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Investigation of the Relationship Between Dental Caries Prevalence and Type 2 Diabetes Mellitus: A Cross-Sectional Study

Diş Çürüğü Prevalansının Tip 2 Diyabet ile İlişkisinin İncelenmesi: Bir Kesitsel Çalışma

ABSTRACT

Objectives

Type 2 Diabetes Mellitus (T2DM) is associated with various oral complications. The aim of this study is to investigate the prevalence and severity of dental caries in patients with T2DM compared to systemically healthy controls.

Material and Methods

This cross-sectional study included 100 participants (50 T2DM patients and 50 healthy controls) aged 35-65 years who applied to the Restorative Dentistry Clinic of Akdeniz University Faculty of Dentistry between 2019 and 2023 and were diagnosed with caries. The ages and genders of healthy individuals were matched with diabetic individuals to be the same for each patient. Dental caries was assessed using DMFT (decayed, missing, filled teeth) index through panoramic radiography. The experimental part of the study was conducted by 2 experienced restorative dentistry specialists to ensure standardization. Panoramic radiographs were viewed on a computer screen in a dark room at x3.5 magnification. Before the evaluation, physicians were informed to read the criteria determined on the panoramic radiography in the same way, and then the evaluation was made by taking the common opinion of two experts. All teeth except third molars were included in the study. Statistical analysis was performed using 2-way ANOVA to evaluate the effects of group and gender on dental parameters, with a significance level set at $P < 0.05$.

Results

When patients with T2DM and non-diabetes were compared, the prevalence of caries was found to be higher in patients with diabetes ($P < 0.001$). No significant difference was found between the 2 groups in the number of existing teeth in the mouth ($p = 0.106$) but not the number of restorations ($p = 0.003$). When comparing between groups, no significant difference was found based on gender and age.

Conclusion

Patients with T2DM demonstrate significantly higher dental caries prevalence and severity compared to healthy controls. These findings underscore the critical importance of implementing comprehensive preventive dental strategies and establishing integrated medical-dental care protocols for diabetic patients.

Key Words

Diabetes mellitus, Dental Caries, Oral health

ÖZ

Amaç

Tip 2 Diyabet (T2DM), çeşitli oral komplikasyonlarla ilişkilidir. Bu çalışmanın amacı, T2DM'li hastalarda diş çürüğünün yaygınlığını ve şiddetini sistemik olarak sağlıklı kontrollerle karşılaştırmaktır.

Gereç ve Yöntemler

Bu kesitsel çalışmaya 35-65 yaş aralığında 100 katılımcı (50 T2DM hastası ve 50 sağlıklı kontrol) dahil edildi. Retrospektif olan bu çalışmada, 2019-2023 yılları arasında Akdeniz Üniversitesi Diş Hekimliği Fakültesi Restoratif Diş Tedavisi Kliniğine başvuran ve çürük tanısı konulan hastalar arasından tip 2 diyabetli 50 birey ve sistemik olarak sağlıklı 50 birey rastgele seçildi. Sağlıklı bireylerin yaşları ve cinsiyetleri, her hasta için aynı olacak şekilde diyabetli bireylerle eşleştirildi. Diş çürükleri panoramik radyografi aracılığıyla DMFT (çürük, eksik, dolgulu dişler) indeksi kullanılarak değerlendirildi. Her iki grupta da bireylerdeki çürük diş sayısı belirlendi. Çürük değerlendirilmesinde mine, dentin ve sementte gözlenen çürük lezyonu diş için pozitif bulgu olarak kabul edildi. Çalışmanın deneysel kısmı standardizasyonun sağlanması için deneyimli iki restoratif diş tedavisi uzmanı tarafından yapıldı. Panoramik radyografiler bilgisayar ekranında, karanlık bir odada x3.5 büyütmede incelendi. Değerlendirilme öncesi panoramik radyografi üzerinde belirlenen kriterlerin aynı şekilde okunması için hekimler bilgilendirildi ve daha sonra iki uzmanın ortak görüşü alınarak değerlendirilme yapıldı. Üçüncü molar dişler hariç tüm dişler çalışmaya dahil edildi. İstatistiksel analizlerde parametrik yöntemler kullanılmıştır. Grup (diyabetik/sağlıklı) ve cinsiyetin dental parametreler üzerindeki etkilerini değerlendirmek amacıyla iki yönlü ANOVA uygulanmıştır. $P < 0.05$ değeri istatistiksel anlamlılık düzeyi olarak kabul edilmiştir.

Bulgular

Tip 2 diyabetli ve diyabetli olmayan hastalar karşılaştırıldığında çürük görülme prevalansı diyabetli hastalarda daha yüksek bulundu ($P < 0.001$). İki grup arasında ağızda mevcut diş sayısı ($p = 0.106$) ve restorasyon sayısı ($p = 0.003$) arasında ise anlamlı bir fark bulunamadı. Gruplar arası karşılaştırmalara bakıldığında cinsiyete ve yaşa bağlı anlamlı bir fark bulunamadı.

Sonuç

T2DM'li hastalarda, sağlıklı kontrollere kıyasla önemli ölçüde daha yüksek diş çürüğü görülme sıklığı ve şiddeti görülmektedir. Bu bulgular, diyabet hastaları için kapsamlı koruyucu diş stratejilerinin uygulanmasının ve entegre tıbbi-diş bakımı protokollerinin oluşturulmasının kritik önemini vurgulamaktadır.

Anahtar Sözcükler

Tip 2 diyabet, Diş çürüğü, Ağız sağlığı

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both. Globally, it represents a major public health challenge, contributing to more than 3 million deaths annually and accounting for approximately 5.2% of all-cause mortality (1).

The prevalence of DM continues to rise rapidly, especially in low- and middle-income countries. India, for example, harbors the largest diabetic population worldwide, with 32 million cases, and projections estimate this number will increase to nearly 80 million by 2030 (2). DM is broadly classified into two major subtypes: type I, an autoimmune-mediated destruction of pancreatic β-cells leading to absolute insulin deficiency, and type II, the more prevalent form, which is strongly associated with obesity, sedentary lifestyle, and persistent hyperglycemia (3). While systemic complications of DM such as cardiovascular disease, nephropathy, and retinopathy are well established, increasing attention has been directed toward its impact on oral health, particularly its relationship with dental caries.

Multiple biological mechanisms link diabetes to an increased risk of caries. Poor glycemic control alters salivary flow and composition, leading to xerostomia and elevated salivary glucose concentrations, which provide a favorable substrate for cariogenic bacteria such as Streptococcus mutans and Lactobacillus spp. (4,5). Hyperglycemia also impairs neutrophil function, reduces host defense capacity, and contributes to microbial dysbiosis, further enhancing enamel demineralization and plaque accumulation (6). Clinical studies have demonstrated higher rates of root and coronal caries among individuals with poorly controlled diabetes, while improved glycemic regulation appears to mitigate this risk (7).

Moreover, dental infections in diabetic patients may exacerbate hyperglycemia, creating a bidirectional relationship that complicates both systemic and oral health outcomes (8). Therefore, comprehensive diabetes management should integrate preventive dental care, regular oral examinations, and strict metabolic control. The null hypothesis of the present study is; there is no difference in the number of dental caries, restorations and the number of missing teeth between T2DM patients and healthy patients.

MATERIAL and METHODS

Ethical permission was obtained from the Akdeniz University Ethics Committee and permission was obtained from the relevant authorities of the hospital to examine the radiographic data of the patients (2023/950). This retrospective study was conducted on patient records from the Department of Restorative Dentistry, Faculty of Dentistry, Akdeniz University, between 2019 and 2023. A total of 100 individuals were included. Of these, 50 patients had a confirmed diagnosis of T2DM, while 50 systemically

healthy individuals served as the control group. To minimize potential confounding, each healthy participant was matched to a diabetic participant based on age and sex in a 1:1 ratio.

The primary measure was the number of decayed teeth per individual. A tooth was recorded as carious if a lesion involving enamel, dentin, or cementum was detected. Third molars were excluded, while all other teeth were assessed.

Exclusion criteria were as follows: individuals younger than 18-year of age; Patients with more than half of their teeth missing or with the presence of crowns or fixed dental bridges; Patients with a history of trauma or surgical intervention resulting in tooth loss, detectable on panoramic radiography; Radiographs containing artifacts that hindered proper evaluation.

To ensure methodological consistency, caries assessment was performed by two experienced specialists in restorative dentistry. Prior to evaluation, both examiners were calibrated regarding the diagnostic criteria. Panoramic radiographs were examined on a computer monitor in a darkened room at ×3.5 magnification. Each radiograph was independently reviewed, and the final diagnosis for each tooth was established by consensus between the two examiners.

Statistical analyses were conducted in R (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables were summarized as mean ± standard deviation and compared using two-way ANOVA with fixed factors of health status and gender. Normality (Shapiro–Wilk) and homogeneity of variances (Levene's test) were verified before analysis. A two-sided significance level of $\alpha = 0.05$ was adopted for all tests.

RESULTS

A total of 100 participants were included in the study, comprising 50 diabetic and 50 systemically healthy individuals. The demographic and clinical characteristics of the study population are presented in Table 1.Values are expressed as mean ± standard deviation (range) unless otherwise specified. Percentages are based on the total number of participants within each group.

Table 1. Demographic and baseline characteristics of participants.

Characteristic	Diabetic ($n = 50$)	Healthy ($n = 50$)	Total ($n = 100$)
Age (years)	48.5 ± 12.6 (18-72)	45.4 ± 12.2 (18-71)	46.9 ± 12.4 (18-72)
Gender [n (%)]			
Male	20 (40%)	8 (16%)	28 (28%)
Female	30 (60%)	42 (84%)	72 (72%)
Number of teeth present	24.4 ± 2.7 (16-28)	25.9 ± 2.0 (18-28)	25.1 ± 2.5 (16-28)
Number of restored teeth	2.4 ± 2.6 (0-17)	5.0 ± 3.2 (0-14)	3.7 ± 3.1 (0-17)
Number of teeth with caries	6.6 ± 3.8 (0-23)	3.5 ± 2.7 (0-11)	5.1 ± 3.7 (0-23)

The mean age of the diabetic group was 48.5 ± 12.6 years (range: 18-72), while that of the healthy group was 45.4 ± 12.2 years (range: 18-71), showing no significant age difference between the groups. In terms of gender distribution, 60% ($n = 30$) of the diabetic participants were female and 40% ($n = 20$) were male, whereas the healthy group consisted of 84% females ($n = 42$) and 16% males ($n = 8$). Regarding oral health parameters, the mean number of teeth present was slightly lower in the diabetic group (24.4 ± 2.7) compared with the healthy group (25.9 ± 2.0). The number of restored teeth was significantly higher in the healthy group (5.0 ± 3.2) than in the diabetic group (2.4 ± 2.6), suggesting that healthy individuals may have received more restorative dental care. Conversely, the mean number of teeth with dental caries was notably higher in the diabetic group (6.6 ± 3.8) compared to the healthy group (3.5 ± 2.7), indicating a greater prevalence of untreated carious lesions among diabetic individuals.

Overall, these findings suggest that diabetic patients exhibit a higher caries burden and fewer restored teeth compared with non-diabetic controls, despite similar age distribution across both groups.

The age distribution of participants according to health status is shown in Figure 1. Both the diabetic and healthy groups exhibited a comparable age range, with median ages of approximately 50 and 45 years, respectively. The violin plots show a similar overall distribution pattern, indicating that there was no significant age difference between the 2 groups ($P > 0.05$).

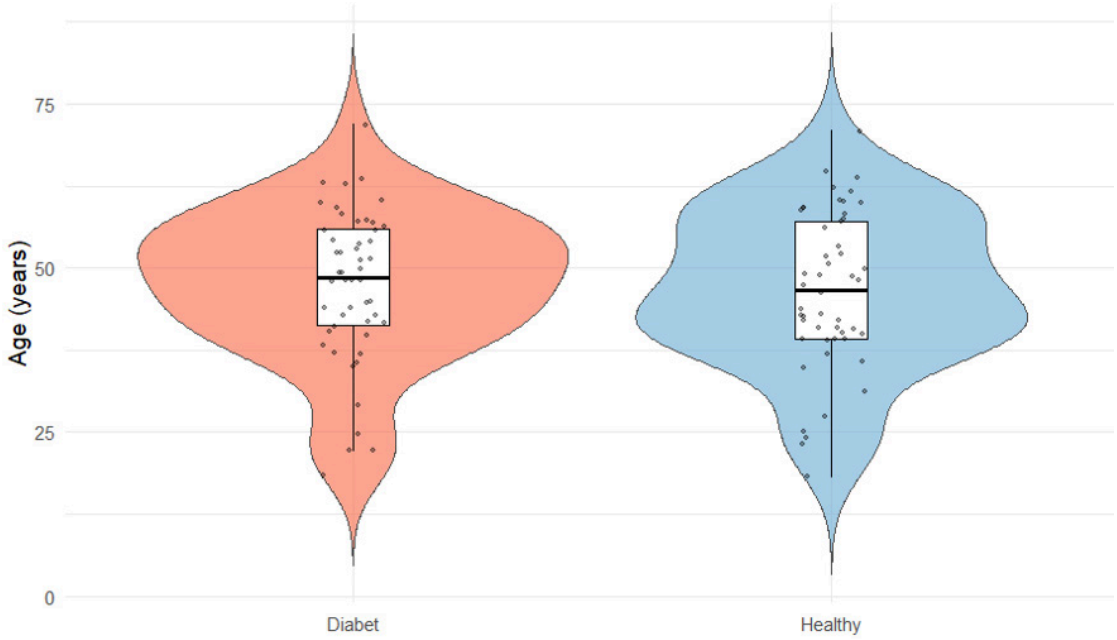


Figure 1. Violin plots with embedded boxplots illustrate the age distribution of diabetic (red) and healthy (blue) participants. The central black line represents the median, and the box boundaries correspond to the interquartile range (IQR). Whiskers extend to 1.5 × IQR, and individual points represent participant data. The violin shape reflects the kernel density of the data, indicating the spread of ages within each group.

The distribution of the number of teeth with caries in diabetic and healthy participants are presented in Figure 2. The diabetic group exhibited a notably higher mean number of carious teeth (6.6 ± 3.8) compared to the healthy group (3.5 ± 2.7). The boxplot demonstrates a wider variability and higher upper range among diabetic individuals, suggesting greater susceptibility to dental caries in this population. The difference between the two groups was statistically significant ($P < 0.05$).

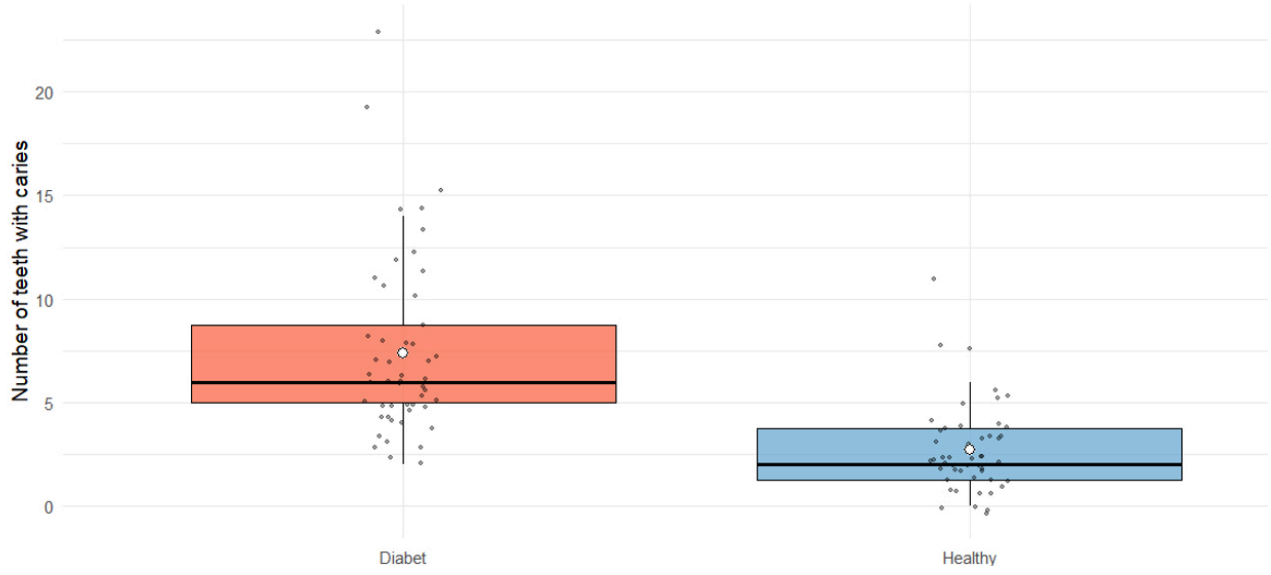


Figure 2. Boxplots illustrate the distribution of the number of teeth with caries among diabetic (red) and healthy (blue) participants. The central horizontal line within each box indicates the median, while the box boundaries represent the interquartile range (IQR). Whiskers extend to 1.5 × IQR, and dots correspond to individual participant values. White circles denote group means.

The comparison of the number of restored teeth between diabetic and healthy participants are illustrated in Figure 3. The healthy group exhibited a higher mean number of restored teeth (5.0 ± 3.2) compared to the diabetic group (2.4 ± 2.6). The boxplot indicates greater variability among healthy individuals, reflecting a higher frequency of restorative dental treatments in this group. The difference between groups was statistically significant ($P < 0.05$), suggesting that individuals without diabetes are more likely to have received restorative dental care.

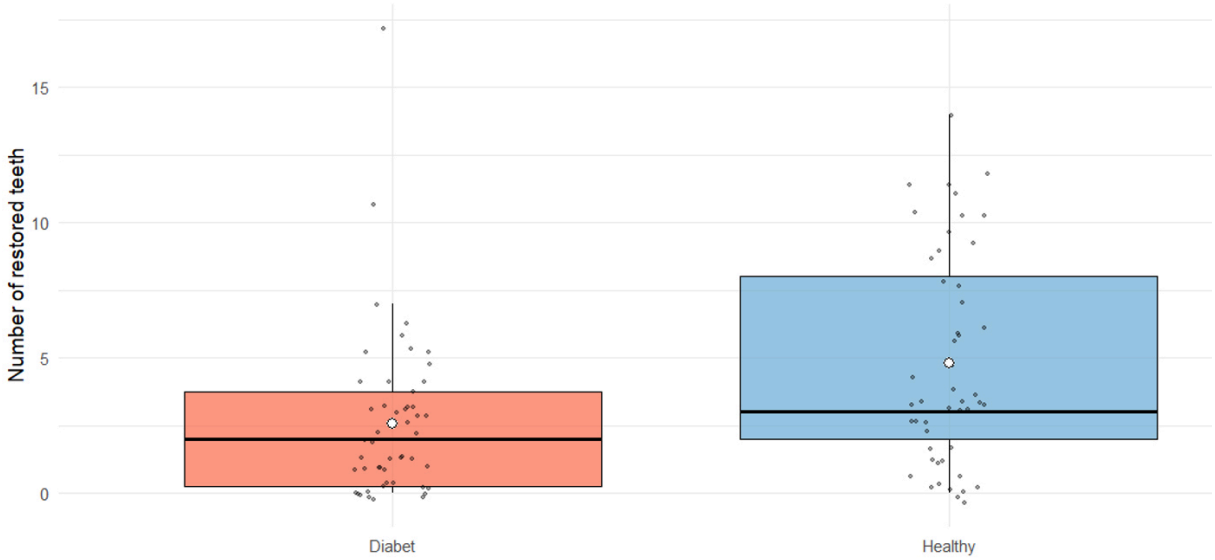


Figure 3. Boxplots display the distribution of the number of restored teeth among diabetic (red) and healthy (blue) participants. The horizontal line within each box represents the median, the boxes denote the interquartile range, and whiskers extend to 1.5 × IQR. White circles indicate group mean values, and individual points represent participant data.

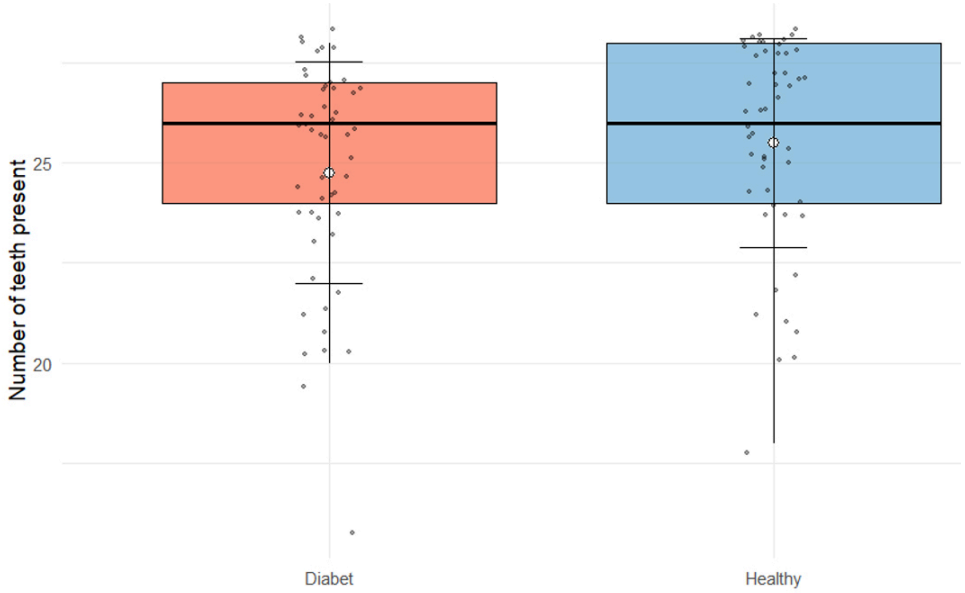


Figure 4. Boxplots illustrate the distribution of the number of teeth with among diabetic (red) and healthy (blue) participants. The central horizontal line within each box indicates the median, while box boundaries represent the interquartile range (IQR). Whiskers extend to 1.5 × IQR, and dots correspond to individual participant values. White circles denote group means.

Figure 4 demonstrates the distribution of the number of teeth present among participants according to health status. The median number of teeth present was comparable between individuals with diabetes and those who were healthy, with both groups exhibiting similar interquartile ranges. The diabetic group showed slightly greater variability, with a few lower outliers indicating participants who had notably fewer teeth. In contrast, the distribution among healthy individuals appeared more symmetrical and concentrated around the median. The mean number of teeth present (indicated by the white dot) was also similar across the 2 groups, suggesting that overall tooth retention did not differ mar- kedly between diabetic and healthy participants.

DISCUSSION

In this present study, the null hypothesis was largely rejected which demonstrated a significant discrepancy in the number of decaying teeth, but no significant difference in the number of restorations when compared to the total number of teeth. Dental caries remains a widespread condition with substantial public health implications, and reducing its burden continues to be a global objective (9). DM, already established as a major public health challenge, has been suggested to increase susceptibility to dental caries through alterations in host response and heightened vulnerability to infections (10). Consistent with this, individuals with diabetes may also experience more frequent dental abscesses

resulting from untreated or progressive caries. The findings of the present hospital-based cross-sectional study, which compared dental caries experience between diabetic and non-diabetic patients, add to the existing literature by highlighting the potential role of systemic conditions such as DM in oral disease outcomes (9).

Recent studies further support and nuance the association between diabetes mellitus (especially type II) and increased risk of dental caries. For example, a study by Shiferaw *et al.* conducted in Ethiopia found dental caries prevalence to be 79.6% in diabetic adults vs. 67.9% in non-diabetic controls ($p = 0.003$), with additional risk factors including poor oral hygiene, dry mouth, and inadequate oral health knowledge (11). Similarly, Frias-Bulhosa *et al.* (12) reported that adults with T2DM and higher BMI tend to have greater prevalence of dental caries. Interestingly, however, in that study glycemic control measured by HbA1c did not show a statistically significant influence on the DMFT score or its components.

A large cross-sectional analysis using NHANES data from 2017-2020, Natarajan *et al.* (13) also demonstrated a statistica- lly significant association between systemic conditions and oral health indicators: diabetes was moderately associated with periodontitis, and while their findings about caries were more definite in relation to hypertension, the pattern underscores the interconnections between systemic metabolic health and dental diseases.

These findings are largely consistent with the results of the present study, in which the prevalence of caries was significantly higher among type II diabetics compared to non-diabetics ($P < 0.001$), while no significant differences were observed in number of remaining teeth or restorations, nor in relation to age or sex. The consistency across diverse geographic regions (Ethiopia, Portugal, the U.S.) strengthens the external validity of the association.

Although the total number of teeth did not differ significantly between groups, diabetic participants exhibited a lower number of restorations. This finding suggests that the difference cannot be attributed to tooth loss but may instead reflect disparities in treatment-seeking behavior, access to dental care, or clinical decision-making. Diabetic individuals may receive fewer restorative interventions despite having a comparable number of remaining teeth, possibly due to differences in oral health awareness, preventive behavior, or clinicians' management preferences considering their systemic condition.

A major strength of this study lies in the careful age and sex-matching of diabetic and non-diabetic participants, which minimized confounding effects in group comparisons. Furthermore, radiographic assessments were independently performed by two experienced restorative specialists, ensuring diagnostic standardization and reliability. Nevertheless, several limitations should be acknowledged. First, the retrospective, hospital-based design may restrict the generalizability of the findings to the broader population. Second, although age, sex, and systemic health status were controlled, other potential confounding factors such as socioeconomic status, dietary patterns, oral hygiene practices, diabetes duration, and glycemic control (HbA1c) were not assessed. Third, the exclusion of third molars, although consistent with epidemiological conventions, may slightly underestimate total caries burden. Finally, the lower number of restorations observed in diabetic participants, despite a comparable number of teeth, may partly reflect methodological limitations of radiographic assessment. Radiographs are less sensitive for detecting small or radiolucent restorations, particularly in anterior teeth or cervical regions, which may have led to an underestimation of the actual number of restorations and caries. Further longitudinal studies incorporating salivary metabolomics, oral microbiome analyses, and HbA1c-based stratification are warranted to clarify the precise pathways by which DM influences caries development.

CONCLUSION

Within the limitations of this study, diabetes mellitus was associated with a significantly higher number of teeth affected by caries compared with non-diabetic individuals, despite no differences in the total number of remaining teeth. The lower number of restorations among diabetic participants may reflect differences in dental care utilization, clinical decision-making, or the limitations of radiographic assessment rather than true treatment disparities. These findings highlight the importance of integrating oral health evaluation into the routine management of patients with diabetes and underscore the need for further longitudinal and clinically based studies to clarify causal mechanisms and optimize preventive strategies.

Ethics Committee Approval

The study was approved by the Akdeniz University Ethics Committee (2023/950).

Author contribution statement

Concept: N.B., Y.H.Y.P., O.T.H.; Design: N.B., Y.H.Y.P.,O.T.H.; Supervision: N.B., Y.H.Y.P., O.T.H.; Resources: N.B., Y.H.Y.P., O.T.H.; Materials: N.B., Y.H.Y.P., O.T.H.; Data Collection and/or Processing: N.B., Y.H.Y.P., O.T.H.; Analysis and/ or Interpretation: O.T.H.; Literature Search: N.B., Y.H.Y.P., O.T.H.; Writing Manuscript :N.B., O.T.H.; Critical Review: N.B.,Y.H.Y.P., O.T.H.

Informed Consent

Written informed consent was obtained from participants who participated in this study.

Conflict of Interest

The author declare that they have no conflict of interest.

Financial Disclosure

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