



## RESEARCH ARTICLE

### PREVALENCE OF GINGIVITIS AND PERIODONTITIS AND A SIGNIFICANT TOOTH LOSS IN DIABETIC FEMALES OF HAIL REGION IN SAUDI ARABIA

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#### ABSTRACT

Obesity and cases of diabetes are rising in the adult male and female Saudi population. According to the WHO 2014 World Health ranking survey Saudi Arabia was ranked 27<sup>th</sup> in coronary heart disease (CHD) related deaths, and, according to the same survey, diabetes was the fourth leading cause of death in Saudi Arabia. Association between uncontrolled diabetes and periodontitis has been very well established. Patients with diabetes have been shown to have higher incidences of periodontitis. Especially in diabetic patients with poorly controlled blood sugar (glucose) levels. For the current study we selected 114 non-diabetic control females with age range of 14-75 years (mean age 33.82 years) and 204 diabetic females with the age ranging between 15-86 years (mean age 48.3 years). 95% of our female diabetic patients had gingivitis and 65% of the patients showed cases of chronic periodontitis. Further analysis of our results showed 27.2% of tooth loss among these patients. Statistical analysis of data showed overall a significant increase in cases of periodontitis and percent tooth loss in diabetic females (at  $p < 0.05$ ) as compared to the control group. Additionally, in control females 0.87% subjects had 100% tooth loss as compared to 4.41% of diabetic patients with total (100%) teeth loss. Further analyses of our results show 6.14% incisors were lost in the control group while 15.3% incisors were lost among the diabetic females. Similarly, in diabetics 10.29% canine teeth were missing as compared to the 5.04% canine missing among the control female subjects. In our survey we also found significantly higher number of premolars and molars lost among both the groups. In the control group 14.14% premolars were lost while 25.85% premolars were missing among the diabetic females. Finally, we found 29.45% of molars were missing from among the control subjects while 41.74% molars were found to be missing from among the diabetic females. In summary, in our female community oral hygiene survey in Hail region of Saudi Arabia, we found statistically no significant difference in the cases of gingivitis between the control and the diabetic female group at  $p < 0.05$ . However, we found a significant increase in the cases of chronic periodontitis and tooth loss (incisors, canine, premolars and molars) in the diabetic female population (at  $p < 0.05$ ) as compared to the randomly selected female control group.

**Key words:** Dental caries, diabetes mellitus (T2DM), HbA1c, Obesity, gingivitis, periodontitis, incisors, canine, premolar, molar teeth loss

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#### INTRODUCTION

According to the World Health statistics 2017 report, in 2015 the life expectancy in Saudi Arabia at birth was 73.2% for the male population and 76% for the female population. Combined life expectancy for both sexes was 74.5%. However, according to the same survey, the probability of dying in Saudi Arabia from any of the CVD, cancer, diabetes, and the CRD diseases, between the age 30 and age of 70 was 16.4%, which was almost twice as high when compared to the population of Norway (9.6%) and almost half as compared to the Mongolian population (29.9%). Globally, every year some 1.6 million deaths are attributed to diabetes.

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According to the WHO updates, one in three adults over the age of 18 years is overweight and one in ten is obese. If obesity is not controlled it can lead to many diseases such as diabetes and many other health complications. Globally, cases of diabetes are rapidly rising, and WHO projects diabetes to become the seventh leading cause of death by 2030. In a recent 2017 survey, Saudi Arabia was ranked seventh in prevalence of diabetes. It is long known that severe consequences of diabetes can be either delayed or avoided if one chooses to carefully select his or her diet, is involved in regular physical activity, and gets regular screening and treatment for diabetic complications (WHO November 2017 update). If diabetes remains uncontrolled, it can eventually lead to damage to the blood vessels, nerves and many organs such as the kidneys, the heart, and the eyes, eventually leading to blindness. In a recent

International Diabetes Federation (IDF) country ranking survey, in 2017, Saudi Arabia was ranked seventh in the prevalence of diabetes (IDF 2017 survey, Index mundi 2017). It is widely known that, in women, due to the frequent changes in hormonal levels at various stages of their lives such as when they attain puberty, during their menstruation cycle, when they are pregnant and on attaining their menopause, they are considered to be more susceptible to many health risks such as heart disease, diabetes and even certain types of cancers. We and others have recently reported rapidly rising rates of obesity (Farshori *et al.*, 2015, Hazmi and Warsy 1997), prevalence of diabetes in adult males (Alqurashi *et al.*, 2011, Farshori *et al.*, 2016, Suhad Bahijri *et al.*, 2016) and adult females (Alqurashi *et al.*, 2011, Farshori *et al.*, 2017) in the Saudi population. It is well established that uncontrolled obesity due to lack of exercise and/or poor diet selection may eventually lead to type II diabetes (T2DM). And if blood sugar levels and, thus, diabetes is not properly regulated, it can eventually cause serious complications such as many types of cancers, heart disease, and even renal failure. In addition to the above mentioned health problems, women are also susceptible to many oral diseases such as dental carries and periodontitis. A very poorly maintained oral hygiene can lead to gingivitis, and eventually severe periodontitis and major tooth loss (Schulze and Busse, 2016). Although bacteria are considered to be one of the major causes of periodontitis, many other factors such as diabetes, smoking, and genetics may also play a significant role (Al Ghamdi 2009). Poor oral hygiene during pregnancy (Fawzia A. Habib, 2009), smoking, and diabetes can contribute to the enhancement of gum disease. We have previously reported high rates of smokers in Saudi youths and their parents (Ibrahim Khalil al Ibrahim *et al.*, 2015) and a high prevalence of diabetes in the non-college educated Saudi adult male (Farshori *et al.* 2016) and the female adult population (Farshori *et al.*, 2017). In our community survey of young female adults (n=394), we found a low prevalence of diabetes among the young educated adults (4.6%). In contrast, this eye-opening survey revealed an overwhelming percentage of one or both parents (91.8%) having diabetes (Farshori *et al.*, 2017). Since smoking and diabetes both are the major contributors to gum disease, and since both are more prevalent in Saudi Arabia (as we and others have previously reported), we decided to look at the prevalence of gum disease chronic periodontitis and percent and type of tooth loss in randomly selected control non-diabetic population and compared its prevalence and severity with diabetic Saudi female patients of Hail region in Saudi Arabia.

#### **Aim of this study**

According to the 2014 World Health ranking survey, diabetes was the fourth leading cause of death in Saudi Arabia (WHO, 2014 World Health Survey). Additionally according to the global report on diabetes by World Health Organization (WHO), in 2014, some 422 million adults had diabetes. According to International Diabetes Federation (IDF), 3 countries of MENA region are among the top 10 nations in the prevalence of diabetes (Qatar is ranked 7<sup>th</sup>, Saudi Arabia is ranked 8<sup>th</sup>, and Kuwait was ranked 9<sup>th</sup>). Since we (Farshori *et al.*, 2017) and others have previously reported very high rates of diabetes in Saudi adult female population (Alqurashi *et al.*, 2011, Alotaibi *et al.*, 2017, Farshori *et al.*, 2017), in this study we decided to further look at the consequences of diabetes on the general oral hygiene of a female diabetic population as compared to the randomly selected non diabetic control population.

#### **Study Design**

In this case control study, we performed oral exams on 114 randomly selected non-diabetic control female subjects and compared their oral hygiene with 204 diabetic female patients. During the exams of their oral cavity, we looked for signs of smoker's teeth, dental carries, tooth decay, tooth loss, presence of gingivitis, and/or presence and severity of periodontitis. Thorough oral exams of female community were performed by female interns of College of Dentistry in dental clinics of University of Hail.

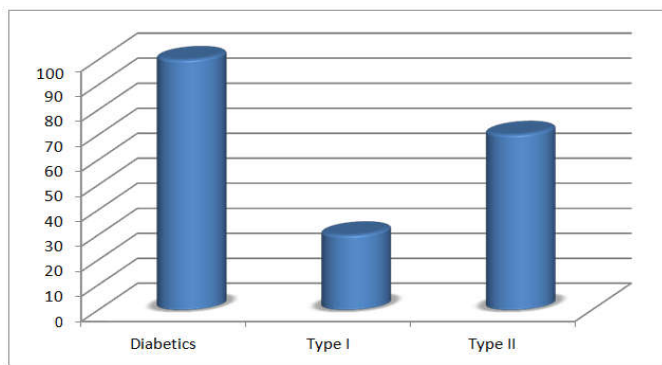
#### **METHODS**

Oral exams were performed carefully and thoroughly (under the strict supervision of qualified college of dentistry faculty members) by the 5th year female dental students and the female interns of College of Dentistry at University of Hail (UOH) on 114 randomly selected female non-diabetic control group followed by equally thorough oral exams on 204 T2DM female patients who were enrolled at the dental clinic of College of Dentistry. We especially looked for the presence of dental carries (tooth decay and appearance of cavities), signs of gingivitis and periodontitis. Additionally, tooth decay and the number and type of tooth loss was also recorded. Diagnostic instruments were used to check the oral cavities of random control and diabetic female patients for any carries, lesions, missing teeth, dental fluorosis, also known as mottled enamel, or other oral findings and dental prop to measure the pocket and check the clinical attachment loss. Dental charting was done at UOH dental clinic.

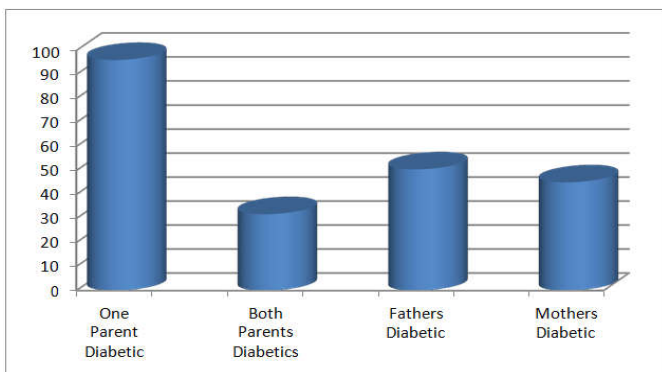
#### **RESULTS**

##### **Prevalence of diabetes Type I and Type II in female population**

According to the 2017 WHO diabetes updates, cases of diabetes have increased from 108 million in 1980s to 422 million adults in 2014. Since cases of diabetes have risen dramatically in Saudi Arabia also, especially in the female population, for this study we selected 204 female diabetic patients. Out of these, 29.1% had diabetes type I and 70.9% were type II diabetes (T2DM) patients (Figure 1). Through a questionnaire, these diabetic female subjects were asked about the prevalence of diabetes in their immediate family members especially one or both of their parents. Results we received were quite alarming. A high percentage of their parents were also found to be diabetics. 50.5% of our diabetic female subjects had diabetic fathers and 45.58% of their mothers were diabetics. In 31.8% of our diabetic subjects, both of their parents were found to be diabetic (Figure II). Previous studies (Alqurashi *et al.*, 2011) have also shown prevalence of diabetes in Saudi community. Recently we also reported the similar community survey findings for our adult male (Farshori *et al.* 2016) and the female adult population (Farshori *et al.*, 2017). However, in the current community survey, we found the percentage of both parents diabetic (31.8%) to be drastically higher (3.9 fold higher) than our previously reported findings (Farshori *et al.*, 2017). Additionally, 96% of our diabetic subjects reported to have at least one diabetic parent (Figure 2).



**Figure 1. Prevalence of diabetes Type I and Type II in Saudi adult female population. 29.1% of our female subjects had diabetes type I and 70.9% were type II diabetes patients**



**Figure II. Prevalence of diabetes Type I and Type II in female patients' parents. 50.5% female diabetic subjects had diabetic fathers and 45.58% of their mothers were also diabetics. In 31.8% of our diabetic subjects both the parents were diabetics**

Since it is already well known that diabetes is rapidly rising in Saudi Arabia (Alqurashi *et al.*, 2011) and other Middle Eastern countries of MENA region (WHO 2017 updates), and since not too many studies have been done to look for the oral health among diabetic females, we next decided to look at the consequences of diabetes on the oral health of the female adult community of Hail region in Saudi Arabia. We especially looked for prevalence of gingivitis and chronic periodontitis in non-diabetic control population and compared it with the prevalence among the female diabetic patients. Additionally, we looked for oral cavities, any caries, lesions, missing teeth, and dental fluorosis, also known as mottled enamel.

#### **Comparison of Prevalence of Gingivitis and Periodontitis between the non-diabetic and diabetic female patients:**

We next performed detailed oral exams on 114 randomly selected non-diabetic female subjects ranging in age from 14-75 years (mean age 33.8 years). 89.5% of the randomly selected control females showed signs of gingivitis (102 out of 114) and 31.6% had moderate to severe case of periodontitis (36 out of 114 subjects). Additionally, the control population also showed almost 17% of tooth loss (Table, I, Figure III) with 83.03% remaining intact teeth. Only 18.42% of the control female subjects showed 100% intact teeth (no tooth loss) while 0.87% subjects showed a complete tooth loss (100% tooth loss, Figure 4).

**Table 1. Control Female profile**

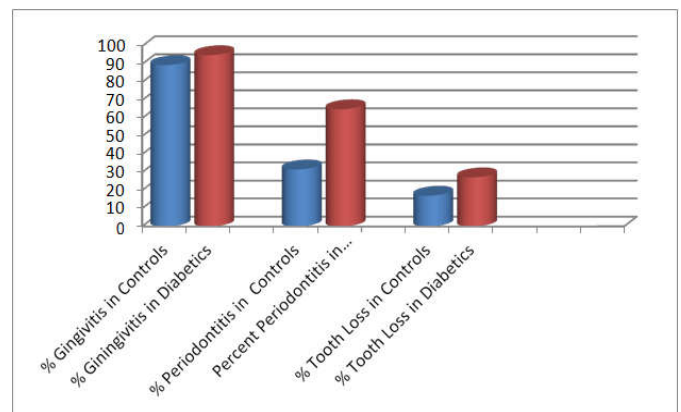
Number (n)	Age Range	Mean Age	Gingivitis (%)	Periodontitis (%)	Tooth Loss
114	14-75 years	33.82 years	89.5 %	31.6 %	17%

In comparison to the control population, we found 95% of the diabetic female patients with gingivitis and 65% of them had severe cases of periodontitis (Table 2 and Figures 3). Statistical analysis using the Z calculator for two population proportions revealed no significant difference in prevalence of gingivitis between the control and the female diabetic patients at  $p < 0.05$ . The Z-score was -1.846 and the p-value was .0643.

**Table 2. Diabetic Female patient profile**

Number (n)	Age Range	Mean Age	Gingivitis (%)	Periodontitis (%)	Tooth Loss
204	15-86 years	48.28 years	95 %	65 %	27.2%

However, in diabetic females we found a statistically significant increase in the cases of severe chronic periodontitis as compared to the control populations at  $p < 0.05$  (Table 2, Figure III). The Z-score was -5.723. Additionally, we found a significant increase in teeth loss in the diabetic female population (Table II) as compared to the randomly selected non-diabetic population at  $p < 0.05$  (Figure III). The Z-score was -2.055 and p-value was .0394. These results clearly show a statistically significant increase in the cases of chronic periodontitis and a significant increase in tooth loss among the female diabetic patients as compared to the female control population.

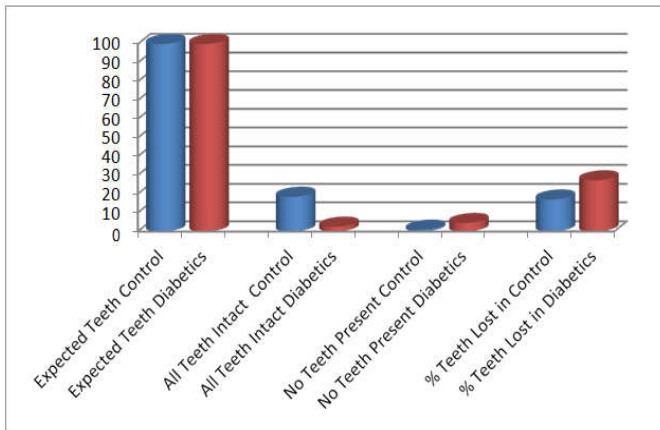


**Figure 3. Comparison of prevalence of gingivitis, periodontitis and the percent tooth loss in non-diabetic controls and the female diabetic patients**

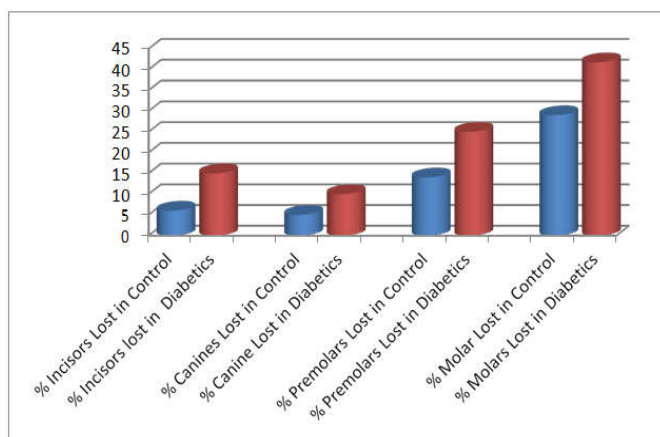
#### **Comparison of incisors, canine, premolars or molar tooth loss between the non-diabetic controls and the female diabetic patients**

Since, in our community survey we found a significantly increased tooth loss among the diabetic female population as compared to the control group, next we wanted to know the percentage of subjects with hundred percent intact teeth. We found 18.42% of the control subjects with all the teeth intact while among the diabetics only 5 out of 204 patients (2.45%) had full hundred percent intact teeth (Figure 3 and 4). Next, we decided to look at the type and percent of tooth loss in our female subjects. As stated above, overall there was a statistically significant increase in total tooth loss among the diabetics as compared to the control group. In control group, only 0.87% subjects had lost all teeth as compared to the 4.41% among the diabetics (Figure V). Further analysis of our results revealed 6.14% incisors were lost in the control subjects as compared to the 15.3% incisor loss among the female diabetic patients. Additionally, among the diabetics, 10.29% canine teeth were also missing as compared to the 5.04% canine

missing among the control group. In our survey, we found as compared to incisors and canine there was significantly higher number of premolars and molar loss among both the groups. In control females 14.14% premolars were missing while 25.85% premolars were missing among the diabetic females. Likewise, we found 29.45% of molars missing among the control group while 41.74% molars were found to be missing among the diabetic females (Figure 5).



**Figure 4.** Comparison of percent of subjects with all teeth intact, complete teeth loss and or percent teeth loss in the non-diabetic controls and the female diabetic patients



**Figure 5.** Comparison of percent incisors, canine, premolars or molar teeth loss in non-diabetic controls and the female diabetic patients

#### Representative photographs of community survey of control and the diabetic male and female Saudi population

Figure 6 shows a photographic representation of male and female Saudi population with prevalence of gingivitis, periodontitis and the significant tooth loss in the diabetic male (Figure 6 B) and the female patients (Figure 6 D) as compared to the randomly selected nondiabetic male and the female controls Figure 6 A & C). Figure 6A, represents a control male non-smoker Saudi youth with all intact and healthy teeth with no sign of gingivitis or periodontitis. Figure 6B, shows a 57 year old male diabetic patient with periodontitis. He lost most of his lower premolars except the tooth number 45. Additionally, he lost all lower molars and all the upper molars except tooth number 16. Figure 6C, shows the oral cavity of a 35 year old non-diabetic female with gingivitis and number 24 root fragments. Figure 6D is a photographic representation of a 49 year old diabetic female with clear signs of a chronic periodontitis. She has three root fragments (numbers 11, 21,

and 26). She has mobility grade three in tooth number 23. She lost most of her molars except tooth number 26. Additionally, she lost teeth number 12, 22, 24 and number 25. Our results suggest majority of diabetic patients to have poor dental health when compared with a non-diabetic female control group. In general, we also found a poor dental hygiene among the control group.



**Figure 6.** Photograph showing prevalence of gingivitis, periodontitis and the significant tooth loss in the diabetic male (B) and the female patients (D). Photographs A and C show a representative control male (A) and female (C) from our community survey

#### Statistical Analysis of prevalence of gingivitis, periodontitis and tooth loss in control and the diabetic female population

We used a Z score calculator for the two population proportions (two tailed hypothesis) to determine if there was a significant difference in the prevalence of gingivitis, periodontitis and tooth loss between the adult female control subjects and the diabetic female population. Our results showed prevalence of gingivitis in both the control and diabetic population. However, it was not significantly different at  $p < 0.05$ . Our p value was 0.064 and the Z-score was -1.846. Next, we used the same calculator to compare the prevalence of periodontitis between the two populations. Our results show significant statistical difference in the prevalence of periodontitis between the control and diabetic population at  $p < 0.05$ . The Z score was -5.72 and the p-value was 0. We also found a significant difference in the percent tooth loss between the control and diabetic female population at  $p < 0.05$ . The Z score was -2.055 and p value was 0.0394. Percentage of control population with 100% intact teeth was also significantly higher than the diabetic female population at  $p < 0.05$ . The Z-score was 5.20 and the p value was 0. On the contrary the percentage of control population with complete tooth loss was not significantly (lower) than the diabetic female population at  $p < 0.05$ . The Z-score was 1.735 and p value was 0.081. Next, we compared the specific type of tooth loss between control versus diabetic female population. We found a significant increase in incisor tooth loss among the diabetic female population as compared to the control population at  $p < 0.05$ . Z score was -2.388 at p value of 0.0168. However, there was no significant increase in the canine teeth loss among the diabetics as compared to the controls at  $p < 0.05$ . The Z- score was -1.557 and the p value was .118. Next, we found a statistically significant increase in premolar teeth loss in diabetic females as compared to the control group at  $p < 0.05$ . Finally, we looked at the statistical difference in molar teeth loss among diabetics as

compared to the females. Like incisors and premolars, we again found a significant increase in molar tooth loss among the diabetic females as compared to the control group  $p < 0.05$ .

## DISCUSSION

According to the WHO's 2014 World Health Ranking Survey, diabetes mellitus was the fourth leading cause of death in Saudi Arabia. Association between uncontrolled diabetes and periodontitis has been very well established. Patients with diabetes have been shown to have higher incidences of periodontitis, especially in the subjects with poorly controlled blood sugar (glucose) levels. In our community survey of female diabetic patients, we found diabetes II to be more prevalent as compared to Type I diabetes. 29.1% our female subjects had diabetes type I and 70.9% were type II diabetes patients (Figure 1). In this survey we also found a very high percentage of adult parents (mothers and fathers) of our diabetic subjects to be diabetic also (Figure 2). Women are susceptible to gum diseases especially during their pregnancies (Fawzia Habib, 2009, Naseem *et al.*, 2016), due to variations in their hormonal levels. Poor oral hygiene during the pregnancy (Fawzia Habib, 2009), smoking, and diabetes can also contribute to the enhancement of gum diseases. Gum disease at an early stage is referred to as the gingivitis. However, if gingivitis is left untreated, it can eventually develop into periodontitis, a more serious disease. In periodontitis, the inflamed gums start separating from the teeth, thus creating small pockets or cavities sufficient for the bacteria to start growing and causing many symptoms that are known to be associated with the disease, such as bleeding, swelling of the gums, difficulty in chewing, and loose teeth.

As expected, we found high rates of gingivitis and periodontitis among the female diabetic patients. Since we and others have previously reported higher rates of diabetes in the Saudi female population (Alqurashi *et al.*, 2011, Alotaibi *et al.*, 2017, Farshori *et al.*, 2017) and since earlier studies (Pucher and Stewart, 2004) have suggested a greater risk of developing the periodontitis in diabetic patients, it did not come as surprise to us to see the higher incidences of gingivitis and periodontitis among the diabetic female Saudi population. However, what we found surprising was a very high percentage of gingivitis and periodontitis in the randomly selected predominantly non-diabetic control group (Figure III, Table I). We found 89.5% of the control females with gingivitis while 31.6% showed moderate to severe cases of periodontitis. In comparison, we found 95% of the diabetic patients showing signs of gingivitis; however, we found drastically higher percentage (65%) of the female diabetic patients with severe cases of periodontitis (Table II and Figures III). Although there was no significant difference in the cases of chronic gingivitis between the two populations, our results did suggest an unhealthy oral hygiene even in general non-diabetic control population. We also found a statistically significant increase in the cases of severe chronic periodontitis among the female diabetic patients as compared to the female control group (Table, Figure III). Recent studies have shown that poorly maintained oral hygiene can cause gingivitis, eventually chronic periodontitis and tooth loss (Schulze and Busse, 2016). Although bacteria are considered as the major cause of periodontitis, other factors such as smoking, diabetes, and genetics are also known to play a significant role (Al Ghamdi 2009). In the current study, we also found a significant increase in the tooth loss among diabetic patients. The control subjects showed 17% of tooth loss (Table I) with

83.03% remaining intact teeth, with only 18.42% of the control population showing 100% intact teeth or no tooth loss, and only 0.87% subjects showing a complete tooth or 100% tooth loss (Figure 4). In contrast, our community survey of diabetic females showed a significant increase in tooth loss (27.2%) as compared to the control group (Tables I & II, Figure 4). Additionally, 18.4% of the female control subjects had 100% teeth intact while only 2.45% of the female diabetic subjects had 100% intact teeth (Figure 4). These results suggest a statistically significant decrease ( $p < 0.05$ ) in maintaining the hundred percent intact healthy teeth in the diabetic population.

Next, we looked in more details to find out the specific type and percentage of the tooth loss in our control subjects and compared it to our female diabetic patients. Overall, as expected, we found a statistically significant increase in the total tooth loss among the diabetics as compared to the control group at  $p < 0.05$ . In the control group only 0.87% subjects had lost all their teeth as compared to the 4.41% among the female diabetic patients (Figure 5). Overall, our community oral hygiene survey revealed canines to be the least lost teeth among both the groups (control and diabetic females), and molars were the most lost teeth among both groups. However, in every case, the diabetic patient had statistically higher tooth loss of incisors, canine, premolars and the molars as compared to the females in the control group (Figure 5). Our results clearly suggest that female diabetic patients are at much higher risk of losing teeth. However, we found a significant tooth loss among the general control female population as well (Figure 5). Earlier studies have shown an association between poor glycemic controls and elevated levels of gingival crevicular fluid levels of interleukin 1 beta (GCF IL-1 beta) (Engebreston *et al.*, 2004). The current study on Saudi female diabetic patients oral health supports the hypothesis that hyperglycemia due to poorly maintained blood sugar levels may be one of the causes of dramatic rise in the cases of chronic periodontitis (Figure 3) and increased tooth loss as compared to the female non diabetic control subjects (Figures 4, 5). We have recently shown a close association between the prevalence of diabetes and the inheritance of ABO and the Rh blood groups in male and female Saudi diabetic patients (Farshori *et al.*, 2016, 2017). We found statistically higher incidences of diabetes mellitus in the males with B<sup>+</sup> blood group and a very high resistance or low incidences of diabetes mellitus in Rh<sup>-</sup> male patients (Farshori *et al.*, 2016). Similarly, in our recently published studies on Saudi female diabetic patients, we also found a statistically significant decrease in the cases of diabetes in Rh<sup>-</sup> female patients as compared to the control group (Farshori *et al.*, 2017). Currently, studies are underway to look at correlation, if any, between the inheritance of ABO and Rh blood groups antigens and prevalence of periodontitis in the male and female Saudi population. Although earlier studies have shown an association between the inheritance of ABO blood groups and the severity of chronic periodontitis, results of these studies have not been consistent (Kaslik *et al.*, 1980, Demir *et al.*, 2007, Gautam *et al.*, 2017, AL-Ghamdi 2009).

## Conclusion

Our studies found a high prevalence of gum disease in the general female population. A high percentage of non-diabetic control groups showed prevalence of gingivitis and chronic periodontitis, although the incidences of periodontitis were more than doubled (65%) in female diabetic patients as compared to the control group (31%). We also found

statistically significant increase in percent tooth loss among the diabetics (27.2% tooth loss) as compared to the control group (17%). In the female control group survey, 18.42% subjects had full 100% intact teeth as compared to only 2.45% among the diabetic patients. In contrast, in the control group, only 0.87% subjects lost all the teeth as compared to 4.41% in the diabetic group. We found the loss of incisors, canine, premolars and molars to be statistically higher in the female diabetic patients as compared to the control subject; however, in comparison to the loss of incisors and the canines in both groups, we found significantly higher number of premolars and molar teeth loss among both the groups. In conclusion, our studies suggest an immediate need of raising awareness regarding the importance of good dental hygiene among the general Saudi female population, and special attention should be given towards the overall health of diabetic female patients. Local libraries can organize periodic seminars for raising awareness about affects of diabetes control of on oral health of local population.

**Conflict of interest:** Authors of this study have no conflict of interest.

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