Control groups (n=88)

| Parameters | Group 1 T2DM (N=44) | Group 2 Control (N=44) | P value |
|---|---|---|---|
| Age | 51.79 ± 10.15 | 43.09 ± 6.24 | 0.27 |
| Gender (male/female) (%) | 22/22 (53.7/46.8) | 19/25 (46.3/53.2) | 0.52 |
| Fasting salivary glucose (mg/dl) | 13.1 ± 4.3 | 1.35 ± 0.54 | < 0.001* |
| Fasting plasma glucose (mg/dl) | 196.3 ± 44.0 | 92.50 ± 6.74 | < 0.001* |
| Glycated hemoglobin A1c (%) | 7.2 ± 0.89 | 5.18 ± 0.55 | < 0.001* |

Pearson Correlation analysis was computed to assess the relationship of FSG with FPG and HbA1c, both within the diabetic and control groups. The value of correlation coefficient "r" was calculated for these variables for both study groups. Results were statistically significant when $P \leq 0.05$.

In both diabetic and control groups statistically, significant positive correlation was found between FSG and FPG. The value of correlation coefficient (r) for both diabetic and control group was 0.689 and 0.447 respectively and the value of p was < 0.001. Also Fasting salivary glucose had a statistically significant positive correlation with HbA1c in both diabetic and control groups. The value of r for both diabetic and control group was 0.433 and 0.498 respectively. Table 2 showing P < 0.001.

Table 2: Correlation between fasting plasma glucose and haemoglobin A1c in healthy subjects and those with diabetes, as measured by the Pearson coefficient (n= 88)

| | Control group (n = 44) | | Diabetic group (n = 44) | |
|---|---|---|---|---|
| | FSG | | FSG | |
| Variables | r value | P value | r value | p value |
| FPG | 0.447** | < 0.001 | 0.689*** | < 0.001 |
| HbA1c | 0.498** | < 0.001 | 0.433** | < 0.001 |
| FPG: Fasting plasma glucose, FSG: Fasting salivary glucose, HbA1c: Glycated hemoglobin | | | | |
| n= number | | | | |
| ** Statistically significant (two-tailed) correlation at the 0.01% level. | | | | |
| * Statistically significant (two-tailed) correlation at the 0.05% level. | | | | |

For the prediction of the values of FPG and HbA1c corresponding to a given value of fasting salivary glucose following linear regression equations were also calculated for both study groups.

HbA1c (diabetic group) = 6.09 + 0.09 ×Salivary glucose (diabetic group)

FPG (diabetic group)  = 1.05E2 + 6.93 × Salivary glucose (diabetic group)

HbA1c (control group) = 4.48 + 0.52 ×Salivary glucose (control group)

FPG (control group)  = 84.96 + 5.57 × Salivary glucose (control group)

To determine the linear relationship of FSG with FPG and HbA1c in both study groups scatter dot plots were also plotted as shown in figure1,2,3,4.
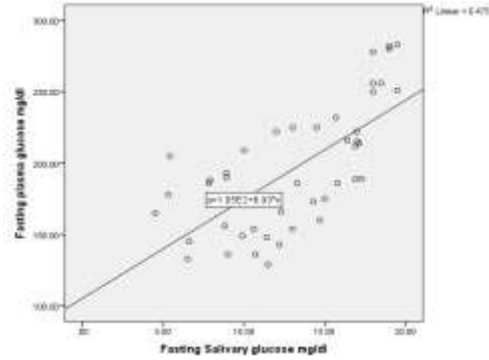


Figure 1: Correlation of FSG with FPG in diabetics (n= 44)
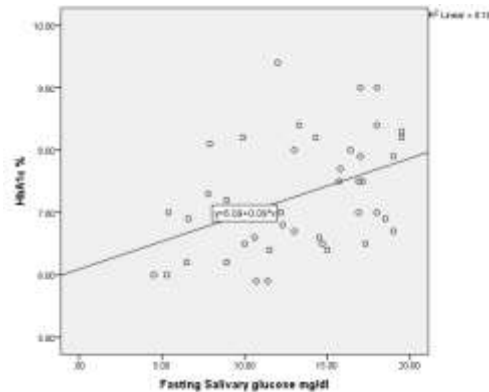


Figure 2: Correlation of FSG with HbA1c in diabetics (n=44)
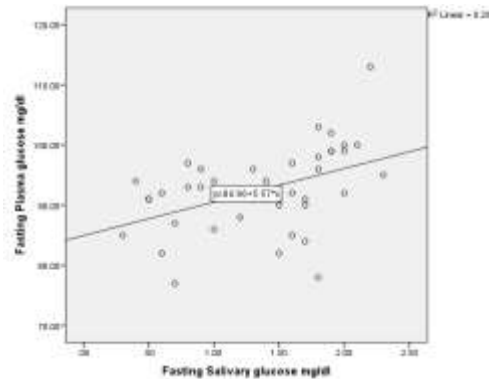


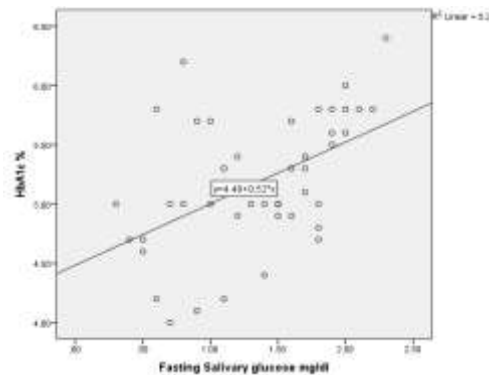Figure 3: Correlation of FSG with FPG in controls (n= 44)



Figure 4: Correlation of FSG with HbA1c in controls (n= 44)

## DISCUSSION

We studied the relationship between salivary glucose and fasting plasma glucose and glycated haemoglobin A1c in type 2 diabetics.. Our results demonstrated meaningful correlation of FSG with FPG and HbA1c in both T2DM and control groups. These results were similar to the research work conducted by Amir AH et al., who observed increased prevalence of DM between 41- 60 years of age group.[2] Similarly, AM Sharon et al., also observed increasing trend of FSG and FPG with age.[12]

We discovered that male T2DM individuals had higher FSG and FPG levels in the current study. These findings were similar to the observations of Agrawal et al., and Franck Muavais et al., who also observed increased prevalence of diabetes specially impaired fasting glucose in males.[13,14] Our finding were contradictory to the findings of Vineet Gupta et al., who discovered that the occurrence of diabetes mellitus has no effect on gender.[15]

The current study discovered a substantial positive correlation of FSG with FPG, as well as the fact that as plasma glucose levels rise, so does saliva glucose levels in T2DM patients. These observations were similar to the Divya K et al., and Dhanya M et al., studies who found positive correlation FSG with FPG in both diabetic and healthy controls.[16,17] whereas Wang B et al., did not find any correlation FSG with FPG in mixed unstimulated saliva but with saliva collected from parotid duct they found that the correlation was positive.[4]

Similarly in the current investigation, we discovered a meaningful correlation of FSG with glycemic control in both T2DM and healthy controls. Seyyed Omid et al., and Abikshyeet et al., also showed the results comparable to our study. In contrast, Muzzaferi et al. found no correlation of FSG with glycemic control in an Iranian investigation.[9,18,10]

It was single centered study with small sample size because of financial constraints which limited us to recruit substantial number of participants. The study was conducted for a brief period of duration. Large sample size and longer duration of research project could have achieved additional results.

## CONCLUSION

Our study observed substantial positive correlation of FSG with FPG and HbA1c in T2DM patients. Because the levels of glucose in T2DM patients' serum are mirrored and reflected in their saliva, We came to the conclusion that salivary glucose estimate can replace blood in the screening, diagnosis, and monitoring of diabetes.

The collection of saliva for glucose estimation is noninvasive technique as compared to other biological fluids sample collection, so it can be easily used in children, elderly, critically ill and debilitated patients for the diagnosing and monitoring of diabetes mellitus.

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