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Research Article

Assessment of the Correlation Between Periodontal Disease Severity and Specific Systemic Diseases: A Retrospective Study

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ABSTRACT

Background
Although the potential influence of numerous systemic diseases on the periodontium is well established, periodontal infection may significantly enhance liability to or modify the progression of certain systemic diseases, such as diabetes mellitus and hypertension. These are the most common disorders sharing a pathogenesis that involves an enhanced local and systemic inflammatory response to periodontal bacteria. The current study was intended to assess the correlation of periodontal disease severity with diabetes mellitus and/or hypertension.

Methods
This study analyzed the records of patients who visited the hospital in 2018. Age, gender, periodontal disease severity and systemic condition, were obtained from patients' records without including any identifying information. Data were gathered, arranged in tables, and analyzed using the chi-squared test (X^2) and Pearson correlation coefficient (r). Significance was determined when P-values were < 0.05.

Results
The frequencies of gingivitis and chronic periodontitis were greater in males than in females ($p = 0.001$ and 0.000, respectively). Periodontal disease severity was found to increase with age ($p = 0.000$). The frequency of chronic periodontitis was statistically higher than that of gingivitis ($p = 0.000$) and the frequency of severe chronic periodontitis was statistically higher than that of moderate and slight chronic periodontitis in all patients, whether they had diabetes mellitus and/or hypertension ($p = 0.000$).

Conclusions
A large significant difference was found between the frequency of chronic periodontitis and that of gingivitis in all diabetic and/or hypertensive patients. Moreover, the severity of chronic periodontitis had a significant positive correlation with diabetes mellitus and/or hypertension.

1. INTRODUCTION

Periodontal diseases are common, complicated interplays between periodontopathogenic bacteria and the host's immune response inflicted by risk factors that may be environmental, behavioural, or genetic (Marcenes et al., 2013). The classification of periodontal diseases was first attempted in 1989 at the World Workshop in Clinical Periodontics (American Academy of Periodontology. 2015). Later, in 1993, various scholars agreed to modify the previous classification at the First European Workshop in Periodontology (Lang *et al.*, 1999). In 1999, a different classification was submitted at the International Workshop of Periodontology (Lindhe *et al.*, 1999), where periodontitis severity was categorised based on clinical attachment loss (CAL) into slight, moderate, severe chronic and aggressive. However, the measurement of CAL is time-consuming and challenging, especially when the gingival margin is coronal to the cementoenamel junction (CEJ) and may involve some guesswork via tactile sensation. Hence, in 2015, a task force charged by the American Academy of Periodontology (AAP) Board of Trustees developed a clinical clarification of the 1999 classification (American Academy of

Periodontology. 2015) in which the diagnosis of periodontitis was based on multiple clinical and radiographic parameters, such as bleeding on probing, radiographic bone loss, probing depth (PD) and CAL. In 2017, a new classification redesigned the disease classification structure, advising comprehensive treatment planning and authorising a personal way of patient management (Panos *et al.,* 2018).

Gingivitis is gingival inflammation that occurs on a periodontium without attachment loss or on a reduced periodontium with stable and non-progressive attachment loss. Periodontitis is the inflammation of a periodontium that results in its destruction through increased probing depth, clinical attachment loss, gingival recession, radiographic bone loss, progressive tooth mobility and, eventually, tooth loss (Novak *et al.,* 2003). The prevalence of periodontal diseases differs in various regions and may be more prevalent in developing than developed countries (Stoltenberg *et al.,* 1993). Periodontitis was reported to affect more than 40% of American adults (Eke *et al.,* 1018). Moreover, severe periodontitis was reported as the sixth diffusely prevailing universal disease and is estimated to afflict 7.4% of the world's population (Kassebaum *et al.,* 2017).

Although the potential influence of numerous systemic diseases on the periodontium is well established, periodontal infection may significantly enhance liability to or modify the progression of systemic diseases, such as coronary heart diseases; diabetes mellitus; respiratory disorders; preterm labour and low-birth-weight delivery; chronic kidney disease; liver, pancreas, and colorectal region cancer; rheumatoid arthritis; dementia; and Alzheimer's disease (Linden *et al.,* 1013).

Diabetes mellitus and hypertension are the most common disorders sharing a set of risk factors that include stress, increased age, smoking and socioeconomic status. Diabetes and periodontal diseases are thought to share a pathogenesis that involves an enhanced local and systemic inflammatory response to periodontal bacteria (Southerland *et al.,* 2005). Likewise, hypertension and periodontitis are prevalent conditions caused by common factors, such as smoking, male gender, older age, low socioeconomic status, and obesity (Del Pinto *et al.,* 2020).

Numerous studies have reported a higher prevalence of periodontitis in hypertensive patients, consistent with the severity of periodontitis and attributed to changes in microcirculation with the resultant ischemia in the periodontium, favouring periodontal disease. The inflammatory response to periodontitis negatively impacts blood pressure regulation by interfering with endothelial function, indicating that inflammation may be an influential link between hypertension and periodontitis (Humphrey *et al.,* 2008; Leong *et al.,* 2014). Moreover, periodontal therapy showed a symmetrical amelioration in blood pressure profile and systemic inflammatory markers, confirming the influence of periodontal status on hypertension (Czesnikiewicz-Guzik *et al.,* 2019).

Diabetes mellitus and periodontitis were documented to have a two-way relationship with a codependent effect on their clinical outcomes. Diabetes mellitus can increase the progression of periodontitis, and it is thought that periodontitis is the sixth most common complication of diabetes mellitus (Chee *et al.,* 2013). On the contrary, periodontitis was recently classified as a risk factor for deteriorating glycemic control and might enhance liability for diabetic complications (Mealey *et al.,* 2008). Based on the available scientific evidence, diabetes mellitus is now considered an established risk factor for the evolution of periodontitis and contributes to its expanding prevalence, severity and rate of progress. On the other hand, severe periodontitis was reported to be linked with poor glycemic control, suggesting that severe periodontitis is a risk factor that jeopardises diabetes management. A prospective study evaluating the impact of periodontitis on diabetes incidence reported that moderate and severe periodontitis was significantly linked with an expanded incidence of diabetes mellitus (Ide *et al.,* 2011). Moreover, the treatment of periodontal disease was found to reduce the level of glycated haemoglobin in diabetic patients significantly (Madianos *et al.,* 2018).

Therefore, there is justification for assessing the relationship of periodontal disease severity to diabetes and/or hypertension, as it would allow us to predict periodontal diseases earlier in the mild forms and prevent progression to more severe forms that might extend to systemic condition degradation. Moreover, although previous studies on the prevalence of periodontal disease in Saudi Arabia have been undertaken (Hossain *et al.,* 2013; Al-Mugeiren *et al.,* 2018; Al-Qahtani *et al.,* 2017), periodontal disease severity and its correlation with associated systemic diseases have not been studied in the region of Makkah. Thus, the present study assessed the possible correlation of periodontal disease severity with diabetes mellitus and/or hypertension among Umm Al-Qura University Dental Teaching Hospital patients.

2. MATERIALS AND METHODS

2.1. Ethical approval

The Biomedical Ethics Committee at Umm Al-Qura University approved the study (approval number: HAPO-02-K-012-2022-09-1189).

2.2. Study setting

This study was conducted in the Dental Teaching Hospital, Faculty of Dentistry, Umm Al-Qura University, Makkah City, Saudi Arabia.

2.3. Study design and sampling

The present retrospective, hospital-based study was intended to assess the severity of periodontal disease and its possible correlation with diabetes mellitus and/or hypertension using the records of patients who sought dental treatment from January to December 2018. The records of 3,158 periodontal-affected patients were examined in this study. Blind, standardised, recorded data on gender, age, periodontal clinical parameters and systemic status were obtained from patients' records without including any identifying information. The study population was clearly defined and drawn from the same general population. The inclusion criteria were used to select

dentulous patients at least 18 years old who were classified under American Society of Anesthesiology (ASA) categories I (regular, healthy patients) or II (patients with mild diabetes and/or hypertension) (Mayhew *et al.*, 2019). The exclusion criteria were set to rule out patients with insufficient or absent recorded data, who had undergone periodontal treatment in the previous six months, who had been administered systemic antibiotics in the previous three months, who had more severe classifications than ASA II or who had other systemic diseases than diabetes and/or hypertension. The patients were categorised according to age into groups under 20 years, from 20 to 35 years, > 35 to 50 years and over 50 years old. Finally, the periodontal condition of each patient was classified as gingivitis; slight, moderate or severe chronic periodontitis; or aggressive periodontitis.

2.4. Study procedure

Clinical and radiographic investigations were carried out during patients' examinations, and screening forms and periodontal charts were then completed. The parameters evaluated were Plaque Index scores (Silness *et al.*, 1964), Gingival Index scores (Loe *et al.*, 1963), PD and CAL. PD was measured from the free gingival margin (FGM) to the bottom of the sulcus. CAL was the distance from the cementoenamel junction to the FGM added to the distance from the FGM to the bottom of the pocket/sulcus. Measurements were taken in millimetres (mm) and approximated to the next mm. Periodontal status was examined following the Task Force Report update on the 1999 AAP classification. Gingivitis was diagnosed when there was bleeding on probing without attachment, bone loss or a clinically inflamed, reduced periodontium with attachment loss, recession and probing depths of 3 mm or less. Chronic periodontitis was considered slight when there was a probing depth > 3 and < 5 mm, bleeding on probing, up to 15% of root length or radiographic bone loss ≥ 2 mm and ≤ 3 mm, and 1- to 2-mm CAL. Moderate periodontitis was diagnosed when there was a probing depth ≥ 5 and < 7 mm, bleeding on probing, 16–30% of root length or radiographic bone loss > 3 mm and ≤ 5 mm, and 3 – 4 mm CAL. Severe periodontitis was diagnosed when there was a probing depth ≥ 7 mm, bleeding on probing, > 30% of root length or radiographic bone loss > 5 mm, and ≥ 5 mm CAL. On the other hand, aggressive periodontitis was typically diagnosed in young patients with rapid periodontal destruction involving incisors and first molars (American Academy of Periodontology. 2015). Afterwards, each patient's screening data were transferred to the dental hospital's electronic database. All authors independently interpreted the patients' records and radiographs during data extraction to rule out potential sources of bias.

2.5. Statistical analysis

The data were gathered, tabulated and then analysed using SPSS version 20. They were displayed as frequencies, and comparisons were made using the chi-squared test (X2), while correlations were evaluated using Pearson correlation coefficients (r). P-values less than 0.05 were considered significant.

3. RESULTS

Of the 3,158 periodontally affected patients, 1118 (35.4%) were diagnosed as having gingivitis, 2033 (64.4%) presented with chronic periodontitis, while only 7 (0.2%) had aggressive periodontitis, table 1. Patients with chronic periodontitis were more frequent than those with either gingivitis or aggressive periodontitis. Regarding the total 2033 patients with chronic periodontitis, 379 (18.6%) had slight periodontitis, 736 (36.2%) presented with moderate periodontitis, while 918 (45.2%) were diagnosed as having severe periodontitis, table 2.

3.1. Severity of periodontal disease and gender

Table 1 shows the frequency of different periodontal diseases in relation to gender. The frequency of patients with gingivitis and chronic periodontitis was statistically more significant in males than females (p = 0.001 and 0.000, respectively). In contrast, the frequency of patients with aggressive periodontitis was statistically higher in females than in males (p 0.000). Table 2 shows the relationship between gender and the three chronic periodontitis forms. A significant difference was found between males and females regarding different forms of chronic periodontitis (p = 0.000).

Table 1. Frequency of different periodontal diseases in different genders

Variables	***Gingivitis***	***Chronic periodontitis***	***Aggressive periodontitis***	***Total***
	N (%)	***N (%)***	***N (%)***	***N (%)***
Male	606 (19.2%)	1239 (39.3%)	2 (0.05%)	1847 (58.5%)
Female	512 (16.2%)	794 (25.1%)	5 (0.15%)	1311 (41.5%)
Total				
	1118 (35.4%)	2033 (64.4%)	7 (0.2%)	3158 (100%)
X^2 (P value)	47.58 (0.001) **	136.31 (0.000) **	142.74 (0.000) **	129.84 (0.000) **

(X^2) Chi-square; ** Highly significant at p-value < 0.01

3.2. Severity of periodontal disease and age

Table 3 shows the frequency of different periodontal diseases in relation to age. The frequency of gingivitis patients increased in the less than 20 and 20-35-year age groups and dramatically declined after that (p = 0.000). In contrast, the frequency of chronic periodontitis patients was rising progressively with age and mainly above the age of 35 years (p = 0.000). Moreover, the frequency of aggressive periodontitis patients was mainly under the age of 20 years (p = 0.000). Table 4 shows the frequency of various chronic periodontitis forms in relation to age. The frequency of slight chronic periodontitis patients was statistically higher between 20 to 35 years of age than below 20 and above 35 years of age (p = 0.000). The frequency of patients with moderate and severe chronic periodontitis was above 35 years of age and gradually increased with the advancement of age (p = 0.000).

3.3. Severity of periodontal disease and systemic diseases

Table 5 shows the frequency of different periodontal diseases in relation to systemic conditions. A high statistically significant difference was found in the frequency of chronic periodontitis versus gingivitis in all patients suffering from diabetes mellitus and/or hypertension (p=0.000). The Pearson correlation value (r = 0.716) indicated a significant positive correlation between associated specific systemic diseases and different forms of periodontal diseases. Table 6 shows the frequency of various chronic periodontitis forms in relation to associated systemic diseases. The frequency of patients with severe chronic periodontitis was statistically higher than moderate and slight chronic periodontitis in all patients, whether having diabetes mellitus only, hypertension only or both diabetes and hypertension (p=0.000). The Pearson correlation value (r = 0.652; p=0.000) indicated a significant positive correlation between the severity of chronic periodontitis and diabetes mellitus and/or hypertension.

Table 2. Frequency of various chronic periodontitis forms in relation to Males and females

Variables	*Slight chronic periodontitis*	*Moderate chronic periodontitis*	*Severe chronic periodontitis*	*Total*
	N (%)	*N (%)*	*N (%)*	*N (%)*
Male	261 (12.8%)	412 (20.3%)	566 (27.8%)	1239 (60.9 %)
Female	118 (5.8%)	324 (15.9%)	352 (17.4%)	794 (39.1 %)
Total				
	379 (18.6%)	736 (36.2%)	918 (45.2%)	2033 (100%)
X^2 (P value)	159.32 (0.000) **	137.41 (0.000) **	154.23 (0.000) **	163.27 (0.000) **

(X^2) Chi-square; ** Highly significant at p-value < 0.01

Table 3. Frequency of different periodontal diseases in different age groups

Variables	*Gingivitis*	*Chronic periodontitis*	*Aggressive periodontitis*	*Total*
	N (%)	*N (%)*	*N (%)*	*N (%)*
< 20	504 (16%)	28 (0.8%)	6 (0.2%)	538 (17%)
20 - 35	437 (13.8%)	301 (9.6%)	1 (0.03%)	739 (23.4%)
>35 - 50	146 (4.6%)	781 (24.8%)	0	927 (29.4%)
> 50	31 (1%)	923 (29.2%)	0	954 (30.2%)
Total				
	1118 (35.4%)	2033 (64.4%)	7 (0.2%)	3158 (100%)
X^2 (P value)	151.42 (0.000) **	143.57 (0.000) **	136.78 (0.000) **	141.39 (0.000) **

(X^2) Chi-square; ** Highly significant at p-value < 0.01;

Table 4. Frequency of various chronic periodontitis forms in different age groups

Variables	*Slight chronic periodontitis*	*Moderate chronic periodontitis*	*Severe chronic periodontitis*	*Total*
	N (%)	*N (%)*	*N (%)*	*N (%)*
< 20	24 (1.2%)	3 (0.1%)	1 (0.1%)	28 (1.4%)
20 - 35	225 (11.1%)	37 (1.8%)	39 (1.9%)	301 (14.8%)
> 35 - 50	82 (4%)	308 (15.2%)	391 (19.2%)	781 (38.4%)
> 50	48 (2.3%)	388 (19.1%)	487 (24%)	923 (45.4%)
Total				
	379 (18.6%)	736 (36.2%)	918 (45.2%)	2033 (100%)
X^2 (P value)	123.45 (0.000) **	156.23 (0.000) **	184.62 (0.000) **	196.37 (0.000) **

(X^2) Chi-square; ** Highly significant at p-value < 0.01;

4. DISCUSSION

In the current study, 2,033 patients (64.4%) had chronic periodontitis, which was a significantly greater number than that of gingivitis patients, who totaled 1,118 (35.4%), and aggressive periodontitis patients, who totaled 7 (0.2%). These results are in agreement with earlier studies that reported a statistically higher prevalence of chronic periodontitis than both gingivitis and aggressive periodontitis (Prathypaty *et al.*, 2019; Sharma *et al.*, 2014). The prevalence of gingivitis in our study was also consistent with figures reported in earlier studies (Fan *et al.*, 2021; Hamid *et al.*, 2021). However, it was lower than the prevalence of 58.4% reported by an earlier study (Al-Mugeiren *et al.*, 2018). This inconsistency might be due to the large difference in sample sizes between our study and the previous one.

The prevalence of chronic periodontitis (64.4%) in our study was in accordance with some previous research (Rajkarnikar *et al.*, 2014; Helmi et al., 2019). However, it was higher than the 23.4% figure reported in an earlier study (Al-Mugeiren *et al.*, 2018) in which the community periodontal index of treatment needs (CPITN) was used to examine periodontal status, as the Task Force Report update on the AAP's 1999 classification was used in this study. The CPITN index depends on pocket depth measurement and does not record gingival recession. Hence, it may not determine the actual expansion of periodontal disease. However, the merged utilization of CAL and PD was found more trustworthy in the definition of periodontitis. CAL measurements properly assess the destruction of the periodontium, while PD measurements best anticipate the attachment loss (Savage *et al.*, 2009).

The prevalence of aggressive periodontitis in this study

Table 5. Frequency of different periodontal diseases in relation to systemic condition

Variables	*Diabetes mellitus*	*Hypertension*	*Diabetes mellitus & Hypertension*	*Total*
	N (%)	*N (%)*	*N (%)*	*N (%)*
Chronic periodontitis	298 (29%)	273 (26.6%)	274 (26.7%)	845 (82.4%)
Gingivitis	59 (5.8%)	73 (7.1%)	49 (4.8%)	181 (17.6%)
Total				
	357 (34.8%)	346 (33.7%)	323 (31.5%)	1026 (100%)
X^2 (P value)	182.49 (0.000) **	161.48 (0.000) **	174.26 (0.000) **	198.59 (0.000) **
Pearson's R (P value)	0.716 (0.000) **			

(X^2) Chi-square; ** Highly significant at p-value < 0.01

Table 6. Frequency of various chronic periodontitis forms in relation to associated systemic diseases

Variables	*Diabetes mellitus*	*Hypertension*	*Diabetes mellitus& Hypertension*	*Total*
	N (%)	*N (%)*	*N (%)*	*N (%)*
Slight chronic periodontitis	62 (7.4%)	76 (9%)	61 (7.2%)	199 (23.6 %)
Moderate chronic periodontitis	99 (11.7%)	91 (10.8%)	92 (10.9%)	282 (33.4 %)
Severe chronic periodontitis	137 (16.2%)	106 (12.5%)	121 (14.3%)	364 (43.1 %)
Total				
	298 (35.3%)	273 (32.3%)	274 (32.4%)	845 (100%)
X^2 (P value)	134.62 (0.000) **	111.84 (0.000) **	126.81 (0.000) **	134.27 (0.000) **
Pearson's R (P value)	0.652 (0.000) **			

(X^2) Pearson Chi-square; ** Highly significant at p-value < 0.01

(0.2%) was in line with previous studies that reported a prevalence range of 0.1%–0.2% (Van der Velden et al.,1986; Kronauer et al., 1986). On the other hand, it was lower than rates reported by many other studies, such as 0.89% (Hossain et al., 2013), 9.67% (Prathypaty et al., 2019) and 3.6% (Imran et al., 2010), reflecting the impact of environmental and genetic factors in varied geographical locations. Susin et al. (Susin et al., 2014), in their systematic research on aggressive periodontitis prevalence in different global areas, found that the prevalence of aggressive periodontitis varies significantly between different geographic locations and different races/ethnicities.

Our results revealed an overall prevalence of slight, moderate and severe periodontitis of 18.6%, 36.2% and 45.2%, respectively. These results were consistent with an earlier study (Gopalankutty et al., 2020) but diverged from another study performed on 2,739 attending patients at the College of Dentistry, King Khalid University, where the prevalence of mild, moderate and severe periodontitis was 57.4%, 36.6% and 4.95% respectively (Al-Mugeiren *et al.*, 2018). Severe chronic periodontitis was more prevalent in our study, which could be related to the influence of diabetes mellitus and/or hypertension, which was not reported in their study.

In the present study, males exhibited a greater prevalence of gingivitis and chronic periodontitis (19.2% and 39.3%, respectively) than females (16.2% and 25.1%, respectively). Moreover, males showed higher frequencies of slight, moderate and severe periodontitis (12.8%, 20.3% and 27.8%, respectively) compared to females (5.8%, 15.9% and 17.4%, respectively). These results coincide with similar findings reported in the literature, where periodontal disease was more common in males (Eke *et al.*, 1018; American Academy of Periodontology. 2015). On the other hand, our results found a higher distribution of aggressive periodontitis in females (0.15%) than in males (0.05%). These results align with many previous studies that suggested a positive relationship between the female gender and the incidence of aggressive periodontitis (Prathypaty *et al.*, 2019; Cortelli *et al.*, 2002).

The results of this study revealed that age is a crucial factor in the prevalence of various periodontal diseases. Gingivitis was higher in the under-20 and 20–35-year age groups and dramatically declined afterwards. This reinforces the fact that gingivitis more commonly affects younger age groups. Our finding coincided with previous studies in which gingivitis prevalence increased with age to peak in 21–30-year-olds (Hossain *et al.*, 2013), and in another study, with 25–34-year-old patients (Al-Qahtani *et al.*, 2017). In contrast, our results showed that periodontitis was more significant in those over 35 and increased afterwards, indicating that chronic periodontitis is detectable mainly during the late ages. These results agree with reports in which the prevalence of chronic periodontitis increased with age (Prathypaty *et al.*, 2019; Bourgeois *et al.*, 2007). Regarding chronic periodontitis severity, our results reveal that the frequency of all forms of chronic periodontitis gradually increases with t advancement of age. This may be accounted for by the cumulative effect of periodontal breakdown over time together with the decline in tissue integrity and immune defence in old age, which may enhance susceptibility to periodontal disease, as well as the increased chance of developing systemic diseases, such as diabetes and hypertension, with older age. These results align with earlier

studies that reported increased severity of periodontal diseases with age (Helmi *et al.,* 2019; Mittal *et al.,* 2010).

Diabetes mellitus and hypertension were the only systemic diseases in the present study, as they are the disorders most commonly reported to have a relationship with periodontal disease in the literature. Our results revealed that all patients with diabetes mellitus and/or hypertension presented with periodontal diseases, verifying the relation between periodontal disease and diabetes and hypertension. Additionally, the prevalence of chronic periodontitis was significantly greater than that of gingivitis in all patients with diabetes mellitus and/or hypertension. Moreover, a highly significant positive correlation was found between the severity of chronic periodontitis and diabetes and/or hypertension, which was consistent with previous studies suggesting that these systemic diseases exaggerate periodontal destruction (Mittal *et al.,* 2010; Muñoz Aguilera *et al.,* 2020).

The results of this study show that the frequency of severe chronic periodontitis in patients with only diabetes mellitus is significantly higher than that of moderate and slight chronic periodontitis. This may be related to glycemic control and the duration since diabetes mellitus was diagnosed. It was reported that poor glycemic control and the time since the diagnosis of diabetes were highly significant for anticipating periodontal disease severity (Taylor *et al.,* 1996). Likewise, a previous study reported that the duration of diabetes was associated with the prevalence and severity of periodontal disease (Rajhans *et al.,* 2011). Conversely, severe periodontitis increased the risk of diabetes incidence by 53%, confirming the bidirectional relationship between periodontal disease and diabetes (Wu *et al.,* 2020). Our findings were consistent with previous studies documenting that periodontal disease is more prevalent and severe in diabetic patients (Mittal *et al.,* 2010; Borgnakke *et al.,* 2013).

Chronic inflammation may be the primary mechanism linking diabetes and periodontitis. Many studies suggest that diabetes produces a state of chronic inflammation. The level of circulating tumour necrosis factor (TNF) in diabetic patients was found to be higher than that in non-diabetic patients, and the inflammatory level in different tissues was also higher and mainly manifested as increased vascular permeability and inflammatory cell infiltration (Daniele *et al.,* 2014). Moreover, it has been shown that chronic hyperglycemia might activate various mechanisms that result in oxidative stress, augmented inflammation and apoptosis (Polak *et al.,* 2018).

Conversely, periodontal disease could adversely impact glycemic control in diabetic patients. Periodontitis could cause increased systemic levels of TNF-α, interleukin (IL-6) and C-reactive protein (CRP), and the resultant enhanced systemic inflammation, which might contribute to insulin resistance. Moreover, periodontitis was reported to increase oxidative stress, which leads to cytokine imbalance and immune dysfunction. As a result, HbA1c levels were elevated in the blood and glucose transporter-4 receptor transcription was reduced, resulting in impaired insulin secretion, which might lead to chronic hyperglycemia (Graziani *et al.,* 2018). Additionally, periodontal therapy was found to significantly reduce glycated haemoglobin levels in diabetic patients by significantly reducing systemic inflammation levels, which might restore insulin sensitivity, thereby improving glycemic control (Preshaw *et al.,* 2020).

Our finding of a higher prevalence of severe periodontitis among hypertensive patients agrees with previous studies that reported a greater prevalence of severe periodontitis in hypertensive patients, suggesting that the likelihood of developing hypertension is proportional to the severity of periodontitis. Similarly, various studies have documented that hypertensive patients exhibit a more severe periodontal status (Muñoz Aguilera *et al.,* 2020). Clinical and experimental evidence suggests that this bond might exist because hypertension causes microcirculatory ischemia, enhanced inflammation and/or an altered bacterial composition of the biofilm. On the other hand, periodontitis might lead to increased chronic systemic inflammation with increased inflammatory biomarkers and endothelial dysfunction, which might increase the risk of developing hypertension. Likewise, periodontitis was associated with a higher likelihood of uncontrolled hypertension despite administering antihypertensive medications (Del Pinto *et al.,* 2010). Additionally, systemically healthy individuals with periodontitis reported higher blood pressure readings and a 30%–70% greater chance of presenting with hypertension, especially with gingival bleeding (Muñoz Aguilera *et al.,* 2021). Finally, periodontal therapy presented a parallel improvement in blood pressure profile after treatment, proving that inflammation could be a plausible link between hypertension and periodontitis.

The present study has some limitations in that it is a single-center, hospital-based study, and its results cannot be generalised since hospital patients yield greater estimates of the disease than field studies. Moreover, we did not describe other factors that might have influenced systemic conditions and hence periodontal disease severity, such as glycemic control, the duration since diabetes had been diagnosed, abdominal obesity, stress and salt intake. Likewise, the patients did not necessarily have similar oral hygiene indexes. However, this is the first study exploring the correlation between periodontal disease severity and systemic condition in Makkah. Multi-centre and population-based longitudinal studies are necessary to explain the relevant causal biological mechanisms.

5. CONCLUSION AND RECOMMENDATION

A large significant difference was found between the frequency of chronic periodontitis and gingivitis in all patients suffering from diabetes mellitus and/or hypertension. Moreover, the severity of chronic periodontitis was found to have a significant positive correlation with diabetes mellitus and/or hypertension.

AUTHOR CONTRIBUTION

Prof. Ayman Ahmed contributed to this research through study design, data collection and manuscript writing. Dr. Ehab Azab contributed to data interpretation, manuscript

writing and editing. Dr. Wael Yaghmoor contributed to manuscript editing and writing. The final manuscript has been revised and approved by all authors.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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