Innovative Journal of Medical and Health Science

IJMHS 10 (06), 1014–1018 (2020) ISSN (O) 2277:4939 | (P) 2589:9341

Gender - based comparison of fasting and postprandial blood and salivary glucose in diabetics and healthy adults

Sharon M.P[⋆,†,1], S. Srikanth[2], A.S. Anil Kumar[3]

[1] *C/O Mr. Philip Mathew, Mundamattom House, Manjadi P.O., Thiruvalla, Kerala*
[2] *Associate Professor, Department of Physiology, Kempegowda Institute of Medical Sciences, Bangalore*
[3] *Associate Professor, Department of Biochemistry, Kempegowda Institute of Medical Sciences, Bangalore*

Accepted 20/06/2020; Received 20/05/2020; Publish Online 25/06/2020

Reviewed By: Dr Daniel V.
Department: Medical

ABSTRACT

Urbanization is to be blamed for the rising prevalence of diabetes in India and other developing countries. A large percentage of diabetics live without being diagnosed.[2] There is a known association between diabetes mellitus and altered salivary composition and function. Diabetes is known to affect salivary composition and function.[6] Type II diabetics show an increased cardiovascular morbidity and mortality. Postprandial blood glucose is an independent risk factor for cardiovascular events in these subjects, with a stronger predictive power in women. This study was done to examine effects of gender on salivary and blood glucose in type II diabetics and healthy adults. 80 adults in the age group of 30 – 50 years were included in the study and divided into 2 groups – diabetics and healthy adults. Both groups were further divided into 2 groups based on gender – male and female. Blood and saliva samples were obtained from subjects after an overnight fast and 2 hours postprandial. Blood samples were analysed with hexokinase enzyme (automated analyser) and saliva samples with glucose oxidase enzyme (colorimeter). Salivary glucose levels were compared between diabetics and healthy adults by t – test. Relationship between salivary and blood glucose was assessed by correlation test. Difference in salivary and blood glucose levels between diabetic and healthy males and females was determined by t – test. Salivary glucose is significantly higher in diabetics ($P<0.001$). Correlation flanked by salivary and blood glucose is not seen. Further studies will help in use of salivary diagnostics for early and non – invasive diagnosis of diabetes. Blood glucose is higher in female diabetics and salivary glucose is higher in male diabetics. Sex differences in fasting and postprandial blood glucose and salivary glucose must be considered in the planning of treatment to achieve better and continuous glycaemic control in type II diabetics.

Key words: Diabetes mellitus–blood glucose–salivary glucose–gender medicine

1 INTRODUCTION

Type II diabetes mellitus (DM), characterized by insulin resistance (IR), impaired insulin secretion and increased glucose production[1] is estimated to affect 65.1 million people in India according to IDF (International Diabetes Federation) in 2013.[2] Asian countries have reported the diabetes burden to be disproportionately high in young to middle-aged adults[3] and Asian Indians are known to be at a greater risk of developing diabetes.[4]

⋆ Corresponding author.
† Email: sharonphilip@bcmch.edu.in

Urbanization is to be blamed for the rising prevalence of diabetes in India and other developing countries.[5] If diagnosed diabetes early, it is highly likely that complications could be prevented[3] thus emphasizing the need for primary prevention of diabetes and its complications.

There is a known association between diabetes mellitus and altered salivary composition and function. Vascular complications develop as a result of changes in the metabolism of lipids and proteins.[9] Glucose moves through membranes of blood vessels, passes from the blood plasma via gingival sulcus to the gingival fluid, and reaches the saliva.[10]

Salivary glucose levels are known to be raised in diabetics[6] and increased blood glucose may cause higher levels of salivary glucose.[4] In a certain study, a decrease in fasting salivary glucose levels was seen in the experimental group.[8]

If diabetes is left undiagnosed and untreated, it can cause progressive microvascular and macrovascular damage and eventually result in a lower life expectancy. Therefore, innovative methods of testing for the disease is essential to overcome this disease burden.

Contradictory results have been obtained from studies that evaluate glucose concentration in saliva, however if a correlation exists, estimating salivary glucose levels could be used as a non-invasive method for determining glucose levels in diabetics.

Insulin resistance, body composition, and energy balance have different effects on men when compared to women because adipose tissue distribution plays the main role in developing insulin resistance and other complications that develop as a result of obesity.[11] Type II diabetics show an increased cardiovascular morbidity and mortality. It has been seen that postprandial blood glucose is an independent risk factor for cardiovascular events, with a stronger predictive power in women.[12] This study was done to examine effects of gender on salivary and blood glucose in type II diabetics and healthy adults.

2 MATERIALS AND METHODS

80 adults in the age group of 30 – 50 years were recruited for the study from outpatients attending KIMS Hospital outpatient department, Bangalore, to determine and compare salivary glucose levels in diabetics and healthy adults and to assess the relationship between blood glucose and salivary glucose levels using the method of colorimetry. They were divided into 2 groups – diabetics and healthy adults. Both groups were further divided into 2 groups based on gender – male and female.

All subjects underwent anthropometric assessment (recording of height using a stadiometer and also weight to the nearest 100gms). BMI was also calculated. The blood and saliva samples were assessed in the lab in the Department of Biochemistry, Kempegowda Institute of Medical Sciences, Bangalore.

Blood and saliva samples were obtained from subjects after an overnight fast and 2 hours postprandial. Blood samples were analysed with hexokinase enzyme (automated analyser) and saliva samples with glucose oxidase enzyme (colorimeter).

Salivary glucose levels were compared between diabetics and healthy adults by t – test. Relationship between salivary and blood glucose was assessed by correlation test. Difference in salivary and blood glucose levels between diabetic and healthy males and females was determined by t – test.

The results were presented as mean ± SD and the significance of any difference was tested with t-test and Mann-Whitney test wherever appropriate. Differences with P values < 0.05 were considered statistically significant. Spearman's rank correlation test was used to determine the correlation between blood and salivary glucose values.

3 RESULTS

Salivary glucose is significantly higher in diabetics. The mean salivary glucose concentration in the fasting state was **9.77 ± 5.34 mg/dl** for the study group and **5.77 ± 2.01 mg/dl** in the control group, a statistically significant difference (P **<0.001**), as shown in Table 2 (Figures 1 & 2). The mean salivary glucose level in the postprandial state for the diabetic group was **13.65 ± 5.92 mg/dl** and in healthy adults, **10.57 ± 3.07 mg/dl** and this difference was statistically significant (P **<0.001**).

Blood glucose is higher in female diabetics and salivary glucose is higher in male diabetics. The mean salivary glucose concentration in the fasting state in diabetic men was **10.30 ± 7.02 mg/dl** and **4.71 ± 1.25 mg/dl** in the control group, a statistically significant difference (P **= 0.001**), as shown in Table 3 (Figure 3). The mean salivary glucose level in the postprandial state in diabetic men was **13.76 ± 7.53mg/dl** and in healthy men, **9.56 ± 1.56mg/dl** and this difference was statistically significant (P **= 0.015**). The mean salivary glucose concentration in the fasting state in diabetic women was **9.38 ± 3.80mg/dl** and **6.23 ± 2.12 mg/dl** in the control group, a statistically significant difference (P**<0.001**), as shown in Table 3 (Figure 3). The mean salivary glucose level in the postprandial state in diabetic women was **13.57 ± 4.57mg/dl** and in healthy men, **11.01 ± 3.46 mg/dl** and this difference was statistically significant (P **= 0.015**).

Correlation flanked by salivary and blood glucose is not seen.

4 DISCUSSION

The onset of diabetes mellitus, a constellation of abnormalities caused by insulin resistance and deficiency, in Asia is at lower BMI levels and younger ages when compared to the Western population.[13] However, the average BMI in Asian populations is still relatively low. In the present study, the mean BMI of the study group was **25.37 ± 2.57 kg/m^2** and that of the control group was **24.46 ± 3.33 kg/m^2** and there was no significant difference between them (P **= 0.204**) (**Table 1**).

Asians are possibly more genetically susceptible to insulin resistance and diabetes than Whites. A few factors that contribute to the rise in the diabetes epidemic in Asians are "normal-weight metabolically obese" phenotype, high prevalence of smoking, excessive alcohol intake, high intake of refined carbohydrates and dramatically decreased physical activity levels. It has also been seen that poor nutrition during intrauterine and in early life followed by overnutrition later in life may also play a role in Asia's diabetes epidemic.[15]

Alterations in the oral mucosa in diabetes mellitus has been observed in experimental studies and clinical practice.[28–30] The elevated glucose levels in saliva observed by Murrah, Crusson and Sauk also confirms the effect of diabetic membranopathy, which leads to an increased percolation of glucose from blood to saliva, thus affecting the salivary composition in these patients[31] which could explain the increased levels of salivary glucose in diabetics. The higher level of salivary glucose in diabetics in postprandial state suggests the effects of metabolism on simple and complex carbohydrates which form the major portion of the diet of South Indians.

There was no correlation seen in the relation between blood glucose and salivary glucose. A similar result was observed by Sashikumar et al[24] for blood and saliva samples collected in the fasting state and Panchbai et al.[6] for postprandial and random blood and saliva samples. There is no correlation probably because separate mechanisms are involved in the metabolism of salivary and blood glucose.

Our results are supported by some studies but differ from those obtained by other researchers probably due to diversity in the selection criteria of the samples and the type of design of each study, differences in the methods employed in collection of saliva and variation in age of the subjects studied, and varying levels of metabolic control in diabetic patients. In order to prevent progression from prediabetes to frank diabetes and its complications, early identification of people at risk of developing type II diabetes will help in preventing. Also if non–invasive methods are employed, greater number of people will participate in the screening of diseases.

Geer et al reported that for a given body mass index, men we have more lean mass while women have higher adiposity. Women had more peripheral or subcutaneous adipose tissue compared to men, who, in turn, were found to have more visceral and hepatic adipose tissue. Along with these differences, differences in sex hormones and adipokines, may explain a more insulin-sensitive environment in women than in men.[11]

In a 5 year follow up study, Cavalot et al, observed that postprandial blood glucose predicts the occurrence of cardiovascular events in type 2 diabetic patients when compared to fasting blood glucose, this effect being stronger in women than in men after correction for cardiovascular risk factors and type of therapy.[12] Another study done by Haas et al noted that fatality rates are higher for women compared with men with diabetes even though women have lower rates of obstructive coronary artery disease (CAD).[36]

In our study, blood glucose is higher in female diabetics and salivary glucose is higher in male diabetics. The differences in fasting and postprandial blood glucose and salivary glucose in male and female diabetics suggest that differences in clinical signs, development of complications, preventative approach, prognosis and gender responses to therapy should be considered to achieve better and continuous glycaemic control in type II diabetics. The field of gender medicine focuses on such differences and considers gender a significant variable in research.

Limitation

The small sample size is a limitation of our study and the study of larger populations in the future can provide more information about the relationship between blood glucose and salivary glucose levels.

5 CONCLUSION

Salivary glucose levels are significantly higher in diabetics in fasting and postprandial states in our study therefore, estimation of salivary glucose levels can be used as a mass screening method for diabetes in large populations. Sex differences in fasting and postprandial blood glucose and salivary glucose suggest that differences in gender responses to therapy should be considered to achieve better and continuous glycaemic control in type II diabetics.

Acknowlegements

We thank all the participants, who volunteered for this study.

Table 1. Characteristics of subjects

	Diabetic group	Control group	
Male (n)	17	12	
Female (n)	23	28	
Age (year)	42.03 ± 5.77	39.95 ± 6.43	BMI
(kg/m2)	25.37 ± 2.57	24.46 ± 3.33	

Value sare expressed in mean ± SD

Table 2. Blood glucose and salivary glucose levels of the groups

	Diabetic group	Control group	value
Fasting blood glucose (FBG)(mg/dl)	147.93 ± 65.50	88.00 ± 12.48	<0.001*
Postprandial blood glucose (PPBG)(mg/dl)	224.40 ± 90.25	126.73 ± 30.85	<0.001*
Fasting salivary glucose (FSG)(mg/dl)	9.77 ± 5.34	5.77 ± 2.01	<0.001*
Postprandial salivary glucose (PPSG)(mg/dl)	13.65 ± 5.92	10.57 ± 3.07	0.001*

*Statistically significant difference

REFERENCES

1. Powers AC. Diabetes mellitus. In: Fauci A, Braunwald E, Kasper D, editors. Harrison's principles of internal medicine. New York: McGraw-Hill, 2008; p. 2275–2304.
2. International Diabetes Federation [homepage on the Internet]. c2014 [updated 2014; cited 2014] Available from: www.idf.org
3. Chan JC, Malik V, Jia W, Kadowaki T, Yajnik CS, Yoon KH, et al. Diabetes in Asia: epidemiology, risk factors and pathophysiology. JAMA. 2009;301 (20):2129-2140.
4. Satish BN, Srikala P, Maharudrappa B, Awanti SM, Kumar P, Hugar D. Saliva: A tool in assessing glucose levels in Diabetes Mellitus. J Int Oral Health. 2014; 6(2):114-117.

Table 3. Blood glucose and salivary glucose levels of males

	Diabetic men	Men in control group	value
Fasting blood glucose (FBG)(mg/dl)	122.94 ± 57.55	88.00 ± 15.46	0.008*
Postprandial blood glucose (PPBG)(mg/dl)	205.06 ± 100.08	132.42 ± 37.24	0.010*
Fasting salivary glucose (FSG)(mg/dl)	10.30 ± 7.02	4.71 ± 1.25	0.001*
Postprandial salivary glucose (PPSG)(mg/dl)	13.76 ± 7.53	9.56 ± 1.56	0.015*

*Statistically significant difference

Table 4. Blood glucose and salivary glucose levels of females

	Diabetic group	Control group	value
Fasting blood glucose (FBG)(mg/dl)	166.39 ± 66.02	88.00 ± 11.30	<0.001*
Postprandial blood glucose (PPBG)(mg/dl)	238.70 ± 81.55	124.29 ± 28.09	<0.001*
Fasting salivary glucose (FSG)(mg/dl)	9.38 ± 3.80	6.23 ± 2.12	<0.001*
Postprandial salivary glucose (PPSG)(mg/dl)	13.57 ± 4.57	11.01 ± 3.46	0.015*

*Statistically significant difference

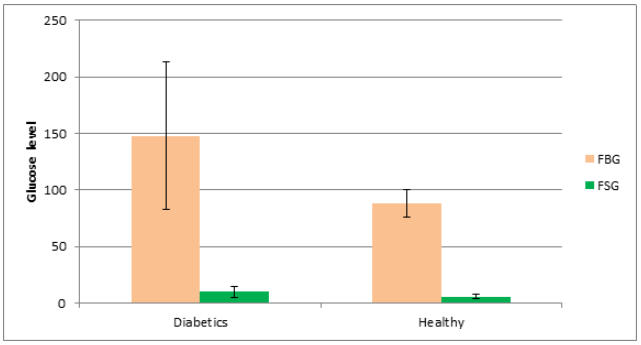

Figure 1. Mean Fasting blood glucose (FBG) and Fasting salivary glucose (FSG) in the groups

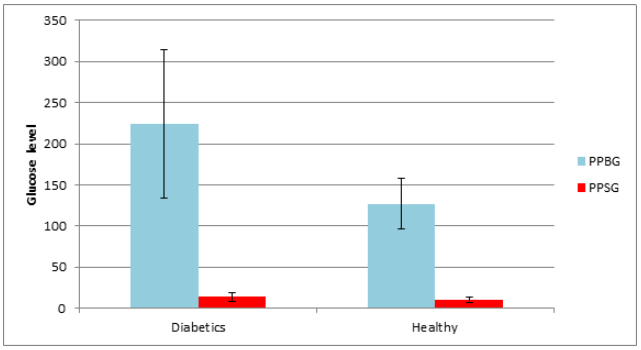

Figure 2. Mean Postprandial blood glucose (PPBG) and Postprandial salivary glucose (PPSG) in the groups

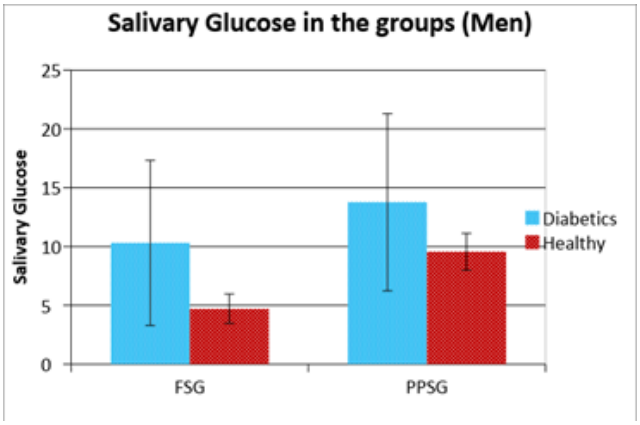

Figure 3. Mean Fasting salivary glucose (FSG) and Postprandial salivary glucose (PPSG) in males

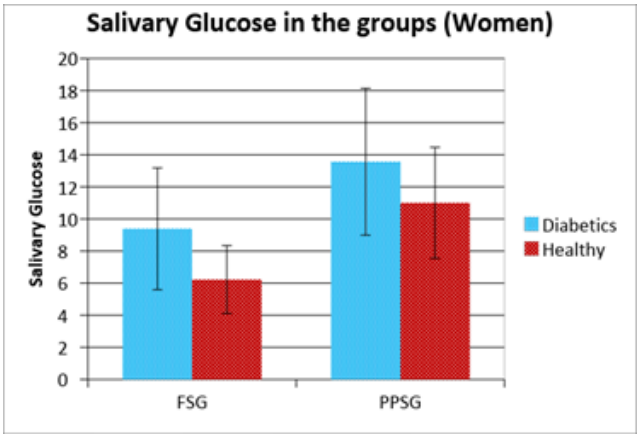

Figure 4. Mean Fasting salivary glucose(FSG) and Postprandial salivary glucose (PPSG) in females

5. Ramachandran A, Mary S, Yamuna A, Murugesan N, Snehalatha C. High prevalence of Diabetes and cardiovascular risk factors associated with urbanization in India. Diabetes Care. 2008 May;31 (5):893-8.
6. Panchbai AS, Degwekar SS, Bhowte RR. Estimation of salivary glucose, salivary amylase, salivary total protein and salivary flow rate in diabetics in India. J Oral Sci. 2010;52 (3):359-368.
7. Dodds MW, Johnson DA, Yeh CK. Health benefits of saliva: a review. J Dent. 2005 Mar;33 (3):223-33.
8. Sariri R, Varasteh A, Erfani A. Alternations in salivary glucose during ramadan fasting. Sci Res. 2010;2 (7): 769-772.
9. Belazi MA, Galli – Tsinopoulou A, Drakoulakos D, Fleva A, Papanayiotou PH. Salivary alterations in insulin – dependent diabetes mellitus. Int J Paediatr Dent. 1998 Mar;8 (1):29-33.
10. Vasconcelos AC, Soares MS, Almedia PC, Soares TC. Comparative study of the concentration of salivary and blood glucose in type 2 diabetic patients. J Oral Sci. 2010;52 (2):293-8.
11. Geer EB, Shen W. Gender differences in insulin resistance, body composition, and energy balance. Gender medicine. 2009 Jan 1;6:60-75.
12. Cavalot F, Petrelli A, Traversa M, Bonomo K, Fiora E, Conti M, Anfossi G, Costa G, Trovati M. Postprandial blood glucose is a stronger predictor of cardiovascular events than

fasting blood glucose in type 2 diabetes mellitus, particularly in women: lessons from the San Luigi Gonzaga Diabetes Study. The Journal of Clinical Endocrinology & Metabolism. 2006 Mar 1;91(3):813-9.
13. Ganong WF. Endocrine functions of the pancreas and regulation of carbohydrate metabolism. In: Barrett KE, Barman SM, Boitano S, Brooks HL, editors. Review of Medical Physiology, 24th ed. New York: McGraw-Hill, 2012; p. 449-450.
14. Hu FB. Globalization of diabetes: the role of diet, lifestyle, and genes. Diabetes Care. 2011 Jun;34 (6):1249-57.
15. Dickinson S, Colagiuri S, Faramus E, Petocz P, Brand-Miller JC. Postprandial hyperglycemia and insulin sensitivity differ among lean young adults of different ethnicities. J Nutr. 2002;132 (9):2574-2579.
16. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care. 2004;27:1047-1053.
17. Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. The Indian journal of medical research. 2007;125 (3):217-30.
18. Ramachandran A, Snehalatha C, Kapur A, Vijay V, MohanV, Das AK, et al. High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. Diabetologia. 2001;44 (9):1094-1101.
19.Mohan V, Deepa R, Deepa M, Somannavar S, Datta M. A simplified Indian Diabetes Risk Score for screening for undiagnosed diabetic subjects. Journal of the Association of Physicians of India. 2005;53:759-763.
20. Mohan V, Anbalagan VP. Expanding role of the Madras diabetes research foundation-Indian diabetes risk score in clinical practice. Indian journal of endocrinology and metabolism. 2013;17 (1): 31.
21. Manfredi M, McCullough MJ, Vescovi P, Al-Kaarawi ZM, Porter SR. Update on diabetes mellitus and related oral diseases. Oral diseases. 2004;10 (4):187-200.
22. Chiappin S, Antonelli G, Gatti R, De Palo EF. Saliva specimen: a new laboratory tool for diagnostic and basic investigation. Clinica Chimica Acta. 2007;383 (1):30-40.
23. Thorstensson H, Falk H, Hugoson A, Olsson J. Some salivary factors in insulin-dependent diabetics. Acta Odontol Scand. 1989;47 (3):175–183.
24. Sashikumar R, Kannan R. Salivary glucose levels and oral candidal carriage in type II diabetics. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology 2010;109 (5): 706 –11.
25. Mahdavi SO, Hasheni S, Boostani NS, Zokaee H. A new method to evaluate fasting plasma glucose by salivary glucose measurement. IJDO. 2012;4 (3):127-133.
26. Amer S, Yousuf M, Siddiqiui PQ, Alam J. Salivary glucose concentration in patients with diabetes mellitus - a minimally invasive technique for monitoring blood glucose levels. Pak J of Pharm Sci. 2001 Jan;14 (1):33-7.
27. Darwazeh AM, MacFarlane TW, McCuish A, Lamey PJ. Mixed salivary glucose levels and candidal carriage in patients with diabetes mellitus. Journal of Oral Pathology & Medicine. 1991;20:280–283.
28. Babu NA, Masthan KM, Bhattacharjee T, Elumalai M. Saliva-the key regulator of oral changes in diabetes patients. IJPSR. 2014;5 (7):2579-2583.
29. IvanovskiK, Naumovski V, Kostadinova M, Pesevska S, Drijanska K, Filipce V. Xerostomia and salivary levels of glucose and urea in patients with diabetes. Prilozi Macedonian Academy of Sciences and Arts, Section of Biological and Medical Sciences. 2012;33 (2):219.
30. Navalkar A, Bhoweer A. Alterations in whole saliva constituents in patients with diabetes mellitus and periodontal disease. JIAOMR. 2011;23 (4):498-501.
31. Murrah VA, Crosson JT, Sauk JJ. Parotid gland basement membrane variation in diabetes mellitus. J Oral Pathol. 1985 Mar;14 (3):236-46.
32. Vaziri PB, Vahedi M, Mortazavi H, Abdollahzadeh S, Hajilooi M. Evaluation of salivary glucose, IgA and flow rate in diabetic patients: a case-control study. Journal of dentistry (Tehran, Iran). 2010;7 (1):13-8.
33. McAdams MA, Van Dam RM, Hu FB. Comparison of self-reported and measured BMI as correlates of disease markers in U.S. adults. Obesity. 2007;15:188.
34. Zhang W, Wang ML, inventors; Northeastern University., assignee. Saliva glucose monitoring system. United States patent 20140197042.Jul 7.
35. Mucci DA, Clark RG, Fox JS, inventors; Quick Technologies., assignee. Mobile smart device infrared light measuring apparatus, pimethod, and system for analyzing substances. United States patent 20140027641. 2014 Jan 30.
36. Haas AV, Rosner BA, Kwong RY, Rao AD, Garg R, Di Carli MF, Adler GK. Sex differences in coronary microvascular function in individuals with type 2 diabetes. Diabetes. 2019 Mar 1;68(3):631-6.
37. Ahmed AF, Fayed MS, Yasser MH, Lincz LF. Retrospective study among primary care Type 2 diabetes mellitus patients within the city of Zliten, Libya, represented high incidence of early onset of disease diagnosis. Libyan Journal of Medical Sciences. 2019 Jan 1;3(1):13.
38. Satish BN, Srikala P, Maharudrappa B, Awanti SM, Kumar P, Hugar D. Saliva: A tool in assessing glucose levels in Diabetes Mellitus. J Int Oral Health. 2014; 6(2):114-117.

AUTHOR BIOGRAPHY

Sharon M.P C/O Mr. Philip Mathew, Mundamattom House, Manjadi P.O., Thiruvalla, Kerala

S. Srikanth Associate Professor, Department of Physiology,
Kempegowda Institute of Medical Sciences, Bangalore

A.S. Anil Kumar Associate Professor, Department of Biochemistry,
Kempegowda Institute of Medical Sciences, Bangalore