European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 08, Issue 03, 2021

PREVALENCE OF DIABETES MELLITUS AMONG PATIENTS VISITING DIFFERENT OUTPATIENT DEPARTMENTS(OPDs) OF A PRIVATE DENTAL COLLEGE HOSPITAL, CHENNAI, INDIA - A RETROSPECTIVE STUDY

Type of Manuscript: Original research

Running title: Prevalence of diabetes mellitus among patients visiting different outpatient departments(OPDs) of a private dental college hospital

Authors

Vaishnavi Devi. B

Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University Chennai, India

Email Id: 151701024.sdc@saveetha.com

Contact no: +91 7299254666

Pratibha Ramani (Corresponding Author)

Head of Department Department of Oral Pathology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University Chennai, India

Email Id: pratibaramani@saveetha.com

Contact no: +91 9841414603

Delphine Priscilla Antony.S

Senior Lecturer Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University Chennai, India

Email Id: delphine.sdc@saveetha.com

Contact no: +91 9790856274

ABSTRACT

Diabetes mellitus is a group of physiological dysfunctions characterised by increased blood glucose level resulting directly from insulin resistance or impaired insulin secretion leading to micro and macrovascular complications. The oral complications of diabetes mellitus includes increased incidence of dental caries, dry mouth, burning mouth syndrome and periodontitis. Assessment of blood glucose levels is essential prior to any specialised procedure to avert any

further oral and systemic complications. Screening of diabetes mellitus condition has become a necessity in developing countries and study of this nature will have enormous public health impact. The aim of this study is to assess the prevalence of diabetes mellitus in patients visiting different outpatient departments of private dental college hospital, Chennai. All the cases referred from the month of June 2019 to March 2020 for random blood sugar tests were chosen for the study. Data was collected from the dental hospital record system. Result data was tabulated in excel and imported to SPSS for correlation and association. P<0.05 was considered to be the level of statistical significance in this study. Within the limits of the present study, diabetes mellitus prevalence in random blood sugar tested patients is 33.3 % with a higher male incidence and more prevalent among the age group of 41 to 60 years. Knowledge about the prevalence of diabetes mellitus in the patients visiting dental hospital will be helpful to the clinician to prevent any further complications before any specialised procedure.

Key words

Diabetes mellitus; hyperglycemia; insulin resistance; oral complications; random blood sugar

1. INTRODUCTION

Diabetes mellitus is a chronic metabolic disease characterized by hyperglycemia due to defects in insulin secretion, insulin action, or both[1]. Defects in insulin secretion and in insulin action frequently coexists in the same patient. It affects all age groups and it is the main cause of mortality and morbidity all over the world due to its microvascular and macrovascular complications. Various pathologic processes are involved in the development of diabetes mellitus condition. These processes range from autoimmune destruction of the pancreatic β-cells with consequent insulin deficiency to abnormalities that result in resistance to insulin action [2,3].

Diabetes mellitus can be classified into two main types: (i). Type 1 diabetes, also called insulin dependent diabetes mellitus, is caused by impairment of insulin secretion by beta cells of the pancreas. (ii). Type 2 diabetes, also called non-insulin dependent diabetes mellitus, is caused by decreased sensitivity of target tissues to insulin[4]. Type 1 diabetes represents about 10% of diabetes mellitus cases all around the world[5]. Although it affects all age groups, the majority of individuals are diagnosed either at the age of 4 to 5 years or in their early adulthood[6]. Type 2 diabetes is the predominant form of diabetes and accounts for about 90% of all cases of diabetes mellitus[7]. According to the World Health Organization (WHO) held in 2003, India has reported with 32 million diabetic individuals, currently has the highest incidence of diabetes worldwide[3]. It's rising highly in epidemic levels in recent days making India the diabetic capital of the world. The numbers are increasing at an alarming rate[8]. The major risk factors distinct in developing diabetes mellitus among Indians include high familial aggregation, obesity, genetics and lifestyle changes due to urbanization[9]. Advancements in technology and communication systems have greatly affected and shaped modern society leading to a sedentary lifestyle[10]. India currently faces an uncertain future in relation to the potential burden that diabetes mellitus may impose on the country.

The common symptoms of hyperglycemia include frequent urination, excessive thirst, extreme hunger, sometimes weight loss and blurred vision[11]. Impairment of growth and susceptibility to certain infections may also accompany chronic hyperglycemia[12]. It is a universally known fact that nature tries to eliminate anything that is not normal [13]. Acute, life-threatening consequences of uncontrolled diabetes are hyperglycemia with ketoacidosis or the nonketotic hyperosmolar

syndrome[14]. Possible complications of chronic diabetes mellitus includes retinopathy with potential loss of vision; nephropathy resulting in renal failure; peripheral neuropathy with risk of foot ulcers, amputations, and autonomic neuropathy causing gastrointestinal, genitourinary, and cardiovascular symptoms and sexual dysfunction[15].

Dental implications of diabetes mellitus is well known. Various soft tissue abnormalities are reported to be associated with diabetes mellitus in the oral cavity[16]. Periodontal diseases (periodontitis and gingivitis), salivary gland dysfunction leading to a reduction in salivary flow, changes in saliva composition and taste dysfunction are the common oral complications of diabetes mellitus[17]. Whole saliva represents a complex balance among local and systemic sources[18]. This allows for the application of saliva in the diagnosis not only for salivary gland disorders but also for oral diseases and systemic conditions[19]. Due to the increased physiological stress and impaired immunity there is a high incidence of oral fungal and bacterial infections reported in patients with diabetes mellitus[20]. In addition, delayed wound healing, mucosal neurosensory disorders, dental caries and tooth loss are some of the common complications in patients with diabetes mellitus[21]. Prolonged and chronic hyperglycemia leads to increased secretion of proinflammatory cytokines such as tumour necrosis factor-α and prostaglandin E. Altered immune function in these conditions causes impaired polymorphonuclear leukocyte function facilitating bacterial persistence and accumulation of advanced glycation end products in the tissue[22]. Protracted wound healing of the oral mucosa in patients with diabetes mellitus may be attributed to factors like delayed vascularisation, minimised blood flow, decline in innate immunity, decreased growth factor production, and psychological stress[23]. Metabolic disorders like diabetes mellitus follow a proper predictable sequential progression unlike the dysplastic conditions and hence the treatment is easier [24,25].

Diabetes mellitus negatively affects all the age groups but more common in the fourth to fifth decade of life. The overall prevalence of diabetes mellitus in the general population is low but significantly high in adults aged more than 25 years and further increased in those aged more than 40 years[26].For some reasons, the condition seems to be more common in males with a male to female ratio of 2.5:1.0[27]. Hence, screening and diagnosing it at an early stage especially for middle aged men is an important requisite.

An assessment of prevalence of diabetes mellitus among patients visiting dental college will help us to identify the burden of dental fraternity and also to improve disease control. It helps us in disease identification followed by management to avert further systemic and oral complications. Patients with diabetes mellitus have high chances of implant failure, chronic periodontitis leading to delay in extraction procedure. This study will help in raising awareness of the condition and in achieving precise diagnosis followed by treatment. Certain recommendations to the dental clinicians can be given for some specialised or high risk procedures based on the inference of this study. The aim of this study is to assess the prevalence of diabetes mellitus in patients visiting different Outpatient departments(OPDs) of a private dental college hospital, Chennai.

2. MATERIALS AND METHODS

2.1 Study setting

The present study was conducted as a retrospective cross sectional study on the prevalence of diabetes mellitus in the patients visiting the dental hospital. A randomised sample of healthy patients who had been tested for random blood sugar values were chosen for the study. The study took place in a private college hospital setting within the university. The retrospective data

obtained from the institution was being ethically approved(ethical approval number: SDC/SIHEC/2020/DIASDATA/0619-0320) and the number of people involved in the study includes 3 members - Guide, researcher, reviewing expert.

2.2 Sampling

A total of 86000 patient case records were reviewed and analysed for the study. All the cases referred for random blood sugar tests to check for diabetes mellitus from the month of June 2019 to March 2020 were included for the study. The records of all patient data were reviewed from initial to last and were arranged in chronological order. Sample size n = 3982 patients. Normal range of random blood glucose level is 80 to 150 mg/dl. Cut off value for diabetes mellitus is 150 mg/dl and above. All the blood sugar report data were properly reviewed and cross verified by another examiner. Sampling bias was minimised by simple random sampling. Internal validity is applicable to the study.

2.3 Data analysis

The collected data includes both normal and diabetes mellitus patients undergoing blood glucose tests. Gross incomplete data was excluded as it affects the study. Excel tabulation of all the verified data and importing to the Statistical Package for Social Sciences(SPSS) software, version 1.0.0.1327 64 bit edition(IBM corp., NY, USA) for the statistical tests was done. The data was assessed by being subjected to descriptive analysis with the help of frequencies, percentage and analysed by running descriptive statistics in the form of crosstabs. Independent variables in the study include ethnicity, age, frequency and gender and the dependent variables include diabetes mellitus, blood sugar levels. Non parametric test - Chi square statistical test was done and the results were correlated and associated.

3. RESULTS AND DISCUSSION

The study evaluated the prevalence of diabetes mellitus among the patients visiting private dental college. A total number of 3982 patients' blood glucose reports were included in this study. The statistical software SPSS was used for the descriptive and inferential analysis. Results on categorical measurement were presented in percentage(%). Level of significance was predetermined at the probability value of $P \leq 0.05$ and any value≤ 0.05 was considered to be statistically significant.

The age prevalence in random blood sugar tested patients infer that 8. 3% in the age group of 1 to 20 years and 20. 7% in the age group of 21 to 40 years have tested random blood sugar. In the age group of 41 to 60 years, 48. 2% and 22. 2% above the age group of 60 years have tested for random blood sugar(Figure 1). The blood glucose report shows that below the age of 20 years all the patients are normal and in the age group of 21 to 40 years 22% of patients have borderline diabetes mellitus condition and in the age group of 41 to 60 years 41% of patients have been significantly reported with diabetes mellitus. Above the age group of 60 years 35. 7% are diabetic with the remaining patients being predominantly normal. It shows that 41 to 60 years show more prevalence of diabetes mellitus(Figure 2). P value is □ =0.001 and hence it is statistically significant.

Gender prevalence in the Random blood sugar tested patient shows that the 60% male patients, 39% female patients and 1 transgender patient has reported(Figure 3). There is an male prevalence in the random blood sugar levels. Among 3982 patients, 38% male patients have been reported with diabetes mellitus condition and 62% male patients have reported normal. 68% of female patients have reported normal and 32% of female patients have reported with diabetes mellitus(Figure 4). P value is p=0.001 and hence it is statistically significant.

Normal range of random blood glucose level is 80 to 150 mg/dl. Cut off value for diabetes mellitus is 150 mg/dl and above. Diabetes mellitus prevalence among the random blood sugar tested patients shows that 33.5% are diabetic and the remaining 66. 5% are normal(Figure 5). P value is p=0.001and hence it is statistically significant. Clinic prevalence of random blood sugar tested patients shows that 61% patients have been reported from the graduate(UG) clinic and 38.9% patients from postgraduate(PG) clinics(Figure 6). 51% of patients reported from the graduate clinics are known to be diabetic and the remaining 49% patients are normal. Also, 47% of patients reported from the postgraduate clinics are diabetic and the rest 53% patients being normal(Figure 7). P value is p=0.001 and hence it is statistically significant. This data shows there is a high incidence of diabetes mellitus among the patients reported from the graduate clinics. The probability value is p=0.001 for the study hence the study was statistically significant(Table 1).

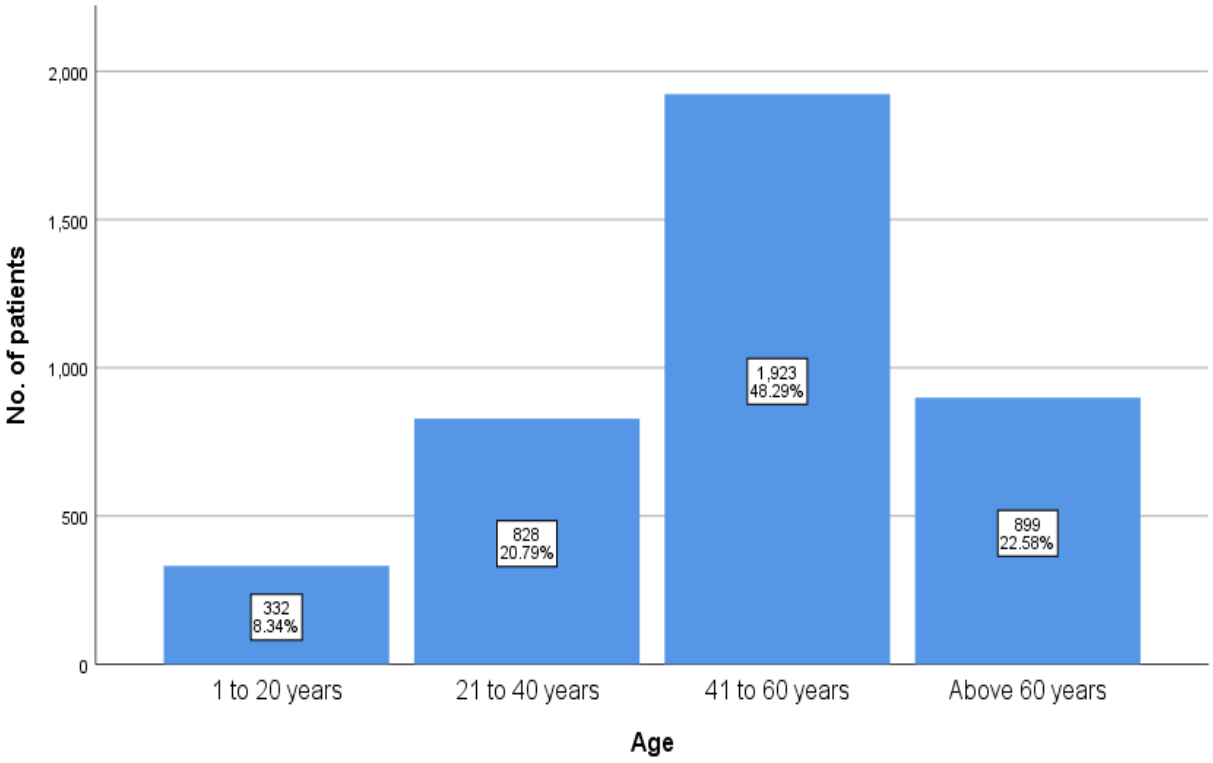

Figure 1. Bar graph showing the distribution of different age groups in the random blood sugar tested patients. X axis represents the age group and y axis represents the number of patients across the scale of patient count in the y axis and age group in the x axis. There is a significant higher incidence of patients in the age group of 41 to 60 years testing for random blood glucose values. Chi square statistical test was done and the p value was found to be 0.001(p value $\leq$0.05, statistically significant).

ISSN 2515-8260 Volume 08, Issue 03, 2021

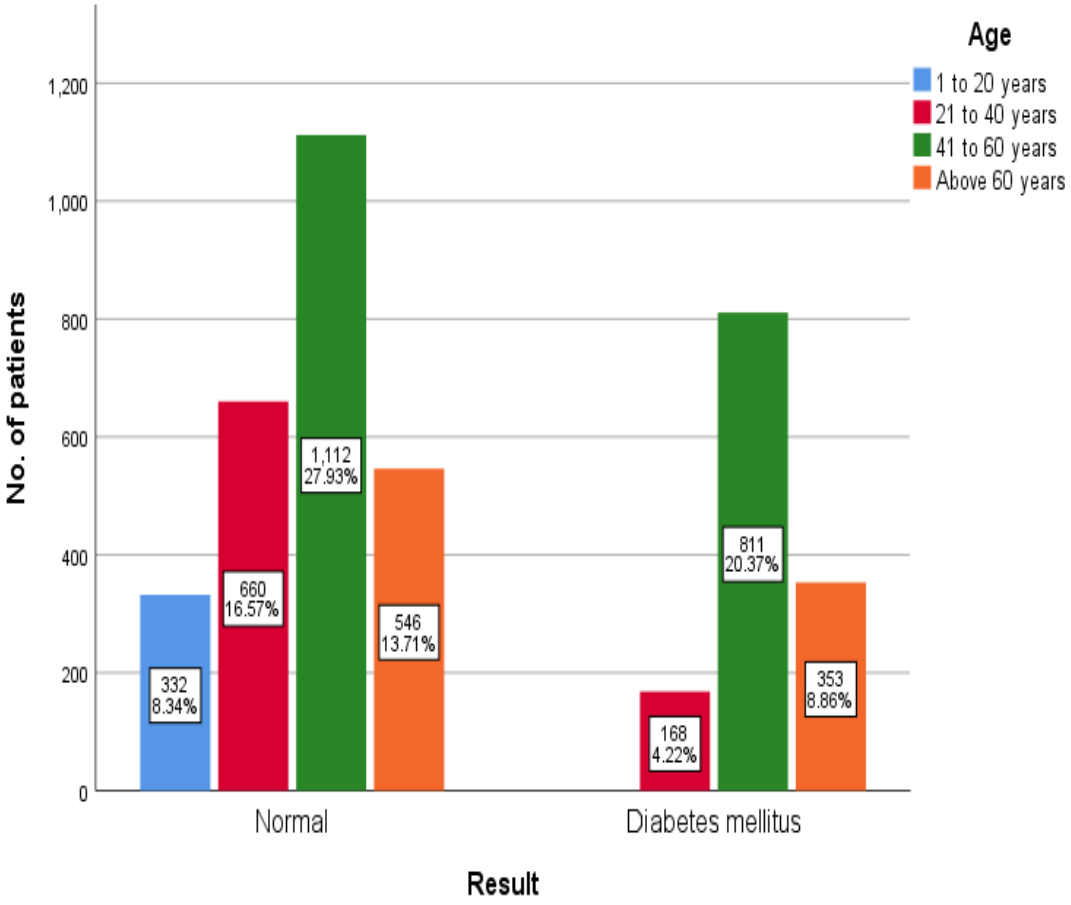

Figure 2. Bar graph showing the distribution of different age groups in random blood sugar tested patients. X axis represents the age prevalence in random blood sugar tested patients and the y axis represents the number of patients. The blue colour represents the 1 to 20 years age group, red colour represents the 20 to 40 years, green colour represents the 40 to 60 years, and orange colour represents above 60 years age group. There is a significant higher incidence of diabetes mellitus in the age group of 41 to 60 years than the other age groups. Chi square statistical test was done and the p value was found to be 0.001(p value $\leq$0.05, statistically significant).

ISSN 2515-8260 Volume 08, Issue 03, 2021

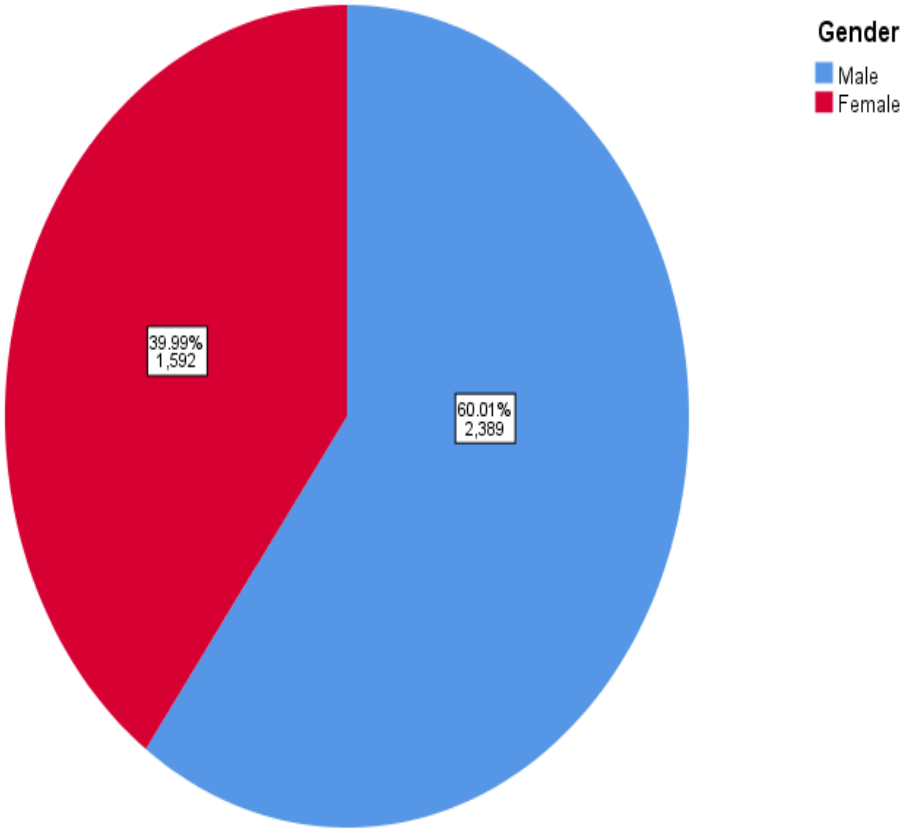

Figure 3. Pie chart showing the gender distribution in random blood sugar tested patients. The blue colour represents the male patients and red colour represents the female patients. There is a significantly higher incidence of male patients reporting for the random blood sugar test. Chi square statistical test was done and the p value was found to be 0.001(p value $\leq$0.05, statistically significant).

ISSN 2515-8260 Volume 08, Issue 03, 2021

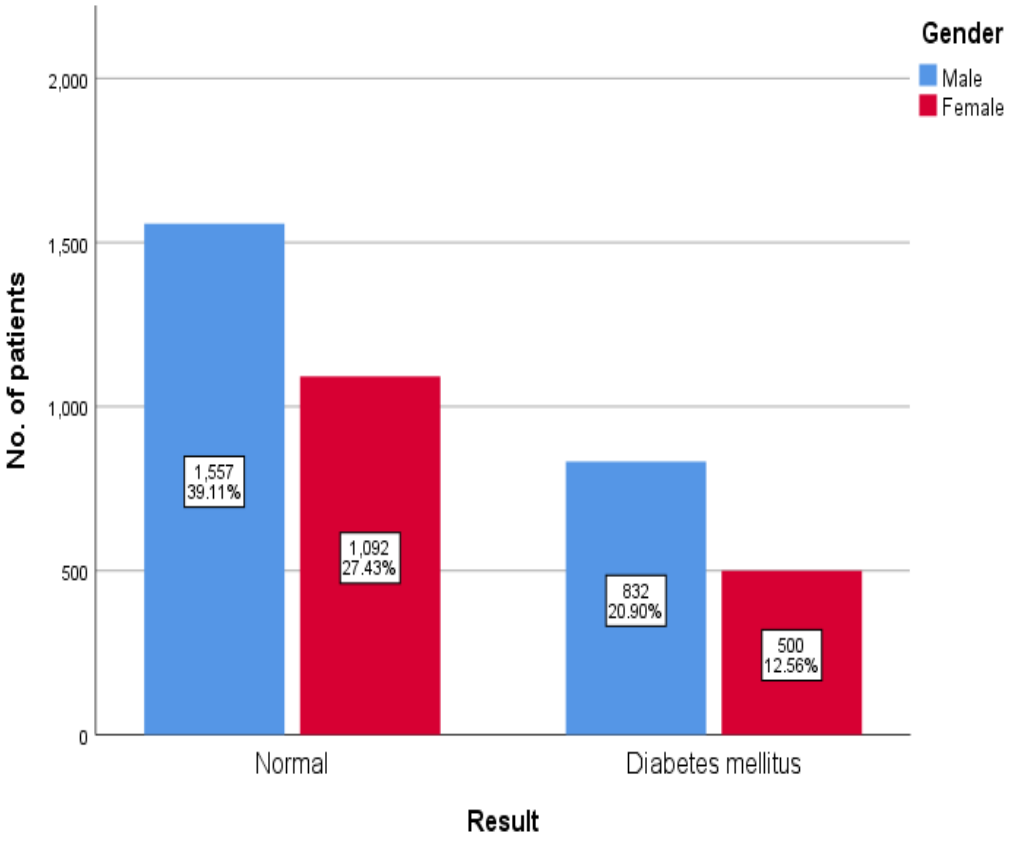

Figure 4. Bar graph showing the gender distribution in random blood sugar tested patients. X axis represents the gender prevalence in random blood sugar tested patients and y axis represents the number of patients. The blue colour represents the male patients and red colour represents the female patients. There is a significantly higher incidence of male patients reported with diabetes mellitus than the female patients. Chi square statistical test was done and the p value was found to be 0.001(p value $\leq$0.05, statistically significant).

ISSN 2515-8260 Volume 08, Issue 03, 2021

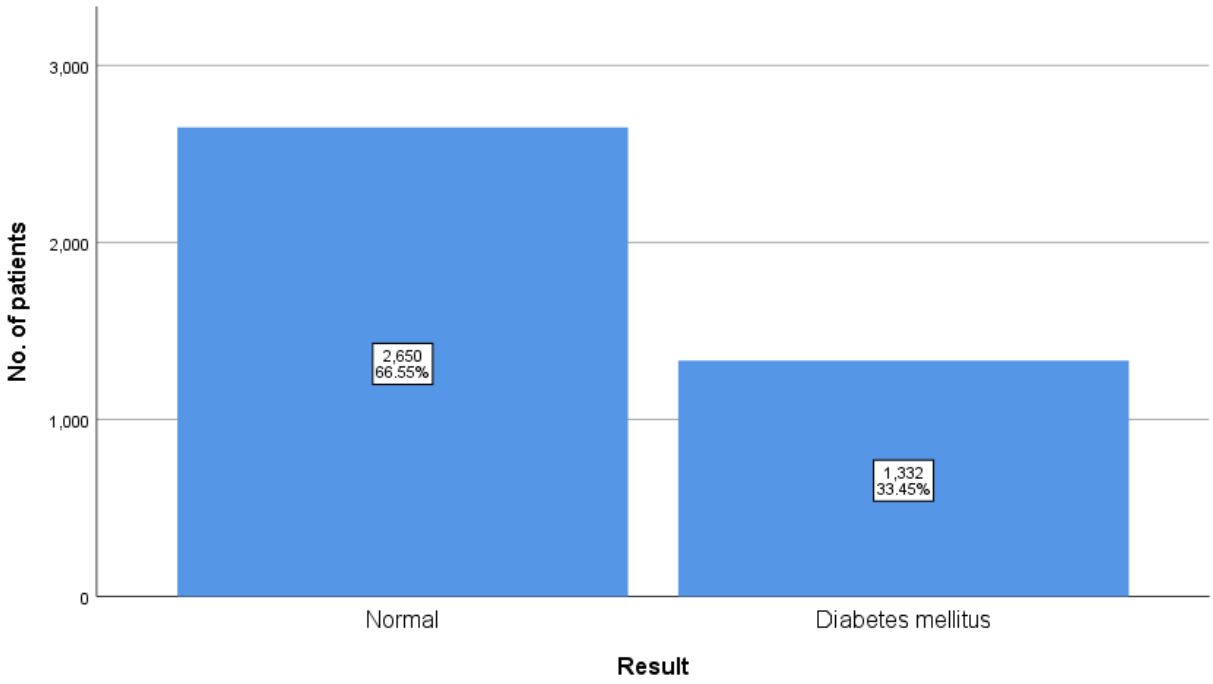

Figure 5. Bar graph showing the prevalence of diabetes mellitus condition in random blood sugar tested patients. X axis represents the random blood sugar test reports and the y axis represents the number of patients. There is a significant incidence of diabetes mellitus among the patients reporting for the random blood sugar tests. Chi square statistical test was done and the p value was found to be 0.001(p value $\leq$0.05, statistically significant).

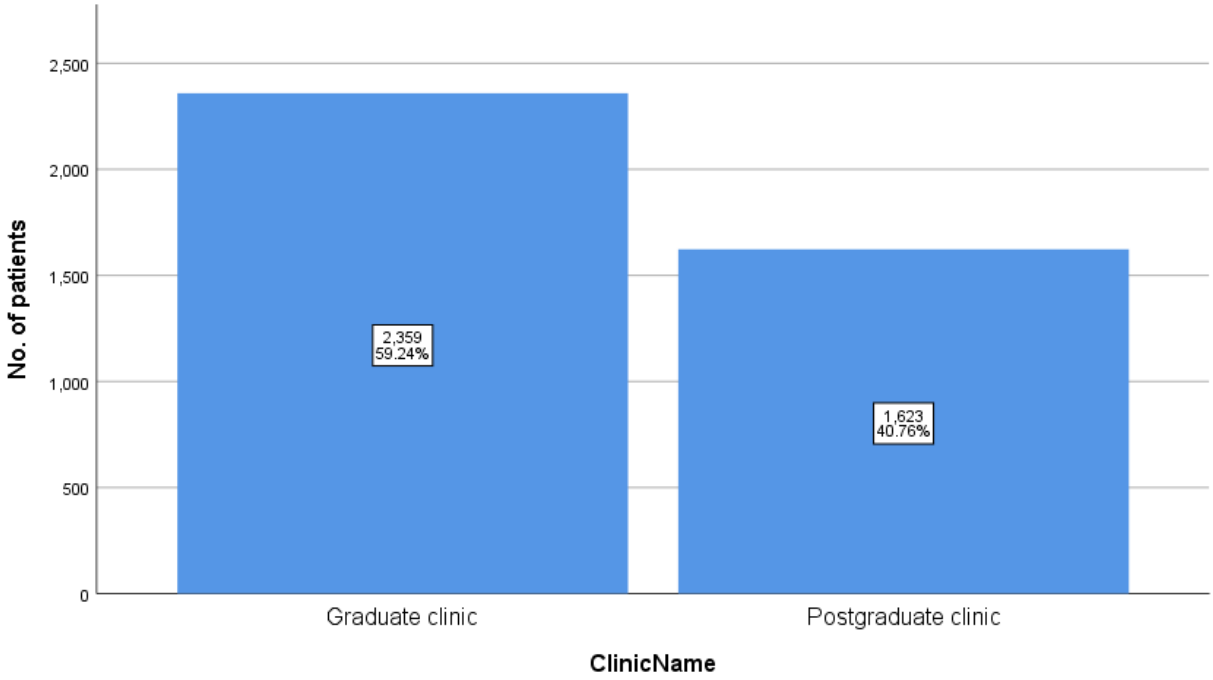

Figure 6. Bar graph showing the clinic prevalence in random blood sugar tested patients. X axis represents the clinic name and y axis represents the number of patients. There is a significant higher incidence of patients reporting from the graduate clinic for the random blood sugar tested patients than the postgraduate clinic. Chi square statistical test was done and the p value was found to be 0.001(p value $\leq$0.05, statistically significant).

ISSN 2515-8260 Volume 08, Issue 03, 2021

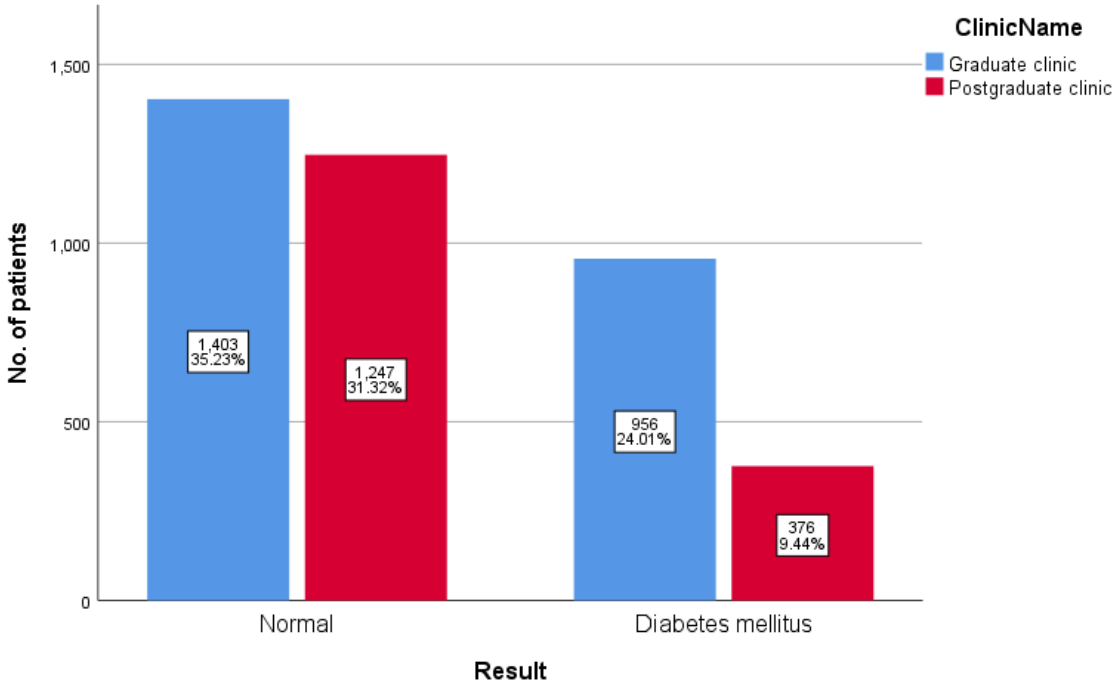

Figure 7. Bar graph showing the clinic prevalence in random blood sugar tested patients. X axis represents the clinic prevalence in random blood sugar tested patients and y axis represents the number of patients. The blue colour represents the graduate clinic and red colour represents the postgraduate clinic. There is a significantly higher incidence of patients reporting from the graduate clinic with diabetes mellitus than the postgraduate clinic. Chi square statistical test was done and the p value was found to be 0.001(p value $\leq$0.05, statistically significant).

Test Statistics

	Age	Gender	ClinicName
Chi-Square	1343.905[a]	159.560[b]	136.036[c]
df	3	1	1
Asymp. Sig.	.000	.000	.000

a. 0 cells (0.0%) have expected frequencies less than 5.

The minimum expected cell frequency is 995.5.

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 1990.5.

c. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 1991.0.

Table 1. Table showing the non parametric Chi square test analysis of the study. The test results showed the probability value to be ≤ 0.05. Hence, the study is statistically significant.

Diabetes mellitus is a polygenic disorder and maybe a cluster of metabolic disorders within which there are high glucose levels over a protracted amount. It is associated with disturbances in the carbohydrates, lipid, and protein metabolism[28]. Diabetes is gaining the status of a potential epidemic in India with more than the 65 million diabetes mellitus individuals currently diagnosed with the disease. Its prevalence is higher than in nearly all Western European nations[29]. The trends in epidemiology of oral cancer and systemic conditions like diabetes mellitus in Asia in the past decade (2000-2012) shows an alarming increase in number[3031] Long term consequences of hyperglycemia are very heterogeneous and affect all the tissues and organs of the body partially. Ischemia, increased reactive oxygen species (ROS) production and inflammation are some of the several damaging processes initiated by these implications[32] The relationship between diabetes mellitus and oral diseases has received considerable attention in the past few decades. Oral complications can be expected in diabetes mellitus patients since the oral cavity is highly vascularized and innervated. Pathogenic mechanisms of diabetic complications include insulin resistance, dyslipidemia, hypertension, immune dysfunction[33]. Also, patients with diabetes mellitus are highly prone to secondary infections[34]. The triggers for these processes should be studied further[35]. For better diagnosis and understanding the origin of various cellular changes using markers of immune response like human leukocyte antigen-DR (HLA-DR) and those expressed on monocytes and macrophages like CD 68 and leukocyte common antigen(LCA), immunohistochemistry can be preferred[36]. The occurrence of histopathological changes in the oral mucosa identified using cytological markers should be helpful in finding disease progression in these systemic conditions[37].

There is evidence that low oxidant levels produced by diabetes mellitus leads to periodontitis than in non diabetic patients[38]. Saliva acts as a buffer against the acidic byproducts from the bacterial fermentation of carbohydrates, a change in mere quantity(hyposalivation) could influence its protective act against dental caries[39]. Some studies say that the reason for hyposalivation in diabetes mellitus patients is mainly due to diabetic neuropathy [39,40]. Similarly, the periodontal pocket will get deeper carrying the dental plaque as the disease worsens, until it reaches the alveolar bone that will eventually be destroyed with the periodontal attachment[41]. It leads to destruction of periodontal tissues, loss of alveolar bone and finally tooth loss. Tooth loss due to periodontitis is very common in these patients. Diabetes mellitus patients are highly immunocompromised and hence infections like human cytomegalovirus (CMV) have tropism for salivary gland ductal epithelium and establish a persistent and lifelong infection[42].

The pattern of age distribution in the prevalence of diabetes mellitus showed that people of all groups are affected but the peak incidence was however observed in the age group of 41 to 60 years(fig 1,2)($p < 0.05$). This finding is in concordance with a number of previous studies in

India and other parts of the world. According to a study among the American population, the mean age group of the diabetes mellitus patients is 52. 8±12. 7 years[43]. With the increasing age there is an impaired pancreatic function leading to decreased insulin action. Reduced functional status of the body leads to substantial lipid accumulation which leads to atherosclerosis giving rise to microvascular complications [44,45].

More recently, it has become apparent that middle-aged men are at significantly higher risk of diabetes than women in several different populations [46]. One possible explanation for this observation is that men, on average, may have to gain less weight due to obesity with increased insulin resistance to develop type 2 diabetes mellitus than women, in part because men without diabetes are generally more insulin resistant than women [43,47,48]. In our study, the gender distribution reveals male preponderance in the blood glucose tested patients(fig 3,4)($p < 0,05$). This finding is in accordance with a study held in Scotland, prevalence of diabetes is increasingly more in male population[49]. There is an impaired pancreatic function and increased insulin resistance with increase in age in the male population.

In our study, the prevalence of diabetes mellitus in the patients visiting the dental hospital is 33%(fig 5)($p<0.05$). Urban population screened for diabetes mellitus in Chennai showed that prevalence of diabetes mellitus was 42% in the adult population which is slightly higher than the values obtained in our study[50]. This finding of our study is in concordance with a study conducted by Yang, which shows that 34. 4% of diabetes mellitus patients have been reported[51]. It is important to know the prevalence of diabetes mellitus, as these patients have decreased wound healing ability and are more prone to infections. Early detection and prompt diagnosis can lead to better prognosis and help in the implementation of successful clinical treatment[52].

In our study, we have found that more number of patients have been reported from the graduate clinics (fig 6)($p < 0.05$) and the prevalence of diabetes mellitus condition is also more in the patients reported from the graduate clinics(fig 7). Postgraduate clinics have limited patient count and thereby there is a reduced number of patients referred for the blood glucose level tests. This finding is the first data to analyse this parameter based on the best of knowledge obtained from the available data.

This study will have a huge impact in public health and will be helpful in creating awareness by knowing the prevalence among different gender and age groups. The findings of this study will assist the clinician to be prepared for any treatment in the diabetic patients by knowing its prevalence. There is a geographic limitation to the study as it predominantly covers the South Indian population and it is also an unicentered study. This can be modified by performing longitudinal and periodic studies to evaluate the prevalence of diabetes mellitus. In the future, a larger population with different ethnicity can be included to provide better results and for precise diagnosis HbA1C tests can be preferred in the future studies. This study gives valuable information to oral health planners in proposing strategies for the development of oral health management.

4. CONCLUSION

Within the limits of the present study, a significant number of patients have been reported with. diabetes mellitus. The most common age group reported with diabetes mellitus condition is 41 to 60 years with a higher incidence of male patients, primarily reported from the graduate clinics. Routine glucose testing with regular screening and pre monitoring of diabetes mellitus condition is an essential factor during dental checkup and beneficial to the community as it plays a major role in wound healing and other problems.

5. ACKNOWLEDGEMENT

The authors would like to acknowledge the help and support rendered by the Department of Special care Dentistry and Information Technology department of SIMATS for their constant assistance with the research.

6. CONFLICT OF INTEREST

Authors declare no potential conflict of interest.

7. REFERENCES

1. Mellitus Tecotdacod, The Expert Committee On The Diagnosis And Classification Of Diabetes Mellitus. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus [Internet]. Vol. 21, Diabetes Care. 1998. p. S5–19. Available from: http://dx.doi.org/10.2337/diacare.21.1.s5
2. Mellitus EC on TDAC of D, Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Follow-up Report on the Diagnosis of Diabetes Mellitus [Internet]. Vol. 22, Clinical Diabetes. 2004. p. 71–9. Available from: http://dx.doi.org/10.2337/diaclin.22.2.71
3. Moore PA, Zgibor JC, Dasanayake AP. Diabetes: a growing epidemic of all ages. J Am Dent Assoc. 2003 Oct;134 Spec No:11S – 15S.
4. Ozougwu, Ozougwu O. The pathogenesis and pathophysiology of type 1 and type 2 diabetes mellitus [Internet]. Vol. 4, Journal of Physiology and Pathophysiology. 2013. p. 46–57. Available from: http://dx.doi.org/10.5897/jpap2013.0001
5. Chan JCN, Malik V, Jia W, Kadowaki T, Yajnik CS, Yoon K-H, et al. Diabetes in Asia [Internet]. Vol. 301, JAMA. 2009. p. 2129. Available from: http://dx.doi.org/10.1001/jama.2009.726
6. Bloom A, Hayes TM, Gamble DR. Register of newly diagnosed diabetic children [Internet]. Vol. 3, BMJ. 1975. p. 580–3. Available from: http://dx.doi.org/10.1136/bmj.3.5983.580
7. Gonzalez ELM, Johansson S, Wallander M-A, Rodriguez LAG. Trends in the prevalence and incidence of diabetes in the UK: 1996-2005 [Internet]. Vol. 63, Journal of Epidemiology & Community Health. 2009. p. 332–6. Available from: http://dx.doi.org/10.1136/jech.2008.080382
8. Ramachandran A, Snehalatha C, Kapur A, Vijay V, Mohan V, Das AK, et al. High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey [Internet]. Vol. 44, Diabetologia. 2001. p. 1094–101. Available from: http://dx.doi.org/10.1007/s001250100627
9. Ackermann RT, Cheng YJ, Williamson DF, Gregg EW. Identifying Adults at High Risk for Diabetes and Cardiovascular Disease Using Hemoglobin A1c [Internet]. Vol. 40, American Journal of Preventive Medicine. 2011. p. 11–7. Available from: http://dx.doi.org/10.1016/j.amepre.2010.09.022
10. Hannah R, Ramani P, Herald. J. Sherlin, Ranjith G, Ramasubramanian A, Jayaraj G, et al. Awareness about the use, Ethics and Scope of Dental Photography among Undergraduate Dental Students Dentist Behind the lens [Internet]. Vol. 11, Research Journal of Pharmacy and Technology. 2018. p. 1012. Available from: http://dx.doi.org/10.5958/0974-360x.2018.00189.0

11. Clark NG, Fox KM, Grandy S, for the SHIELD Study Group. Symptoms of Diabetes and Their Association With the Risk and Presence of Diabetes: Findings from the Study to Help Improve Early evaluation and management of risk factors Leading to Diabetes (SHIELD) [Internet]. Vol. 30, Diabetes Care. 2007. p. 2868–73. Available from: http://dx.doi.org/10.2337/dc07-0816
12. Zhang X, Gregg EW, Williamson DF, Barker LE, Thomas W, McKeever Bullard K, et al. Response to Comment on: Zhang et al. A1C Level and Future Risk of Diabetes: A Systematic Review. Diabetes Care 2010;33:1665-1673 [Internet]. Vol. 34, Diabetes Care. 2011. p. e21–e21. Available from: http://dx.doi.org/10.2337/dc10-2155
13. Sivaramakrishnan SM, Ramani P. Study on the Prevalence of Eruption Status of Third Molars in South Indian Population [Internet]. Vol. 07, Biology and Medicine. 2015. Available from: http://dx.doi.org/10.4172/0974-8369.1000245
14. Cherry-Peppers G, Ship JA. Oral Health in Patients With Type II Diabetes and Impaired Glucose Tolerance [Internet]. Vol. 16, Diabetes Care. 1993. p. 638–41. Available from: http://dx.doi.org/10.2337/diacare.16.4.638
15. Bell GW, Large DM, Barclay SC. Oral health care in diabetes mellitus. SADJ. 2000 Mar;55(3):158–65; quiz 175.
16. Sanjeeta N, MDS, Professor A, Dental College, Regional Institute of Medical Sciences, Imphal. Oral changes in Diabetes – a review [Internet]. Vol. 13, IOSR Journal of Dental and Medical Sciences. 2014. p. 36–9. Available from: http://dx.doi.org/10.9790/0853-13153639
17. Guggenheimer J, Moore PA, Rossie K, Myers D, Mongelluzzo MB, Block HM, et al. Insulin-dependent diabetes mellitus and oral soft tissue pathologies: II. Prevalence and characteristics of Candida and Candidal lesions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000 May;89(5):570–6.
18. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. J Oral Pathol Med. 2019 Apr;48(4):299–306.
19. Shree KH, Hema Shree K, Ramani P, Herald Sherlin, Sukumaran G, Jeyaraj G, et al. Saliva as a Diagnostic Tool in Oral Squamous Cell Carcinoma – a Systematic Review with Meta Analysis [Internet]. Vol. 25, Pathology & Oncology Research. 2019. p. 447–53. Available from: http://dx.doi.org/10.1007/s12253-019-00588-2
20. Ueta E, Osaki T, Yoneda K, Yamamoto T. Prevalence of diabetes mellitus in odontogenic infections and oral candidiasis: an analysis of neutrophil suppression. J Oral Pathol Med. 1993 Apr;22(4):168–74.
21. Kuo L-C, Polson AM, Kang T. Associations between periodontal diseases and systemic diseases: A review of the inter-relationships and interactions with diabetes, respiratory diseases, cardiovascular diseases and osteoporosis [Internet]. Vol. 122, Public Health. 2008. p. 417–33. Available from: http://dx.doi.org/10.1016/j.puhe.2007.07.004
22. Alberti KGMM, K G M, Zimmet PZ, Consultation WHO. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus. Provisional report of a WHO Consultation [Internet]. Vol. 15, Diabetic Medicine. 1998. p. 539–53. Available from: 3.0.co;2-s">http://dx.doi.org/10.1002/(sici)1096-9136(199807)15:7<539::aid-dia668>3.0.co;2-s
23. D'Aiuto F, Gable D, Syed Z, Allen Y, Wanyonyi KL, White S, et al. Evidence summary: The relationship between oral diseases and diabetes. Br Dent J. 2017 Jun 23;222(12):944–8.
24. Jayaraj G, Sherlin HJ, Ramani P, Premkumar P, Natesan A. Stromal myofibroblasts in oral

squamous cell carcinoma and potentially malignant disorders. Indian J Cancer. 2015 Jan;52(1):87–92.

25. Jayaraj G, Ramani P, Herald J. Sherlin, Premkumar P, Anuja N. Inter-observer agreement in grading oral epithelial dysplasia – A systematic review [Internet]. Vol. 27, Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology. 2015. p. 112–6. Available from: http://dx.doi.org/10.1016/j.ajoms.2014.01.006
26. Asha Bai PV, Murthy BN, Chellamariappan M, Gupte MD, Krishnaswami CV. Prevalence of known diabetes in Chennai City. J Assoc Physicians India. 2001 Oct;49:974–81.
27. Jangid K, Alexander A, Jayakumar N, Varghese S, Ramani P. Ankyloglossia with cleft lip: A rare case report [Internet]. Vol. 19, Journal of Indian Society of Periodontology. 2015. p. 690. Available from: http://dx.doi.org/10.4103/0972-124x.162207
28. Force ICGT, IDF Clinical Guidelines Task Force. Global Guideline for Type 2 Diabetes: recommendations for standard, comprehensive, and minimal care [Internet]. Vol. 23, Diabetic Medicine. 2006. p. 579–93. Available from: http://dx.doi.org/10.1111/j.1464-5491.2006.01918.x
29. Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract. 2011 Dec;94(3):311–21.
30. Viveka TS, Shyamsundar V, Krishnamurthy A, Ramani P, Ramshankar V. p53 Expression Helps Identify High Risk Oral Tongue Premalignant Lesions and Correlates with Patterns of Invasive Tumour Front and Tumour Depth in Oral Tongue Squamous Cell Carcinoma Cases [Internet]. Vol. 17, Asian Pacific Journal of Cancer Prevention. 2016. p. 189–95. Available from: http://dx.doi.org/10.7314/apjcp.2016.17.1.189
31. Gheena S, Ezhilarasan D. Syringic acid triggers reactive oxygen species-mediated cytotoxicity in HepG2 cells. Hum Exp Toxicol. 2019 Jun;38(6):694–702.
32. Kumar PS, Monteiro MF, Dabdoub SM, Miranda GL, Casati MZ, Ribeiro FV, et al. Subgingival Host-Microbial Interactions in Hyperglycemic Individuals [Internet]. Vol. 99, Journal of Dental Research. 2020. p. 650–7. Available from: http://dx.doi.org/10.1177/0022034520906842
33. Giacco F, Brownlee M. Oxidative stress and diabetic complications. Circ Res. 2010 Oct 29;107(9):1058–70.
34. Premkumar J, Ramani P, Chandrasekar T, Natesan A, Premkumar P. Detection of species diversity in oral candida colonization and anti-fungal susceptibility among non-oral habit adult diabetic patients. J Nat Sci Biol Med. 2014 Jan;5(1):148–54.
35. Thangaraj SV, Shyamsundar V, Krishnamurthy A, Ramani P, Ganesan K, Muthuswami M, et al. Molecular Portrait of Oral Tongue Squamous Cell Carcinoma Shown by Integrative Meta-Analysis of Expression Profiles with Validations [Internet]. Vol. 11, PLOS ONE. 2016. p. e0156582. Available from: http://dx.doi.org/10.1371/journal.pone.0156582
36. Sherlin H, Ramani P, Premkumar P, Kumar A, Natesan A. Expression of CD 68, CD 45 and human leukocyte antigen-DR in central and peripheral giant cell granuloma, giant cell tumor of long bones, and tuberculous granuloma: An immunohistochemical study [Internet]. Vol. 26, Indian Journal of Dental Research. 2015. p. 295. Available from: http://dx.doi.org/10.4103/0970-9290.162872
37. Gupta V, Ramani P. Histologic and immunohistochemical evaluation of mirror image biopsies in oral squamous cell carcinoma. J Oral Biol Craniofac Res. 2016 Sep;6(3):194–7.
38. Sandberg GE, Sundberg HE, Fjellstrom CA, Wikblad KF. Type 2 diabetes and oral health: a comparison between diabetic and non-diabetic subjects. Diabetes Res Clin Pract. 2000

Sep;50(1):27–34.
39. Jawed M, Shahid SM, Qader SA, Azhar A. Dental caries in diabetes mellitus: role of salivary flow rate and minerals. J Diabetes Complications. 2011 May;25(3):183–6.
40. Jawed M, Khan RN, Shahid SM, Azhar A. Protective Effects of Salivary Factors in Dental Caries in Diabetic Patients of Pakistan [Internet]. Vol. 2012, Experimental Diabetes Research. 2012. p. 1–5. Available from: http://dx.doi.org/10.1155/2012/947304
41. Andersen CCP, Pontes Andersen CC, Flyvbjerg A, Buschard K, Holmstrup P. Relationship Between Periodontitis and Diabetes: Lessons From Rodent Studies [Internet]. Vol. 78, Journal of Periodontology. 2007. p. 1264–75. Available from: http://dx.doi.org/10.1902/jop.2007.060491
42. Jayaraj G, Sherlin H, Ramani P, Premkumar P, Anuja N. Cytomegalovirus and Mucoepidermoid carcinoma: A possible causal relationship? A pilot study [Internet]. Vol. 19, Journal of Oral and Maxillofacial Pathology. 2015. p. 319. Available from: http://dx.doi.org/10.4103/0973-029x.174618
43. Halter JB, Musi N, McFarland Horne F, Crandall JP, Goldberg A, Harkless L, et al. Diabetes and cardiovascular disease in older adults: current status and future directions. Diabetes. 2014 Aug;63(8):2578–89.
44. Al Habashneh R, Khader Y, Hammad MM, Almuradi M. Knowledge and awareness about diabetes and periodontal health among Jordanians. J Diabetes Complications. 2010 Nov;24(6):409–14.
45. Swathy S, Gheena S, Varsha SL. Prevalence of pulp stones in patients with a history of cardiac diseases [Internet]. Vol. 8, Research Journal of Pharmacy and Technology. 2015. p. 1625. Available from: http://dx.doi.org/10.5958/0974-360x.2015.00291.7
46. Herman WH, Taylor GW, Jacobson JJ, Burke R, Brown MB. Screening for prediabetes and type 2 diabetes in dental offices [Internet]. Vol. 75, Journal of Public Health Dentistry. 2015. p. 175–82. Available from: http://dx.doi.org/10.1111/jphd.12082
47. Gupta HL, Yadav M, Sundarka MK, Talwar V, Saini M, Garg P. A study of prevalence of health problems in asymptomatic elderly individuals in Delhi. J Assoc Physicians India. 2002 Jun;50:792–5.
48. Aaberg ML, Burch DM, Hud ZR, Zacharias MP. Gender differences in the onset of diabetic neuropathy [Internet]. Vol. 22, Journal of Diabetes and its Complications. 2008. p. 83–7. Available from: http://dx.doi.org/10.1016/j.jdiacomp.2007.06.009
49. Gale EAM, Gillespie KM. Diabetes and gender [Internet]. Vol. 44, Diabetologia. 2001. p. 3–15. Available from: http://dx.doi.org/10.1007/s001250051573
50. Ramachandran A, Jali MV, Mohan V, Snehalatha C, Viswanathan M. High prevalence of diabetes in an urban population in south India [Internet]. Vol. 297, BMJ. 1988. p. 587–90. Available from: http://dx.doi.org/10.1136/bmj.297.6648.587
51. Yang W, Lu J, Weng J, Jia W, Ji L, Xiao J, et al. Prevalence of diabetes among men and women in China. N Engl J Med. 2010 Mar 25;362(12):1090–101.
52. Sridharan G, Ramani P, Patankar S. Serum metabolomics in oral leukoplakia and oral squamous cell carcinoma [Internet]. Vol. 0, Journal of Cancer Research and Therapeutics. 2017. p. 0. Available from: http://dx.doi.org/10.4103/jcrt.jcrt_1233_16