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Original Research Article

Association between Dental Caries and Type 2 Diabetes Mellitus among Kanpur Population

Sridevi. N[1], Jaya Prakash Thumu[2], Kiran Kumar P[3], A.V. Rajanikanth[4], Vinay Kumar Mishra[5]

[1]Ph.D. Scholar, [2]Professor and Head, [5]Associate Professor,
Department of Conservative Dentistry and Endodontics, Rama Dental College, Hospital and Research Centre, Kanpur (UP) India.
[3]Assistant Professor, Department of Anatomy, Rama Medical College, Hospital and Research Centre, Kanpur, Rama University, India.
[4]Professor, Department of Prosthodontics, Rama Dental College, Hospital and Research Centre, Kanpur (UP) India.

Corresponding Author: Sridevi. N

ABSTRACT

Type 2 diabetes mellitus is associated with persistent poor glycemic control which inturn has an impact on the oral cavity, resulting in oral manifestations. The aim of this study is to evaluate the effects of caries risk factors such as bacteriological counts, oral hygiene assessment, and frequency of daily sugar exposure on the caries experience among Type 2 diabetic and non diabetic individuals in Kanpur Population. 100 subjects with dental caries, in the age group 30-70 years, were further divided into Group I (n=50) included Type II diabetes mellitus patients and Group II (n=50) included non-diabetic patients with dental caries. Lactobacillus and Mutans streptococcus colony counts, Silness and Leo indices for plaque score, questionnaire for evaluating oral hygiene practices, a3-day dietary record to evaluate the frequency of daily sugar intake and the prevalence of dental caries was assessed by obtaining the DMFT scores among the subjects of both the groups.
Type 2 diabetic patients showed statistically significant increase in the colony counts of Streptococcus mutans (90%) and Lactobacilli, a significantly higher mean plaque indices score and high DMFT score, when compared to non-diabetic patients .Superior oral health habits and higher frequency of sugar intake was observed in subjects of the non-diabetic group when compared to the Type 2 diabetes mellitus patients. In conclusion, our study showed that increase in acidogenic microbes, high plaque scores, less oral hygiene assessment led to high occurrence of caries among Type 2 diabetes mellitus patients when compared to nondiabetic patients.

Key words: Type 2 diabetes mellitus, Dental caries, Oral hygiene assessment, Bacteriological counts.

INTRODUCTION

Diabetes mellitus is one of the primeval diseases first reported in Egyptian manuscript about 3000 years ago. [1] Diabetes mellitus is a chronic disease that occurs due to the decreased insulin production by pancreas or body cells exhibiting resistance to insulin thus resulting in the impairment of the carbohydrates, lipids and protein metabolism leading to chronic hyperglycaemia. [2] Diabetes mellitus can be broadly classified into Type 1, Type 2, "other specific types" in the year 1936. [3] Insulin resistance exhibited by the body cells results in the Type 2 diabetes mellitus which is the most prevalent type of diabetes mellitus. In the year 2011, [4] it has been estimated that 366 million people were affected by Diabetes mellitus. It has been predicted that may be 439 million people were estimated to be sufferers of Type 2

Diabetes Mellitus by the year 2030. [5] 80% of the people affected by diabetes mellitus belonged to low income countries. [4]

Diabetes mellitus is a common disorder with concomitant oral manifestation that impacts dental care and there is concern about the ability of oral manifestations to profoundly affect metabolic control of the diabetes. [6] Oral complications such as gingivitis, periodontal diseases, dental caries and xerostomia are concomitantly prevalent in diabetic patients. [7] Altered buffering activity of the saliva due to decreased availability of the calcium and phosphate ions essential for the remineralization and increased availability of fermentable carbohydrates to oral bacteria, results in demineralization increasing their risk for developing new dental caries lesions are the outcomes of diabetes associated hyperglycaemia and hypo salivation. [8] Gingival recession in Periodontitis which is the major oral manifestation in the diabetes mellitus patients, [9] in turn leads to the exposure of the tooth surfaces resulting in root caries formation. Periodontitis is considered to be the sixth most common complication of Diabetes Mellitus. [10]

Minimal literature is available regarding the relationship between dental caries and Type 2 diabetic patients. Muhammed Jawed et al in 2012 had observed that higher DMFT scores were associated with decreased salivary flow rate and increased HbA1c values in Type 2 diabetic patients. [11] Previous studies had stated high risk of dental caries was observed in subjects with Type 2 diabetes than in normal subjects. [12] Hintao et al in 2007 had observed high risk for prevalence of root caries in Type 2 DM. [9] Hasaan G. Mohamed et al in 2013 had conducted a study to compare the oral health status among Type 2 diabetic patients and non-diabetic patients among Sudanese adults. They had observed that the oral diseases like chronic periodontitis, tooth mobility, furcation involvement and dental caries, were highly prevalent in Type 2 diabetic patients when compared to their non-diabetic matched controls. [13]

The aim of this study is to evaluate the effects of caries risk factors such as bacteriological counts, oral hygiene assessment, and frequency of daily sugar exposure on the caries experience among Type 2 diabetic and non diabetic individuals in Kanpur Population.

METHODOLOGY

Source of Data

A total of 100 patients with dental caries, in the age group 30-70 years who had visited the Department of Conservative dentistry and Endodontics, Rama dental college hospital and research center, Kanpur were included in this study. Out of these participants 53 were male and 47 were females, with 48 years being the mean age. After obtaining the ethical clearance from the institutional ethical committee and the signed informed consent by all the subjects participating in the study, the participants were further divided into two groups. 50 individuals with Type II diabetes mellitus patients undergoing treatment for the last five years were included in Group 1.After that a questionnaire will be given to the patient to obtain information regarding duration of the disease and the type of treatment received for the disease. Group 2 consisted of 50 non diabetic individuals who had no history of diabetes mellitus and had a fasting plasma glucose level <110 mg/dl. Information regarding the past medical history of each individual was obtained in order to rule out if the patients were suffering from systemic diseases other than Type II diabetes mellitus. The patients suffering from other diseases were excluded from the study.

Single investigator was assigned to examine the oral cavity of all the participants. All the participants of the study were asked to chew a standard paraffin wax tablet in order to stimulate the salivary flow, and then the volume of the saliva was collected for five minutes. After dispersing the salivary samples on the magnetic

agitator for 20s they were diluted in 0.05M phosphate buffer with 0.4% KCl (pH 7.1). 0.1 ml of this dilutes sample was plated on MSB agar for enumeration of Mutans Streptococcus and on Rogosa SL medium for Lactobacilli. These plates were incubated at 37ºC for 48 h. Total colony-forming units (CFU) with characteristic morphology of Mutans Streptococcus or Lactobacilli were counted. The colony densities were classified into three groups and scoring of the Bacteriological Colony counts was assigned: score 0 was assigned to 0 to 10^4cfu/ml - low risk, score 1-10^5cfu/ml, moderate risk and score 2 more than 10^5cfu/ml, High risk.

Oral hygiene status in all the subjects was evaluated using questionnaire regarding the current oral hygiene practices and plaque score. The plaque index (PI) of Silness and Loe was measured for 6 selected teeth. Missing teeth were not substituted. Silness and Loe index was recorded in all the subjects for the plaque score. A prospective 3 day dietary record is as a reliable method with minimal chance of missing the information and estimation of the error as compared to other techniques was used to assess the sugar intake in all the subjects participating in the study. A detailed dietary history of all the individuals was obtained by providing them with the diet dairy which was used to record the time and the average daily intake of food, beverages and snacks for three days. The frequency of daily sugar exposure was calculated based on exposure to any sugar containing foods at or between meals. Intra-oral examination was done and all the participants were instructed to fill up the food diary. A short interview with the participants was conducted after checking the dietary charts on the third day. Scores between 0, 1 and 2 were assigned describe the frequency of daily Sugar exposure (3 day dietary chart). Score 0 assigned to Excellent condition thus showing less frequency of intake of sugar, score 1 representing Good condition with frequency of sugar intake to be twice or three times and score2 representing the individuals to be in watch out zone with frequency of the sugar intake to be more than 3 times a day.

With the aid of an air syringe, mouth mirror and probe a single examiner had conducted clinical examination of the oral cavity for the occurrence of carious lesions in each individual. According to the recommendations of WHO for epidemiological surveys DMFT (decayed, missing, and filled) indexing system was conducted to measure the prevalence the dental caries in the individuals.

Statistical analysis

Statistical analysis was done using Statistical Package for the Social Sciences software version 21 .Standard descriptive statistics were applied in the analysis: mean median and min-max range for quantitative variables. Student's t test was used to compare the DMFT between diabetic and non-diabetic patients. Chi-square test and Pearson's correlation were used to evaluate the association between bacteriological counts, oral hygiene assessment, Silness and Loe index, Sugar frequency among the diabetic and non-diabetic participants. Statistical significance was set $p<0.05$.

RESULT

Out of the 100 adults of the Kanpur population, 50 individuals were Type II Diabetes mellitus patients with caries and 50 were non-diabetic patients with caries (fig - 1). In the overall sample 51% of individuals were susceptible for high caries risk with increased colony counts for Streptococcus Mutans whereas only 51% for moderate risk and 49% with low risk with lactobacillus colony counts (Fig 2).

Oral hygiene assessment in the overall population revealed that 89% of the them used tooth brush as a cleaning aid, 79% used tooth paste as material used for cleaning 50% showed twice brushing, 79% using medium type of tooth brush, frequency of changing a brush was observed in 69%, oblique brushing technique was observed in 50% of individuals and 56% used inter dental aids (Table-1).

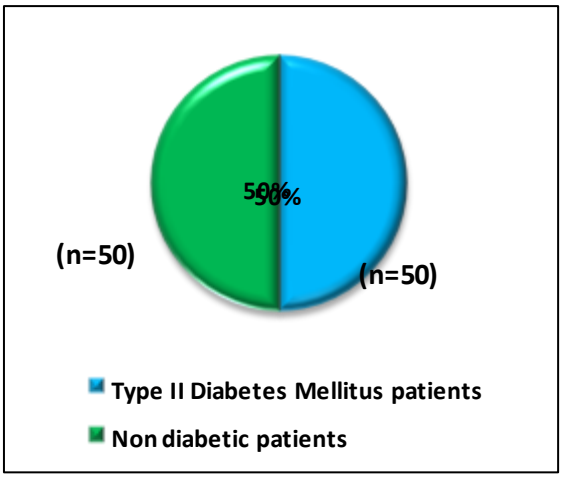

Figure -1

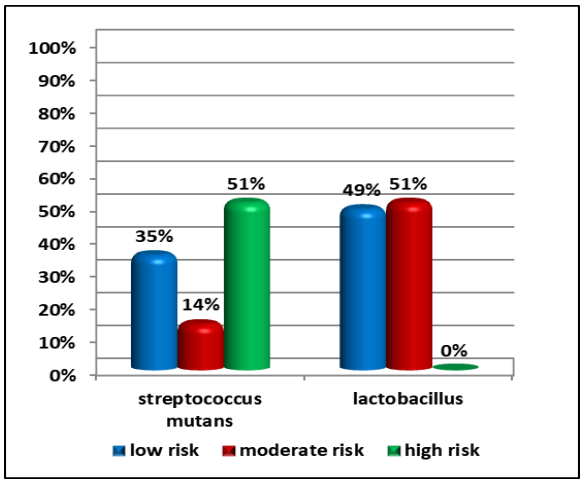

Figure-2

Table 1:

Oral hygiene assessment		Frequency	Percentage
Cleaning aid	Tooth brush	89	89.0
	Finger	11	11.0
Material used for cleaning tooth	Tooth paste	79	79.0
	Tooth powder	21	21.0
Frequency of brushing	Twice a day	50	50.0
	Once a day	49	49.0
	Don't brush everyday	1	1.0
Type of brush used	Soft	10	10.0
	Medium	79	79.0
	Hard	7	7.0
	don't know	4	4.0
Frequency of changing brush	Once in three months	69	69.0
	Once in 6 months	23	23.0
	When brush gets spoiled	8	8.0
Type of brushing	Oblique	50	50.0
	Straight	0	0.0
	Circular	3	3.0
	Oblique and straight	47	47.0
Use of interdental aids	Yes	56	56.0
	No	44	44.0

Silness and Loe indices in the overall population showed a distribution of low Silness and Loe indices scores depicting oral hygiene status as excellent in 40% for, good in 31% and fair in 29% (Fig 3). Sugar frequency in over all sample depicted that 32% excellent, 36% good and 32% watch out zone (fig 4).

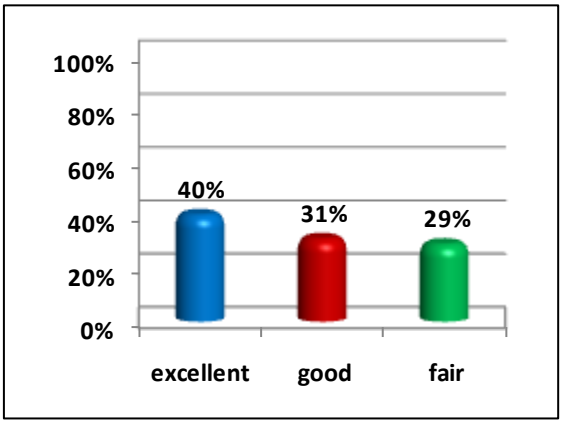

Figure 3: Silness and Loe

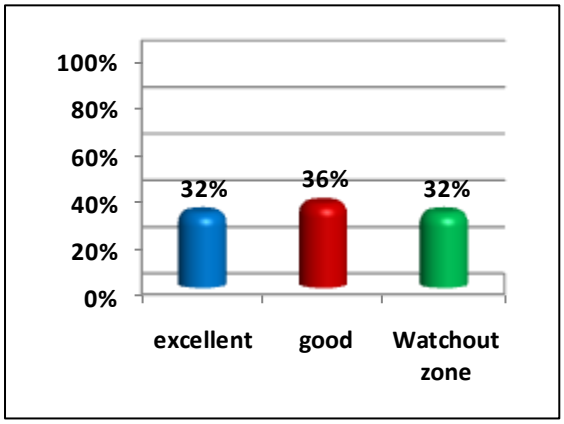

Figure 4: Sugar frequency

Type 2 diabetic patients showed statistically significant increase in the colony counts of Streptococcus mutans (90%) and Lactobacilli when compared to non-diabetic patients (Table-2) (Fig 2). The results of the oral health behavior questionnaire (Table-3) depicted high significant difference in distribution regarding (P<0.01),superior oral health habits such as twice a day of frequency of brushing, oblique and straight type of brushing and use of interdental aids were practiced more among the non-diabetic group in comparison to the Type 2 diabetes mellitus patients. No significant difference was observed in the results among the studied groups relating to the Cleaning Material used, Frequency of changing brush, and Type of brush used.

Table 2: using Chi-square test and Pearson's correlation

		Low risk	Moderate risk	High risk	P value	Pearson's correlation value
Streptococcus mutans count	**Diabetic**	**4%**	**6%**	**90%**	**0.001***	**0.866**
	Non diabetic	**66%**	**22%**	**12%**		
Lactobacillus count	**Diabetic**	**14%**	**86%**	--	**0.001***	**0.700**
	Non diabetic	**84%**	**16%**	--		

Table 3: using Chi-square test and Pearson's correlation

Oral hygiene assessment		Diabetic	Non Diabetic	P value	Pearson's correlation value
Cleaning aid	Tooth brush	53.9%	46.1%	0.025	-0.224
	Finger	18.2%	81.8%		
Material used for cleaning tooth	Tooth paste	51.9%	48.1%	0.461	-0.074
	Tooth powder	42.9%	57.1%		
Frequency of brushing	Twice a day	18%	82%	0.000	0.092
	Once a day	83.7%	16.3%		
	Don't brush everyday	0%	100%		
Type of brush used	Soft	50%	50%	0.151	0.094
	Medium	49.4%	50.6%		
	Hard	28.6%	71.4%		
	don't know	100%	0%		
Frequency of changing brush	Once in three months	50.7%	49.3%	0.971	-0.016
	Once in 6 months	47.8%	52.2%		
	When brush gets spoiled	50%	50%		
Type of brushing	Oblique	100%	0%	0.001*	-0.994
	Circular	0%	100%		
	Oblique and straight	0%	100%		
Use of interdental aids	Yes	9.1%	90.9%	0.001*	-0.725
	No	82.1%	17.9%		

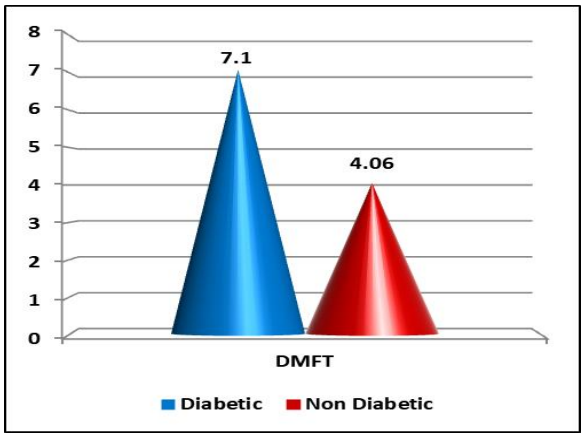

Figure 5: DMFT between diabetic and non diabetic using students t-test

Student's t-test showed a statistically significant high DMFT score in Type II diabetes mellitus (7.1) patients when compared to the non-diabetic individuals (4.6) thus revealing a high caries experience in Type 2 diabetes mellitus compared to non-diabetic inviduals (P =0.01) (Fig-5).

Type 2 diabetic mellitus patients had depicted a significantly higher mean plaque indices score with positive linear relationship was observed (r=0.814, p=0.001) then compared with non-diabetic patients, this resulting in an excellent oral hygiene in non-diabetic patients when compared to diabetic patients. Silness and Loe indices showed higher plaque scores in Type 2 diabetic mellitus patients than compared to non diabetic patients (Fig-6). Sugar frequency compared to diabetic and non-diabetic using Chi-square test depicted more number of non-diabetic individuals to be in watch out zone suggestive of higher

frequency of sugar intake then compared to Type 2 diabetes mellitus patients (Fig-7).

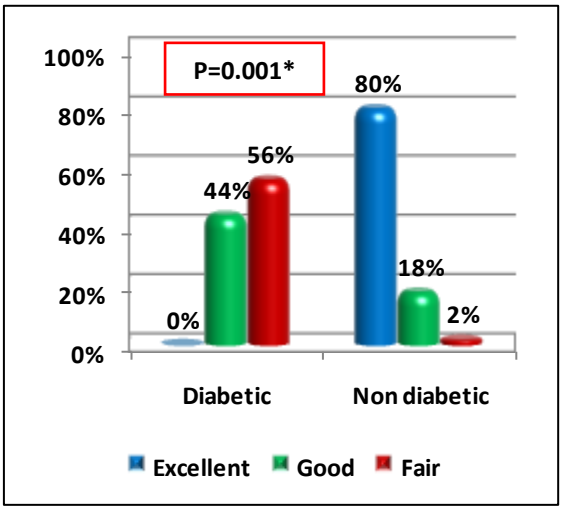

Figure 6: Silness and Loe compared to diabetic and non-diabetic

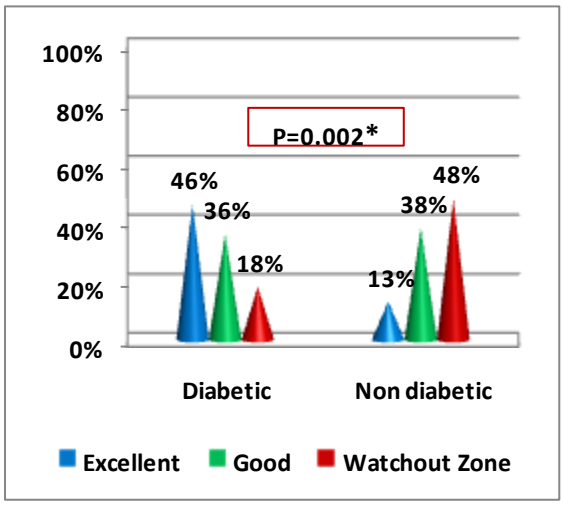

Figure 7: Sugar frequency compared to diabetic and non-diabetic
*Statistically significant

DISCUSSION

Diabetes mellitus is a chronic metabolic disorder affecting major population of the world. Xerostomia, dental caries, gingivitis and periodontal disease, burning mouth and candidal infections are the most prevailing oral manifestations8 a sign of impaired quality of life suggestive that diabetes has a major effect on the oral cavity. [14] Deficiency of insulin in these patients promotes the decreased salivary secretion and high glucose level in saliva directly leads to increased incidence of caries in diabetic patients. [15] Increased level of blood glucose and obesity are listed to be the first reasons among Adults of age above 30 years who were commonly affected by the type II diabetes mellitus. [16] Lin B P et al. reported that with increase in age of the patient, type II diabetes mellitus prevalence also increases. With increase in age the cemental caries tends to rise and on the other hand the enamel caries prevalence decreases with increase in age. Older diabetic patients are more prone to root surface caries. [17] Shu-Fen Chuang et al in 2004 had observed xerostomia due to their lower salivary pH results in high risk of developing dental caries in diabetic when compared to non diabetic uremic patients who are receiving the hemodialysis treatment. [18]

Present study had showed higher frequency of sugar intake in more number of non-diabetic individuals then compared to Type 2 diabetes mellitus patients.). In the present study high caries incidence was observed in Type II diabetes mellitus when compared to non-diabetic individuals. Various factors such as sugar intake contribute for a greater incidence of dental caries in diabetic patients. There is a complex relationship between the diabetes mellitus and dental caries. Lower sugar intake in a controlled diabetic patient, could result in a lower incidence rate of dental caries. [7] Incidence of caries was high among the Type 2 diabetes mellitus patients with the elevated blood sugar levels when compared to non-diabetic patients. [19] Increased frequency of sugar intake increases the oral microbiota that ferments these sugars into acids resulting in demineralization of the calcified tissues of the tooth resulting in dental caries. 50gms or 10teaspoons of sugar is the recommended daily intake of sugar by WHO, which aids in limiting epidemic of the dental caries. [20-22] In the present study among the type 2 diabetes mellitus patients though low frequency of sugar intake was reported high DMFT scores were recorded revealing high incidence of caries. [23-27] This high caries experience among Type 2 diabetic patients

can be explained due to various risk factors such as insufficient salivary flow and composition, increased bacterial population, less exposure to fluoride, improper maintenance of oral cavity, oral medications recession of gingiva, immunological factors and genetic factors. Gingival recession due to poor oral hygiene and loss of attachment due to periodontal diseases exposes the root surface to the oral environment resulting in root caries in the diabetic patient. [23,24] No association between poor glycemic control and increased prevalence of dental caries among type II diabetes mellitus was observed in a study conducted by Lin B P. These results can be due to the relatively smaller sample size with a control group was no significant difference between diabetic and non diabetic. [17] Similarly in a study conducted by Collin HL et al in the year 1998 where they had observed that there was no significant difference in dental caries experience, no association with the metabolic control of the disease, no change in microbes with the dental caries occurrence among both Type 2 diabetes mellitus patients and their control subjects. This study showed limited statistical power to detect the significance as this study was done with small sample size. [28]

Despite of intake of low cariogenic diet the high risk for caries might be due to higher frequency intake of sugary substances and xerostomia, thereby increasing the concentration of glucose in blood and saliva favoring the growth of oral microbiota thus enhancing the high caries risk potential in Type 2 diabetes mellitus9. These results are in accordance with the study conducted by Maria Moin and Aeeza Malik in 2015 in which 90% of type 2 diabetic patients had experienced high caries risk15. One more study showed that diabetics have higher DMFT values as compared to control group children18. Also a study demonstrated that diabetic patients have more active dental caries than control subjects. [29]

Saliva with its components like calcium, inorganic phosphorous, alkaline phosphates, immunoglobulins and salivary proteins plays a vital role in perpetuating the balance in the oral cavity. Alteration in the salivary components, buffering capacity, flow rate, viscosity and pH of the saliva in turn alters the microbial load of the oral cavity resulting in the demineralization of the enamel initiating the caries process. The present study demonstrated significant increase in the colony counts of Streptococcus mutans (90%) and Lactobacilli were observed in Type 2 diabetic when compared to non-diabetic patients (Fig 2) These results were in accordance with the study by Hinato2007 which had revealed a that higher prevalence of root surface caries was associated with the increase in Mutans streptococci and lactobacilli in type 2 diabetic subjects than non-diabetic subjects. [9] This can be attributed to the increased glucose level of the saliva which is in turn is directly related to the glucose concentration in serum. These elevated glucose levels in the saliva enhance the fermenting activity of the Mutans Streptococcus on the plaque adhering to the tooth structure. The endogenic bacteria principally include Streptococcus mutans, Streptococcus sobrinus, Lactobacilli species in the plaque biofilm produces organic acids derived from fermented carbohydrates of diet. This results in decrease in the critical pH in the oral cavity, which eventually lead to loss of mineral from the tooth structures. [23,30] The resultant failure of buffering action of saliva leads to the acidic oral environment which inhibits the reabsorption of minerals from saliva and ultimately resulting in cavity formation. [31]

Previous study had depicted improved oral health habits regarding brushing frequency and cleaning methods among the non-diabetic group in comparison to the diabetic patients with the oral health behavior questionnaire. These results from the previous studies were in accordance with the present study which showed a significant difference in distribution regarding ($P<0.01$), superior oral health habits such as frequency of

brushing such as twice a day of, oblique and straight type of brushing and use of interdental aids were practiced more among the non-diabetic group in comparison to the Type 2 diabetes mellitus patients. In the present study it was observed an poor oral hygiene in Type 2 diabetic mellitus patients as they had depicted a significantly higher mean plaque indices score (r=0.814, p=0.001) then compared with non-diabetic patients. [11] In a study conducted by Bakhshandeh S conducted a study in 2005 it was observed poor oral health with increased DMFT scores were found that in individuals with Type I diabetes as compared to those with Type II diabetes. [9,32]

CONCLUSION

In conclusion, within the limits of the present study a more complex relationship was observed between the type II diabetes mellitus and dental caries. In this study caries risk factors such as increased colony counts of Streptococcus mutans and Lactobacilli, a significantly higher mean plaque indices score with less oral hygiene habits being practiced led to high DMFT scores indicating high caries prevalence among Type 2 diabetic when compared to non-diabetic patients. Further studies, should be conducted in different countries, on different social and ethnic groups, will help in understanding how socio-economic background and ethnicity help determine the prevalence of dental caries in Type 2 diabetes mellitus.

REFERENCES

1. Ahmed AM. History of diabetes mellitus. Saudi Med J. 2002;23(4):373-378.
2. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care. 1997;20:1183–1197
3. Diabetes mellitus history- from ancient to modern times. Available at http:// science.jrank.org/pages/2044/Diabetes-Mellitus.html.
4. Global burden of diabetes. International Diabetes federation. Diabetic atlas fifth edition 2011, Brussels. Available at http://www.idf.org/diabetesatlas.
5. Chamnan P, Simmons RK, Forouhi NG, Luben R. KhawKy, Wareham NJ et al. Incidence of Type 2 diabetes using proposed HbA1c diagnostic criteria in the EPIC-Norflok cohort: Implication for preventive strategies. Available at http://care.diabetesjournal.org.
6. Leite R S, Marlow M N., Fernandes K J .Oral Health and Type 2 Diabetes.Am J Med Sci .2013 ; 345(4): 271–273.
7. Hawraa, KA. 2012. The relationship between the dental caries and the blood glucose level among Type II non insulin dependent diabetic patients. J BaghColl Dent. 2012;24:108–14.
8. Lamster IB, Lalla E, Borgnakke WS, Taylor GW.The relationship between oral health and diabetesmellitus. J Am Dent Assoc 2008; 139:19–24.
9. Hintao J, Teanpaisan R, Chongsuvivatwong V, Dahlen G, Rattarasarn C. Root surface and coronal caries in adults with Type 2 diabetes mellitus. Community Dent Oral Epidemiol. 2007; 35: 302–30
10. Loe H. Periodontal disease. The sixth complication of diabetes mellitus. Diabetes care. 1993; 16(1): 329–34.
11. Jawed M, Shahid SM, Qader SA, AzharA Dental caries in diabetes mellitus: role of salivary flow rate and minerals. J Diabetes Complications.2011;25(3):183–6 25: 183–186. 25.
12. Leung WK, Siu SC, Chu FC, Wong KW, Jin L. Oral health status of low-income, middle-aged to elderly Hong Kong Chinese with Type 2 diabetes mellitus. Oral Health Prev Dent .2008;6: 105–118.
13. Mohamed HG, Idris SB, Ahmed MF, Bøe OE, Mustafa K, et al.) Association between Oral Health Status and Type 2 Diabetes Mellitus among Sudanese Adults: A Matched Case-Control Study. PLoS ONE.2013;8(12): 82158.
14. Ira, B L. 2012. Diabetes and oral health-current concepts regarding periodontal disease and dental caries. US Endocrinol. 2012;8:93–7.
15. Maria Moin and Aeeza Malik. Frequency of dental caries and level of risk among Type II Diabetics. Dentistry. 2015; 5:10:1-5.
16. Alemzadeh, R. and Wyatt, DT.. Diabetes mellitus. In: Nelson Textbook of Pediatrics. Saunders, Philadelphia . 2004,590-593.

17. Lin, BP., Taylor, GW., Allen, DJ. and Ship, JA. Dental caries in older adults with diabetes mellitus. Spec Care Dentist. 1999, 19(1):8-14.
18. Shu-Fen Chuang, Junne-Ming Sung, Shih-Chen Kuo, JengJong Huang, and Su-Yuan Lee. Oral and dental manifestations in diabetic and nondiabetic uremic patients receiving hemodialysis. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics.2005,99(6):689-695.
19. Vasquez, MS. and Contreras, SS. Candida hyphas presence in adults with clinically healthy oral mucous. Rev EstomatolHerediana 2005, 15:5.
20. Marshall, T. Nomenclature, characteristics, and dietary intakes of sugars. The Journal of the American Dental Association. 2015, 146(1):61-64.
21. Moynihan, P. and Kelly, S. Effect on caries of restricting sugars intake: systematic review to inform WHO Guidelines. Journal of Dental Research. 2013,93(1):8-18
22. Sheiham, A. and James, W. A reappraisal of the quantitative relationship between sugar intake and dental caries: the need for new criteria for developing goals for sugar intake. BMC Public Health.2014, 14(1):863.
23. Featherstone, JD., Adair, SM., Anderson, MH., Berkowitz, RJ., Bird, WF., Crall, JJ., et al. Caries management by risk assessment: consensus statement. 2002. J Calif Dent Assoc. 2003 Mar,31(3):257-69.
24. Krol, DM. Dental caries, oral health, and pediatricians. CurrProblPediatrAdolesc Health Care. 2003 Sep, 33(8):253-70.
25. Anderson, M. Risk assessment and epidemiology of dental caries: review of the literature. Pediatr Dent. 2002, 24(5):377-85.
26. Hassell, TM. and Harris, EL. 1995. Genetic influences in caries and periodontal diseases. Crit Rev Oral Biol Med. 1995, 6(4):319-42.
27. Thomson, WM. Dental caries experience in older people over time:what can the large cohort studies tell us? Br Dent J. 2004 Jan 24,196(2):89-92.
28. Collin, HL., Uusitupa, M., Niskanen, L., Koivisto, AM., Markkanen, H.and Meurman, JH. Caries in patients with non-insulin-dependent diabetes mellitus. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998 .Jun,85(6):680-5.
29. Lopez M E et al. A. Salivary characteristics of diabetic children: Brazilian Dental Journal 2003;14:1
30. Caufield, PW. And Griffen, AL. Dental caries. An infectious and transmissible disease. PediatrClin North Am. 2000 Oct, 47(5):1001-19.
31. Selwitz, RH., Ismail, AI. and Pitts, NB. 2007. Dental caries. Lancet. 2007 Jan 6,369(9555):51-9.
32. Bakhshandeh, S., Murtomaa, H., Vehkalahti, MM., Mofid, R. and Suomalainen, K. Dental findings in diabetic adults. Caries Res. 2008,42(1):14-8.

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