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ORIGINAL RESEARCH

Prevalence and severity of periodontitis in a population with end-stage renal disease on hemodialysis: a clinical cross-sectional study

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Abstract

The correlation between periodontitis and chronic renal disease (CRD) is still being debated. Periodontitis increases the systemic inflammatory burden, which worsens CRD, and the CRD can affect the progression of periodontal disease. We don't fully understand how one disease can affect another disease. As a result, the purpose of this study was to determine the prevalence and severity of periodontitis in patients requiring hemodialysis, as well as the relationship between various clinical periodontal parameters and serum creatinine, serum albumin, and blood urea. This cross-sectional study included 167 participants with chronic renal diseases undergoing hemodialysis. Patients' data was collected with face-to-face interviews, followed by biochemical investigations for each participant. Modified Plaque Score and Modified Bleeding Score were recorded. Probing depth and clinical attachment level were measured. The subjects were categorized into three groups: periodontally healthy individuals, gingivitis and periodontitis. The severity of periodontitis has been identified. Out of 167 subjects who participated in the study, 101 were male and 66 were female, with a mean age of 50.45 years. Poor oral hygiene and periodontitis were found to be much higher among dialysis patients. 98.8% of them had periodontitis and 63.0% had severe forms (stage III and IV). A significant positive correlation between serum albumin and staging of periodontitis was also observed ($p=0.03$). Severe periodontal diseases were more prevalent among patients with chronic renal failure undergoing hemodialysis and a substantial drop in albumin levels is linked to severe periodontitis, which may increase the chance of morbidity and death in these individuals.

Keywords Chronic renal disease · Hemodialysis · Periodontal disease · Periodontitis · Albumin levels

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Introduction

Periodontal disease is a chronic inflammatory and destructive multifactorial disease of the gingiva, periodontal ligament, and alveolar bone [1]. It is caused by bacteria in the subgingival biofilm or their microbial products, mainly lipopolysaccharide (LPS), which causes inflammation in the surrounding gingival and periodontal tissues. However, it is now generally acknowledged that the host response plays a significant role in mediating the degradation of collagen and connective tissue in the gingiva and periodontal ligament as well as the loss of alveolar bone [2, 3]. Periodontitis may be linked to systemic disorders in numerous ways. LPS and Gram-negative bacteria present in the biofilms, as well as, proinflammatory mediators from the inflamed periodontal tissues may gain access to the circulation in pathogenic quantities. Furthermore, periodontitis and certain systemic disorders, have the same risk factors such as tobacco use, male gender, race/ethnicity, stress and aging [2, 3]. Periodontitis is a serious public health issue, and the "WHO Global Oral Health Status Report 2022" estimated that the worldwide prevalence of periodontitis is 19% among adults over the age of 15 [4], and it does not only cause local symptoms but can also have a negative impact on an individual's overall health, contributing to the development and worsening of chronic non-communicable degenerative diseases [5]. The majority of the research supporting these connections concentrated on diabetes, pregnancy, and cardiovascular disease; however, it is also important to take into account problems like obesity, auto-immune diseases, some malignancies, respiratory illnesses, and cognitive disorders like Alzheimer's disease [6, 7]. Less is known regarding the relationship between periodontitis and chronic renal disease (CRD). Patients' oral health is impacted by CRD because it causes gingival hyperplasia, xerostomia, root canal calcification, and delayed tooth eruption. Periodontitis worsens CRD by increasing the systemic inflammatory burden, which has been shown to have a negative impact on the CRD of patients on hemodialysis therapy by altering serum albumin and C-reactive protein levels. Because hypoalbuminemia increases mortality in CRD patients, it must be avoided by lowering the systemic inflammatory burden in hemodialysis patients [8].

Chronic renal disease (CRD) is a serious socioeconomic and healthcare issue, affecting almost 7 billion people globally [9, 10]. CRD is responsible for 1.1 million deaths worldwide. Overall, because of its poor prognosis, the death rate from CRD has risen by 31.7% in the last decade, making it one of the fastest-growing main causes of death, alongside diabetes and dementia. According to the same report, CRD is the 17th highest cause of mortality worldwide, with an 18.4% increase since 2005 and the third largest increase among all leading causes of death [11]. It is expected that by 2040, CRD will be the fifth leading cause of mortality worldwide [12]. Because of the high frequency, rapid progression, and poor prognosis of chronic renal disease, new approaches for preventing and regulating CRD progression are necessary. As a result, the study has focused on "non-traditional" risk variables such as systemic inflammation or oxidative stress, which may be affected by periodontitis [13].

In Libya, information about the relationship between periodontitis and hemodialysis is scarce. As a result, additional work is needed to regulate the disease, reduce the severity of other chronic illnesses, and improve patient quality of life. So, this

study aims to estimate the prevalence and severity of periodontitis in patients requiring hemodialysis according to the new 2017 classification of periodontal and peri-implant diseases [14], as well as the correlation between different clinical parameters of periodontal status with serum creatinine, serum albumin, and blood urea. This may rule out a relationship between periodontitis and renal failure in hemodialysis patients.

Subjects and methods

A cross-sectional study was carried out at the largest dialysis center in Benghazi / Libya (Kidney Services Center). Research Ethics Committee of the Faculty of Dentistry/University of Benghazi reviewed and approved the study protocol (October 2022/ Reference Code: 0135). All participants received an explanation of the procedure and provided informed consent. A total of 167 patients, both male and female, were included in the study (sample size calculation was based on the number of patients who visited the hemodialysis centers by statistic).

Inclusion criteria

Patients with end-stage renal disease on hemodialysis for at least 6 months and aged ≥ 18 years were included in the study. Patients with a history of diabetes mellitus, hypertension and cardiac disease were also included in the study because those diseases were the most common medical conditions among people with chronic renal disease and cannot be excluded. Individuals who had acute renal failure, CRD patients under conservative treatment and CRD patients who underwent renal transplants were not included in the study. Patients with a history of malignancy, liver disease and medications that had side effects on periodontal tissue were excluded. Patients who had received periodontal therapy within a period of six months prior to the examination were also excluded from the study.

Data collection method

Patients' data included the patient's age, sex, smoking status, frequency of brushing, duration of hemodialysis and any systemic diseases other than end-stage renal disease. Laboratory assays of updated serum creatinine, serum albumin and blood urea were recorded.

Clinical periodontal examination

The clinical examination was performed by four examiners who were calibrated for the exact diagnostic procedure for the patients. The Modified Plaque Score (MPS), (a coding framework developed based on the Silness and Loe index (1964) utilizing Ramfjord's teeth) [15], and the Modified Bleeding Score (MBS), (a bleeding on probing score developed using Ramfjord's teeth) [16], were measured on four different

surfaces based on their criteria. The MPS and MBS had been estimated to assess the periodontal and oral hygiene status.

With a periodontal Michigan O probe, a full mouth periodontal examination and periodontal charts were done for all the participants. Probing depth (PD) and clinical attachment level (CAL) were measured on six locations of the teeth (mesio-buccal/facial, mid-buccal/facial, disto-buccal/facial, mesio-lingual/palatinal, mid-lingual/palatinal, disto-lingual/palatinal) excluding third molars. Tooth loss due to periodontitis were addressed through history taking from the patient.

Based on the clinical examination and periodontal status according to the new 2017 classification of periodontal and peri-implant diseases [14], subjects were categorized into three groups: periodontally healthy individuals, gingivitis and periodontitis. The severity of periodontitis were determined as (stage I, stage II, stage III and stage IV).

Statistical analysis

The study used IBM SPSS (Statistical Package for Social Sciences), version 29. The data were summarized using descriptive statistics such as means, standard deviations, and percentages. Spearman's correlation coefficient was used to assess numerical correlations. Data analysis was performed using the Pearson Chi-square test with statistical significance set at $p \leq 0.05$.

Results

Demographic data and personal behavior

A clinical cross-sectional study was undertaken with 167 participants to estimate the prevalence and severity of periodontitis in a sample of the Libyan population with end-stage renal disease on hemodialysis. The mean age of the participants was 50.45 ± 13.7 years. Out of 167 subjects who participated in the study, 101 (60%) were male and 66 (40%) were female. A family history of CRD was reported in 23.3% of the participants and the average duration of dialysis was 7.4 ± 7.2. Smoking status was assessed as a smoker, former smoker and non-smoker. Out of the 167 participants, 40 (23.9%) were smokers, 21 (12.6%) of them were former smokers and 106 (63.5%) were non-smokers. All smokers were male (Table 1).

Examination of the oral cavity reveals poor oral hygiene in almost all of the participants (99%). The average Modified Plaque Score (MPS) was 84.4 ± 27.4 and the average Modified Bleeding Score (MBS) was 46.0 ± 38.4 (Table 2). It was also shown that 40% of the participants did not brush their teeth, 34% bushed once daily and 25% bushed twice daily (Fig. 1).

Periodontitis and medical status

With 68% (113) patients, hypertension was the most common medical condition among patients with ESRD having hemodialysis, followed by 21% (35) with diabetes

Table 1 Descriptive data of ESRD patients with different stages of periodontitis

Parameters	Total Sample	Periodontitis Stage				*p* value
	Mean±SD	Stage I	Stage II	Stage III	Stage IV	
Age	13.7±50.45	10.5±35.4	12.6±43	11.7±51.4	11.3±59	0.04*
Sex	Female n (%) Male n (%)	1 (1.5) 4 (4)	22 (33.9) 34 (34)	16 (24.6) 36 (36)	26 (40) 26 (26)	0.9
Smoking Status	Male n (%) Female n (%)	1 (25) 0	8 (17.39) 0	16 (34.0) 0	15 (31.25) 0	0.3
Medical Condition						
Hypertension		5 (4.4)	41(36.6)	31(27.7)	35 (31.3)	
Diabetes mellitus		3 (8.6)	11(31.4)	4 (11.4)	17 (48.6)	
Cardiovascular disease		1 (5.6)	5 (27.8)	4 (22.2)	8 (44.4)	
Duration of hemodialysis	7.4±7.2	3.0±1.6	6.9±6.1	8.6±7.6	7.0±8.0	

* Significant ($p \leq 0.05$)

Table 2 Periodontal clinical parameters and biochemical analysis of ESRD patients with different stages of periodontitis

Parameters	Total Sample	Periodontitis Stage				*p* value
	Mean±SD	Stage I	Stage II	Stage III	Stage IV	
Mean CAL (mm)	5.8±2.3	2.0±0.7	3.8±0.6	6.4±1.6	8.1±1.5	0.0001*
Modified Plaque Score %	84.4±27.4	73.2±28.1	84.2±28.3	81.2±31.0	88.8±21.4	
Modified Bleeding Score %	46.0±38.4	35.6±41.8	48.7±39.9	42.1±36.1	47.6±38.9	
Number of Missing Teeth	7.1±7.6	4±2.8	2.1±2.6	4.0±3.6	16.5±7.2	
Biochemical Analysis						
Blood Urea (mg/dl)	137.3±45.7	170.3±18.2	125.6±41.3	135.4±33.9	144.0±56.5	
Serum Creatinine (mg/dl)	12.1±13.3	11.9±1.6	9.8±2.4	10.7±2.2	9.3±4.9	
Serum Albumin (g/dl)	4.2±1.8	4.8±0.1	4.27±0.3	4.23±0.3	3.8±0.6	0.03*

* Significant ($p \leq 0.05$)

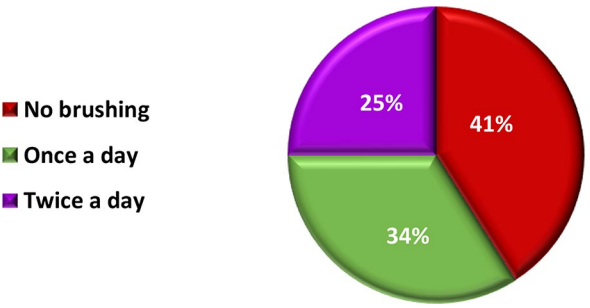

Fig. 1 Pie chart showing the frequency of brushing in ESRD

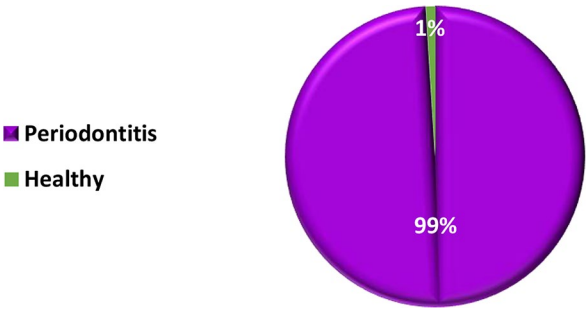

Fig. 2 Pie chart showing the prevalence of periodontal diseases in ESRD

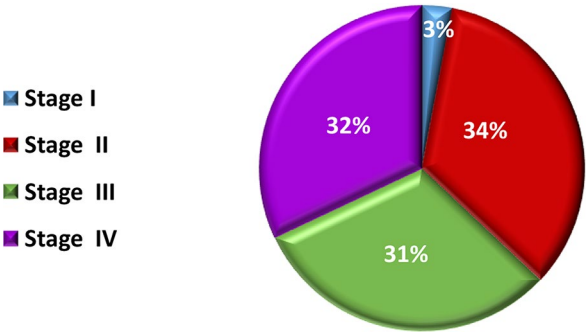

Fig. 3 Pie chart showing the prevalence of different stages of periodontitis in ESRD

mellitus and 11% (18) patients with cardiac disease. Table 1 shows the prevalence of medical conditions in each stage of periodontitis. 4.4% of hypertensive individuals had stage I periodontitis, 36.6% had stage II periodontitis, 27.7% had stage III periodontitis, and 31.3% had stage IV periodontitis. Patients with diabetes mellitus had 8.6% stage I periodontitis, 31.4% stage II periodontitis, 11.4% stage III periodontitis, and 48.6% stage IV periodontitis. 5.6% of cardiac patients had stage I periodontitis, 27.8% had stage II periodontitis, 22.2% had stage III periodontitis, and 44.4% had stage IV periodontitis (Table 1).

Prevalence of periodontitis in ESRD

The average clinical attachment loss in ESRD was 5.8 ± 2.3 and 98.8% of the participants had clinical attachment loss between 2 mm and 11 mm (Table 2). Out of the 167 participants, only 1.2% (2) have healthy gingiva on intact periodontium and 98.8% (165) of them have some form of periodontal disease (Fig. 2) ranging from stage I to stage IV periodontitis and 63.0% (104) of the participants have a severe form of periodontitis (stage III and IV) (Table 1).

The incidence and percentage of stages of periodontitis in ESRD patients are shown in Fig. 3. Stage II was the most common stage of periodontitis with 34% (56) followed by stage IV with 32% (53) and stage III with 31% (51) with no significant difference between them, while the least common stage was stage I with 3% (5) being significantly lower than stages II, III and IV as shown in Fig. 3. The average tooth

loss was 7.1 ± 7.6. Out of the 167 participants, 133 (80%) have missing teeth and 34 (20%) of them have all teeth present (Table 2).

Correlation between various variables

Table 1 displays descriptive data from ESRD patients with various stages of periodontitis. There was no significant association between gender and periodontitis stages (Table 1). There was a significant positive strong correlation between age and stage of periodontitis (rs = 0.5, $p = 0.04$). The most advanced stage of periodontitis, which is stage IV, was more common in older patients and vice versa (Table 1). There was a non-significant positive correlation between the duration of hemodialysis and periodontitis stage (rs = 0.2). The increase in the duration of hemodialysis is directly correlated with an increase in the severity of periodontitis (Table 1).

Correlation between various periodontal clinical parameters and blood urea, serum creatinine and serum albumin levels

Table 2 presents the Mean ± SD values for clinical parameters (MPS, MBS and deepest CAL), blood urea, serum creatinine level and serum albumin. The correlation between various periodontal parameters (MPS, MBS and deepest CAL) and blood urea, serum creatinine and serum albumin levels is presented in Table 3. There was no correlation between MPS and blood urea, serum creatinine, or albumin levels (Table 3). There was a strong positive correlation between MBS and blood urea level (rs = 0.2) and a weak positive correlation between MBS and both serum creatinine and albumin levels (rs = 0.04 and 0.03), respectively (Table 3). There was a significant strong positive correlation between deepest CAL and serum albumin level (rs = 0.2, $p = 0.001$) and no correlation between deepest CAL and both serum creatinine and blood urea level (Table 3).

As shown in Table 2 there was a significant positive correlation between serum albumin and the staging of periodontitis (rs = 0.1, $p = 0.03$). The low level of serum albumin concentration (defined as < 3.8 g/dL). Lower albumin (3.8 g/dL ± 0.5) was associated with severe periodontitis status (stage IV) and higher albumin (4.8 g/dL ± 0.1) was associated with mild periodontitis status (stage I).

Table 3 Correlation between different periodontal clinical parameters and blood urea and serum creatinine and serum albumin level

Parameter	Correlation coefficient (rs)	*p* value
Modified Plaque Score %		
Blood Urea (mg/dl)	-0.11	ns
Serum Creatinine (mg/dl)	-0.01	ns
Serum Albumin (g/dl)	-0.23	ns
Modified Bleeding Score %		
Blood Urea (mg/dl)	0.2	ns
Serum Creatinine (mg/dl)	0.04	ns
Serum Albumin (g/dl)	0.03	ns
Mean CAL (mm)		
Blood Urea (mg/dl)	-0.03	ns
Serum Creatinine (mg/dl)	-0.01	ns
Serum Albumin (g/dl)	0.21	0.001*

* Significant ($p \leq 0.05$); ns; non-significant ($p > 0.05$)

Discussion

Periodontitis has recently been identified as a "non-traditional" risk factor for CRD, even though, no compelling evidence to indicate a causal relationship. Periodontal disease could be increased in renal disease patients, and it is associated with inflammatory and malnutrition markers in hemodialysis patients. Moreover, albumin level is commonly used as a malnutrition marker and can predict mortality in dialysis patients [17, 18].

This study aimed to estimate the prevalence and severity of periodontitis in patients with ESRD. A total of 167 participants were included. The mean age of the participants was (50.45±13.7) years and this was in agreement with previous studies that reported mean ages of (47.9±15.3), (48.12±9.80) and (51.46±8.30) [19–21]. In addition, gender distribution showed a higher prevalence of ESRD in males (60%) than in females (40%) among the participants. This result was aligned with other studies, which stated the number of males was significantly higher than female patients [19, 20, 22]. This may be related to the fact that diabetic females have a lower risk of CRD than diabetic males [23, 24].

Periodontal clinical parameters such as plaque index (PI), bleeding on probing (BOP), and CAL were used to evaluate the condition of periodontal tissues. These are the most reliable parameters to assess periodontal health status and are commonly used in studies [21, 25]. Considering plaque accumulation, the average score was significantly high (84.4±27.4) which has been testified by earlier studies [20, 21, 26]. Oral hygiene is poor in HD patients, according to several studies [27, 28]. It's possible that the patients had little instruction in oral hygiene, or the frequency of oral hygiene practices dropped after dialysis started, which might be viewed as both an insufficient effort to preserve oral health and bad health behavior [29]. In our study we observed that 40% of the individuals did not brush their teeth, 34% brushed once daily, and 25% brushed twice daily. Moreover, inadequate oral hygiene in patients on hemodialysis could be related to antidiuretic drugs, which could reduce salivary flow and decrease lubrication in the oral cavity, consequently, promoting dental biofilm accumulation [25]. However, despite the patients' substantial deposition of dental biofilm, the rate of gingival bleeding was modest (46.0±38.4). Savica et al. [30] suggested that suppressing the reactions to inflammation and obscuring the signs of gingival inflammation can be caused by uremia in hemodialysis patients.

Regarding the frequency of periodontitis among hemodialysis patients, there were 98.8% (165 out of 167 participants) who had periodontitis which was in line with several studies that documented similar results [20, 31–34]. Moreover, our results presented that 63.0% of the participants had severe forms of periodontitis (stage III and IV), but stage II periodontitis was the most prevalent stage of periodontitis (34%) when compared to stages individually.

Concerning the medical status of patients, our results demonstrated that hypertension and diabetes mellitus were the most prevalent medical conditions (68% and 21% respectively) and this was in accordance with previous studies, which confirmed that the most common medical problems in their studies were hypertension and diabetes mellitus [20, 35]. Furthermore, our study also revealed the frequency of periodontitis with different stages among hypertensive and diabetic patients on hemodialysis.

Considering hypertension, the present study detected a high prevalence of moderate periodontitis (Stage II, 36.6%) in hemodialysis patients. On the contrary, Abou-Bakr et al. [20] reported a high incidence of severe periodontitis (Stage III, 39.8%) in hypertensive patients. The association between periodontitis and hypertension could be attributed to many factors including stress, tobacco smoking, aging, socioeconomic factors and the amount of pathogenic periodontal bacteria [36–38].

Regarding diabetes, our study documented a high frequency of severe periodontitis (Stage IV, 48.6%) in diabetic patients on hemodialysis. This fact agrees with Schmalz et al. [39] who expressed a high frequency of severe periodontitis (70.9%) in diabetic patients on hemodialysis, depending on the definition of the American Academy of Periodontology/Centers for Disease Control and Prevention (AAP/CDC) case definitions of 2007 [40]. Whereas, Abou-Bakr et al. [20] established a high frequency of severe periodontitis (Stage III, 57.3%) in diabetic patients. In addition, many patients on hemodialysis have been receiving diabetes therapy for several years. Therefore, there is a general assumption that diabetes mellitus is the main cause of dialysis in patients with renal failure. Furthermore, diabetes is considered a significant risk factor for severe periodontitis [41] and this could explain the link between CRD and periodontitis.

Although someone could argue that both diseases (diabetes mellitus and hypertension) are linked to periodontitis, our results demonstrated that even when those diseases are not present in ESRD patients, the prevalence of periodontitis is still high. As well, we detected a high prevalence of periodontitis (97.7%) with a severe form (Stage III & IV, 71.2%) in hemodialysis patients without any other systemic diseases.

In our research, we also found a significant association between age and periodontitis stage ($rs = 0.5$, $p = 0.04$). Stage IV periodontitis was more prevalent among patients of older age and this fact was in concurrence with other studies [19, 20]. The alteration in the periodontium associated with the age of the patient supports the idea that age could be a risk indicator for periodontal disease progression [42].

The current study found a non-significant positive correlation between hemodialysis duration and periodontitis stage ($rs = 0.2$, $p > 0.05$). This was consistent with earlier research, which found no significant relationship between hemodialysis duration and periodontal disease severity [43, 44]. On the other hand, our findings contradicted Jenabian et al. [19], who discovered a substantial link between dialysis duration and periodontal damage. This discrepancy in findings could be attributed to a variety of factors, including age, medical condition, regular dental care, and oral hygiene practices, as well as variations in hemodialysis duration [18, 20, 34]. Additionally, our results showed a positive correlation between the duration of hemodialysis and both MPS and MBS, but they were not significant ($rs = 0.2$ and 0.1, respectively, $p > 0.05$). This fact is similar to other studies that concluded there was no significant association between the duration of hemodialysis and both PI and BOP [20, 34, 45, 46]. Al Wahadni and Al Omari [46] suggested that high plaque scores in patients on hemodialysis may be because of neglecting oral health care as a whole due to staying a long duration in the dialysis center, and they may have depression due to their severe systemic illness. Accordingly, it can be concluded that a high plaque score in the present study typically was the effect of poor oral hygiene rather than the result of uremia occurring in hemodialysis patients. Therefore, it should be taken into account that

medication for hemodialysis patients, such as anticoagulant therapy, increases BOP and accordingly may not directly indicate the bleeding score of these patients [47].

Regarding biochemical analysis, our research concluded that there was no association between periodontal parameters (MPS, MBS, and CAL) and serum creatinine and blood urea. Of interest, there is controversy about the relationship between renal dysfunction and periodontitis since some studies have concluded elevating serum creatinine with periodontitis and others have established decreasing serum creatinine with periodontitis and changes in blood urea after taking medicines [48, 49]. Therefore, the correlation between decreased renal function and periodontal diseases is not constant, though some studies showed improvement in renal function analysis after non-surgical therapy for periodontal diseases [18, 50].

In terms of albumin level, there was a non-significant positive association between albumin level and both MPS and MBS, but there was a significant strong positive correlation with the highest CAL (rs = 0.2, $p = 0.001$), which is in agreement with Cholewa and his colleagues [34]. Furthermore, the current study also demonstrated that serum albumin has a significant positive correlation with the staging of periodontitis (rs = 0.1, $p = 0.03$). Lower albumin level was associated with stage IV periodontitis (3.8 g/dL ± 0.5) and higher albumin level was associated with stage I periodontitis (4.8 g/dL ± 0.1), which is in line with many studies that confirmed the decrease of albumin level with severe periodontal destruction [18, 34, 50–53]. Several studies confirmed the association between periodontitis, systemic inflammatory markers and malnutrition in hemodialysis patients [18, 50, 51, 54–57]. Serum albumin concentration in the ESRD population is one of the important indicators of dialysis quality [58], as it is believed that hypoalbuminemia is a strong predictor of death [59, 60]. Numerous studies attempted to prove the association between periodontitis and renal disease, but the results were controversial [26]. A decline in serum albumin in chronic renal disease patients increases the risk of morbidity and mortality in these patients [61]. Albumin is an acute-phase protein, and its serum concentration decreases in systemic inflammatory conditions [62]. The inflammatory reaction and production of cytokines can reduce protein synthesis in the liver and since albumin is produced by the liver, its serum level frequently decreases in inflammatory disorders [63]. Ahmadieh et al. revealed that the number of *Porphyromonas gingivalis* is higher in hemodialysis and kidney transplant patients when compared to healthy individuals [64]. Due to damage to the sulcular epithelium in periodontitis, bacteria can penetrate the bloodstream and cause systemic inflammation [65], which clarifies a decrease in serum albumin in severe periodontitis.

To the best of our knowledge, this is the first study to estimate the prevalence and severity of periodontitis in Libyan patients with ESRD; nonetheless, our study is not without limitations. First, the cross-sectional design makes it impossible to evaluate the direction of the observed associations because the periodontal condition was only measured once, rather than throughout time, and there is no control group. Second, many patients refused to participate in the study. Therefore, our study was relatively small. Third, most of the participants were older adult Libyan populations, which may not be generalizable to younger or non-Libyan residents. More research is warranted to discover whether the connections are similar across races and age groups.

In conclusion, periodontitis with different degrees of severity is prevalent among high-risk populations of patients with chronic renal failure undergoing hemodialysis, and the severe form of periodontitis is associated with a significant decline in albumin level, which could increase the chance of morbidity and mortality in these patients.

The current study adds to the growing body of evidence between periodontitis and CRD, but it does not prove causation. Further research is necessary to determine whether the association is fundamental and if the management of periodontal disease modifies the decline of serum albumin levels in renal disease patients, which could be beneficial starting in the early stages of CRD.

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Author contributions HHM: Designed the study, performed the research and contribute to the writing. MSE: performed the research, analyzed the data and contribute to the writing and editing. NAE: performed the research and contribute to the writing. ABE: performed the research. MSB performed the research. SMW Supervision and revision. All authors read and approved the final manuscript.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethical approval This study followed the principles of the Helsinki Declaration. The Faculty of Dentistry/University of Benghazi's Research Ethics Committee approved the application (October 2022/Reference Code: 0135).

Consent to participate All of the study's subjects provided informed consent.

Competing interests The authors declare no competing interests.

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