A Scoping Review Of Alveolar Bone Loss In Patients Undergoing Renal Dialysis

Mohammed Abullah Alelweet[1], Fahad Khalid M Alotaibi[2], Nasser Ali Almosallam[3], Satam Mohammed AlOtibi[4], Sliman Mohamad Alhowimel[5], Khaled Mohammed S Alotaibi[6], Abdullah Faisal Alem[7], Najeeb Hamid Alsahafi[8], Hayaa Abdulqadir Zaki[9], Salem abdulrahman salem alsaif[10]

[1] Dentist, Afif Hospital, Third Health Cluster, Riyadh, Saudi Arabia
[2] Dentist, Afif Hospital, Third Health Cluster, Riyadh, Saudi Arabia
[3] Dentist, Afif Hospital, Third Health Cluster, Riyadh, Saudi Arabia
[4] Dentist, Afif Hospital, Third Health Cluster, Riyadh, Saudi Arabia
[5] Dentist, Afif Hospital, Third Health Cluster, Riyadh, Saudi Arabia
[6] Afif General Hospital, Third Health Cluster, Riyadh, Saudi Arabia
[7] Dentist, infection and prevention control, Makkah health Cluster
[8] Dentist, KFH, OPD Supervisor, Makkah Health Cluster, Makkah, Saudi Arabia
[9] Dentist, Program Manager, Makkah Health Cluster, Makkah, Saudi Arabia
[10] Dentist Salah Eldin PHCC- Hail

Abstract:
Introduction: Loss of periodontal attachment may be the outcome of periodontitis, a host-mediated disease linked to microbial dysbiosis. Patients with renal insufficiency often have this oral health issue. The main therapy for renal failure is hemodialysis (HD). Given the rising incidence of periodontitis and renal failure, it is essential to comprehend their relationships and consequences.
The purpose of this scoping review is to investigate the connection between HD and periodontitis as well as the effects of periodontal health on clinical outcomes and oral health quality of life in HD patients.
Method: Extension for Systemic and Meta-Analyses in Scoping Reviews (PRISMA-ScR). Up to 2024, peer-reviewed English-language papers were found by searching Medline, Embase, Scopus, and grey literature. Thematic analysis was used to summarize the data. Findings: Of the 81 papers that were included, the majority were from Asia and Europe. Among HD patients, the prevalence of periodontitis varied from 36.27% to 99.06%. The results showed links between periodontitis and higher chances of comorbid conditions such metabolic syndrome, cardiovascular disease (CVD), and other systemic diseases.
Conclusion: Patients on HD often develop periodontitis, which is linked to poor systemic and dental health outcomes. The absence of longitudinal research to draw conclusions about causality and the variability in case definitions are limitations of the available data. The study suggests longitudinal research and established diagnostic standards to guide integrated care strategies.
Keywords: alveolar bone loss; blood dialysis; kidney failure; periodontitis; renal dialysis

1. INTRODUCTION

Reduced renal function in chronic kidney disease (CKD) may lead to end-stage renal disease (ESRD) and renal replacement therapy [1]. Renal failure is rising globally, and dialysis is the main therapy for long-term survival [2]. The majority of renal failure patients (82%), utilize haemodialysis (HD) [3]. While HD prolongs life, it increases morbidity, mortality, and reduces

QoL relative to the general population [4, 5].
Chronic host-mediated inflammatory periodontitis with microbial dysbiosis may cause periodontal attachment loss [6]. More than a billion individuals worldwide are affected by this public health issue, especially older persons [7, 8]. Periodontitis may cause extensive periodontal pockets, alveolar bone resorption, tooth mobility, and tooth loss, affecting mastication, speech, and QoL [9]. Periodontitis is one of the most common disorders globally, with documented global increases.
prevalence [10]. Interestingly, periodontitis is linked to cardiovascular disease (CVD), diabetes, hypertension, and CKD [11].
A growing body of research shows that renal failing patients, especially those undergoing HD, have a greater rate of periodontitis [12, 13]. Immune system suppression, prolonged systemic inflammation, and oral pathophysiological alterations such salivary flow and composition may cause this [14, 15].
Poor oral hygiene, limited meals, medication side effects, and malnutrition tend to compromise HD patients' dental care [16–18]. Thus, this must be included in these patients' clinical care. Furthermore, poor peri-odontal health may have non-oral effects. Previous studies have shown that periodontitis microorganisms can spread into the bloodstream and impair systemic markers of inflammation like C-reactive protein (CRP), potentially causing CVDs and mortality in renal failure patients [19, 20]. Periodontitis may potentially cause renal impairment and increase mortality in long-term HD patients [20]. These studies demonstrate that periodontal health directly affects clinical outcomes. With an aging population, more people needing dialysis, and the high prevalence of periodontitis in HD patients, it's important to understand the relationship between the two to develop evidence-based recommendations to improve HD patients' clinical outcomes. Despite an increasing body of literature linking periodontitis, renal failure, and dialysis, no recent reviews have examined HD and periodontitis. Thus, this scoping study examined the relationship between periodontitis and HD in ESRD patients. The specific objectives were to (i) report the prevalence of periodontitis in HD patients, (ii) identify associated oral and systemic complications, (iii) evaluate OHRQoL in HD patients with periodontitis, and (iv) examine the impact of periodontal treatment on HD patients' clinical outcomes.

2. METHODS

1.1. Search Strategy. This scoping review followed the Joanna Briggs Institute (JBI) Scoping Review Methodology and reported using PRISMA-ScR [21]. Med-line, Embase, and Scopus were searched systematically for relevant English-language literature up to December 2023. In addition to the database search, grey literature was searched. We picked primary research on people, including interventional (e.g., clinical trials) and observational (e.g., cohort and case-control studies). In-vitro, animal, review, and editorial research were omitted. To cover the vast literature, no data constraints were used. MeSH terms and keywords including periodontal disease, periodontitis, health, alveolar bone loss, dialysis, HD, and renal dialysis were employed using wildcards and Boolean operators (Figure S1).
1.2. Selection Process. Duplicates were deleted from database-searched records in EndNote. Two reviewers independently checked the titles and abstracts of the chosen publications for research relevance. Reviewers independently read selected entire texts and resolved differences with two more. were studies were patients with renal failure on HD and those with periodontitis or peri-odontal characteristics. Patients not on HD, those on HD without chronic renal failure, such as acute kidney damage, and those without periodontal health markers were excluded. The PRISMA flowchart (Figure 1) shows search and study selection outcomes.

Data Extraction and Analysis (1.3). Four independent reviewers used Excel to extract data from chosen papers. Name of first author, year of publication, place of origin, research design, participant characteristics, renal and peri-odontal parameters are retrieved from chosen papers. Differences were settled via conversation. Google Sheets generated article summaries. Data was analyzed thematically and summarized into five categories.

2. RESULTS

Summary of Studies. This review comprised 81 papers from the article selection process (Figure 1, Table S1). Figure 2A shows that Asia (29.6%) and Europe (23.5%) were studied more than the Middle East (22.2%), South America (14.8%), North America (4.9%), Africa (2.5%), and multi-region (2.5%). Cross-sectional (69%), case–control (13.6%), cohort (11.1%), and clinical trials (6.2%) were the most prevalent research designs (Figure 2B).
The publication year analysis showed that most were published between 2013 and 2023, with a concentration between 2017 and 2020 (Figure 3).
2.2. Periodontitis prevalence and severity. In HD patients, periodontitis prevalence ranges from 36.27% to 99.06% (Table S2) [23–37]. Table S1 shows that these studies diagnosed periodontitis using distinct case criteria. Different periodontal measures and classifications may explain the large variance in prevalence reported. Patients' ages also affected periodontitis prevalence. In one research, periodontitis was rare in 30–39-year-olds but 88.9% in 70–79-year-olds [38]. In another research, younger participants aged 16-19 had lower Community Periodontal Index treatment needs (CPITN) scores compared to older patients aged ≥45 [39].
Studies have shown that HD patients had more periodontal disease than healthy controls in terms of probing pocket depth (PPD), attachment loss, gingival bleeding, bone loss, and periodontal inflamed surface area [40–44]. A Chinese research found that HD patients had 2.5-fold more sextants with PPD ≥4 mm and fourfold more clinical attachment loss (CAL) ≥6 mm compared to healthy controls [45]. Another Polish investigation found that HD patients had more severe peri-dontis than the normal population [25]. Some investigations found no significant link between HD and periodontitis, with no significant variations in periodontal measures between HD and non-HD ESRD patients [46, 47]. Interestingly, numerous studies have shown a positive correlation between HD duration and periodontitis severity [27, 48–51], whereas others have found contradicting data [52–54].
Oral Complications (2.3). HD patients with periodontitis often have xerostomia, increased plaque and calculus, and dental caries (Table S3) [55–60]. A large international, prospective research indicated 40% of HD patients with moderate-to-severe periodontitis had high DMFT scores, dental erosion, dry mouth, and oral discomfort [23]. Oral problems also occurred.
Thrush, oral herpes, precancerous mucosal leukoplakia, and erythroplakia [42]. Additionally, salivary pH and red complex bacteria were raised, reducing salivary flow rates [23, 61, 62]. In addition, HD patients exhibit greater amounts of pro-inflammatory cytokines such TNF-α and IL-8 in their gingival crevicular fluid (GCF) compared to healthy controls [63]. These inflammatory cytokines were also positively correlated with clinical periodontal measures in HD patients [63]. This review likewise found no significant variations in inflammatory cytokine levels between HD-treated and non-treated CKD patients [46]. Another research found that HD patients had more HSV-1 in saliva and GCF than healthy individuals [42].
2.4. Comorbidities and Mortality. Periodontal health and other systemic health issues in HD patients have been linked to unfavorable outcomes, including higher mortality (Table

S4) [64–66]. Some studies have linked HD patients with moderate-to-severe periodontitis to higher all-cause mortality, whereas others have not [67, 68]. A research found that HD patients with moderate-to-severe periodontitis had 5.3 times the risk of CVD mortality compared to those with mild or healthy periodontium [69]. Diabetics also have lower periodontal health [70]. Additionally, HD patients with moderate-to-severe periodonti-tis had a 2.736-fold greater incidence of metabolic syndrome than healthy controls [71, 72]. HD patients with periodontitis had higher CRP, IL-6, and IL-8 levels, according to many studies [46, 63, 73, 74].

HD patients with severe periodontitis had a 2.64 times higher risk of malnutrition and inflammation.

MIA components [75] and lower serum albumin levels [76–78] than individuals without significant pain. Poor nutritional status, measured by higher subjective global assessment (SGA) ratings, was associated with increased mortality, with each one-unit increase equating to a 62% greater risk of death [79]. A research on HD patients and sarcopenia and periodonti-tis found no correlation [80].

2.5. Overall Health Quality of Life. Periodontitis may cause alveolar bone resorption, tooth mobility, and tooth loss, affecting mastication, speech, and OHRQoL (Table S5) [9]. Studies show that HD patients have significant rates of edentulism and poor oral hygiene [58]. HD patients also scored significantly worse on the Geriatric Oral Health Assessment Index (GOHAI-1), typically scoring around 40 (25th percentile [81]). Multiple studies have shown worse oral hygiene and decreased QoL in HD patients with severe periodontitis [31, 32, 82]. HD individuals with periodontitis exhibited lower SF-36 health survey ratings and higher probing depth (PD), gingival index (GI), and plaque index scores [26, 83, 84]. The Oral Health Impact Profile (OHIP-14) also showed poorer ratings for HD patients than healthy controls [26]. Importantly, a research found that HD patients with periodontitis prioritize systemic health above dental health [53]. Mental health issues including sadness and anxiety are also common in this demographic [26].

2.6. Periodontal Treatment Effects. HD periodontal therapy reduces systemic inflammation. Multiple studies have shown that periodontal treatment lowers serum CRP, blood urea nitrogen, and serum albumin (Table S6) [77, 85–88]. A few studies have shown no significant effect of periodontal therapy on mortality, albumin, or creatinine [89, 90]. Periodontal therapy also improved HD patients' estimated glomerular filtration rates (eGFR) and decreased endothelial function marker asymmetric dimethylarginine (ADMA) [91]. In addition, extensive periodontal care reduces the incidence of infectious illnesses such acute and subacute infective endocarditis, pneumonia, and osteomyelitis in HD patients [13]. Studies show that HD patients struggle to maintain dental health and manage periodontitis [44, 92].

1.1. Search Strategy. This scoping review followed the Joanna Briggs Institute (JBI) Scoping Review Methodology and reported using PRISMA-ScR [21]. Med-line, Embase, and Scopus were searched systematically for relevant English-language literature up to December 2023. In addition to the database search, grey literature was searched. We picked primary research on people, including interventional (e.g., clinical trials) and observational (e.g., cohort and case-control studies). In-vitro, animal, review, and editorial research were omitted. To cover the vast literature, no data constraints were used. MeSH terms and keywords including periodontal disease, periodontitis, health, alveolar bone loss, dialysis, HD, and renal dialysis were employed using wildcards and Boolean operators (Figure S1).

1.2. Selection Process. Duplicates were deleted from database-searched records in EndNote. Two reviewers independently checked the titles and abstracts of the chosen publications for research relevance. Reviewers independently read selected entire texts and

resolved differences with two more. were studies were patients with renal failure on HD and those with periodontitis or peri-odontal characteristics. Patients not on HD, those on HD without chronic renal failure, such as acute kidney damage, and those without periodontal health markers were excluded. The PRISMA flowchart (Figure 1) shows search and study selection outcomes.

Data Extraction and Analysis (1.3). Four independent reviewers used Excel to extract data from chosen papers. Name of first author, year of publication, place of origin, research design, participant characteristics, renal and peri-odontal parameters are retrieved from chosen papers. Differences were settled via conversation. Google Sheets generated article summaries. Data was analyzed thematically and summarized into five categories.

2. Results

2.1. Summary of Studies. This review comprised 81 papers from the article selection process (Figure 1, Table S1). Figure 2A shows that Asia (29.6%) and Europe (23.5%) were studied more than the Middle East (22.2%), South America (14.8%), North America (4.9%), Africa (2.5%), and multi-region (2.5%). Cross-sectional (69%), case–control (13.6%), cohort (11.1%), and clinical trials (6.2%) were the most prevalent research designs (Figure 2B).

The publication year analysis showed that most were published between 2013 and 2023, with a concentration between 2017 and 2020 (Figure 3).

2.2. Periodontitis prevalence and severity. In HD patients, periodontitis prevalence ranges from 36.27% to 99.06% (Table S2) [23–37]. Table S1 shows that these studies diagnosed periodontitis using distinct case criteria. Different periodontal measures and classifications may explain the large variance in prevalence reported. Patients' ages also affected periodontitis prevalence. In one research, periodontitis was rare in 30–39-year-olds but 88.9% in 70–79-year-olds [38]. In another research, younger participants aged 16-19 had lower Community Periodontal Index treatment needs (CPITN) scores compared to older patients aged ≥45 [39].

Studies have shown that HD patients had more periodontal disease than healthy controls in terms of probing pocket depth (PPD), attachment loss, gingival bleeding, bone loss, and periodontal inflamed surface area [40–44]. A Chinese research found that HD patients had 2.5-fold more sextants with PPD ≥4 mm and fourfold more clinical attachment loss (CAL) ≥6 mm compared to healthy controls [45]. Another Polish investigation found that HD patients had more severe peri-dontis than the normal population [25].

Some investigations found no significant link between HD and periodontitis, with no significant variations in periodontal measures between HD and non-HD ESRD patients [46, 47]. Interestingly, numerous studies have shown a positive correlation between HD duration and periodontitis severity [27, 48–51], whereas others have found contradicting data [52–54].

Oral Complications (2.3). HD patients with periodontitis often have xerostomia, increased plaque and calculus, and dental caries (Table S3) [55–60]. A large international, prospective research indicated 40% of HD patients with moderate-to-severe periodontitis had high DMFT scores, dental erosion, dry mouth, and oral discomfort [23]. Oral problems also occurred.

Thrush, oral herpes, precancerous mucosal leukoplakia, and erythroplakia [42]. Additionally, salivary pH and red complex bacteria were raised, reducing salivary flow rates [23, 61, 62]. In addition, HD patients exhibit greater amounts of pro-inflammatory cytokines such TNF-α and IL-8 in their gingival crevicular fluid (GCF) compared to healthy controls [63]. These inflammatory cytokines were also positively correlated with clinical

periodontal measures in HD patients [63]. This review likewise found no significant variations in inflammatory cytokine levels between HD-treated and non-treated CKD patients [46]. Another research found that HD patients had more HSV-1 in saliva and GCF than healthy individuals [42].

2.4. Comorbidities and Mortality. Periodontal health and other systemic health issues in HD patients have been linked to unfavorable outcomes, including higher mortality (Table S4) [64–66]. Some studies have linked HD patients with moderate-to-severe periodontitis to higher all-cause mortality, whereas others have not [67, 68]. A research found that HD patients with moderate-to-severe periodontitis had 5.3 times the risk of CVD mortality compared to those with mild or healthy periodontium [69]. Diabetics also have lower periodontal health [70]. Additionally, HD patients with moderate-to-severe periodonti-tis had a 2.736-fold greater incidence of metabolic syndrome than healthy controls [71, 72]. HD patients with periodontitis had higher CRP, IL-6, and IL-8 levels, according to many studies [46, 63, 73, 74].

HD patients with severe periodontitis had a 2.64 times higher risk of malnutrition and inflammation.

MIA components [75] and lower serum albumin levels [76–78] than individuals without significant pain. Poor nutritional status, measured by higher subjective global assessment (SGA) ratings, was associated with increased mortality, with each one-unit increase equating to a 62% greater risk of death [79]. A research on HD patients and sarcopenia and periodonti-tis found no correlation [80].

2.5. Overall Health Quality of Life. Periodontitis may cause alveolar bone resorption, tooth mobility, and tooth loss, affecting mastication, speech, and OHRQoL (Table S5) [9]. Studies show that HD patients have significant rates of edentulism and poor oral hygiene [58]. HD patients also scored significantly worse on the Geriatric Oral Health Assessment Index (GOHAI-1), typically scoring around 40 (25th percentile [81]). Multiple studies have shown worse oral hygiene and decreased QoL in HD patients with severe periodontitis [31, 32, 82]. HD individuals with periodontitis exhibited lower SF-36 health survey ratings and higher probing depth (PD), gingival index (GI), and plaque index scores [26, 83, 84]. The Oral Health Impact Profile (OHIP-14) also showed poorer ratings for HD patients than healthy controls [26]. Importantly, a research found that HD patients with periodontitis prioritize systemic health above dental health [53]. Mental health issues including sadness and anxiety are also common in this demographic [26].

2.6. Periodontal Treatment Effects. HD periodontal therapy reduces systemic inflammation. Multiple studies have shown that periodontal treatment lowers serum CRP, blood urea nitrogen, and serum albumin (Table S6) [77, 85–88]. A few studies have shown no significant effect of periodontal therapy on mortality, albumin, or creatinine [89, 90]. Periodontal therapy also improved HD patients' estimated glomerular filtration rates (eGFR) and decreased endothelial function marker asymmetric dimethylarginine (ADMA) [91]. In addition, extensive periodontal care reduces the incidence of infectious illnesses such acute and subacute infective endocarditis, pneumonia, and osteomyelitis in HD patients [13]. Studies show that HD patients struggle to maintain dental health and manage periodontitis [44, 92].

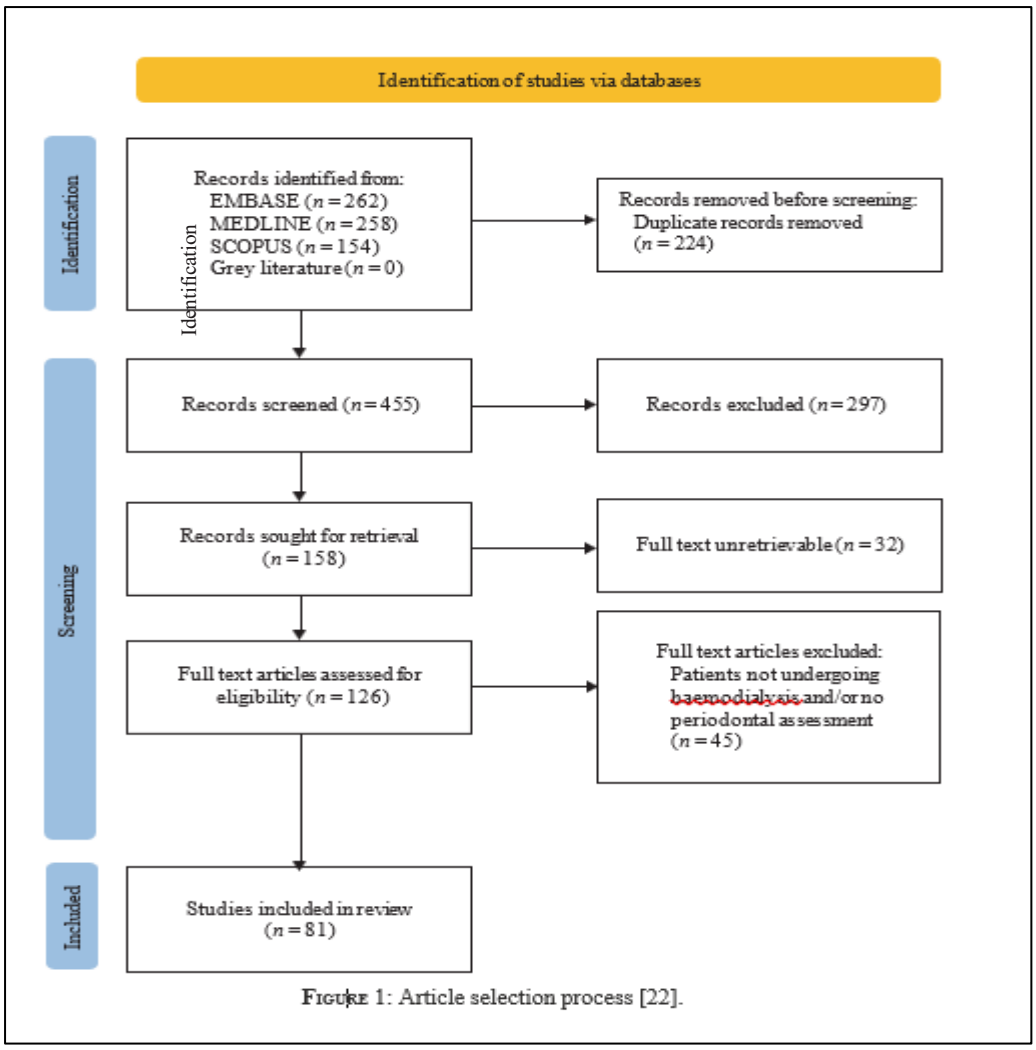

FIGURE 1: Article selection process [22].

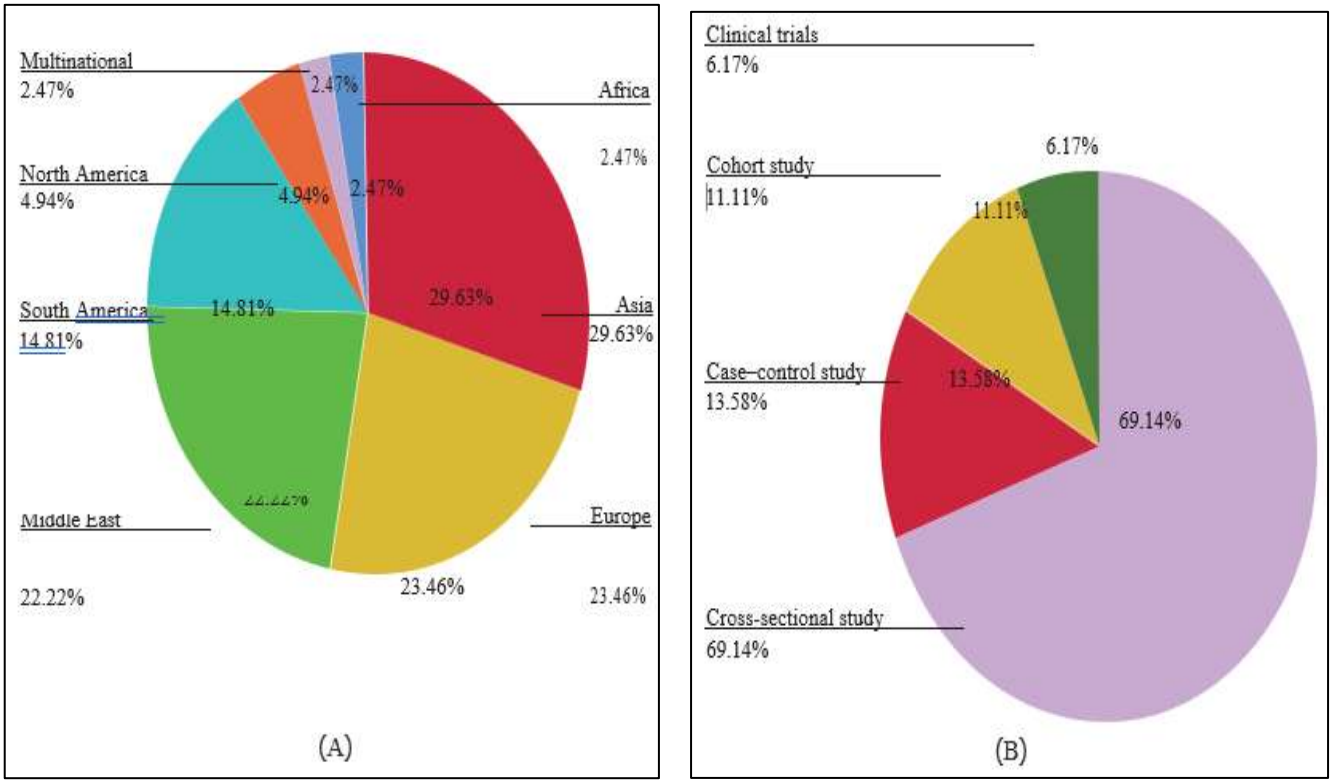

FIGURE 2: Distribution of studies: (A) by location; (B) by study design.

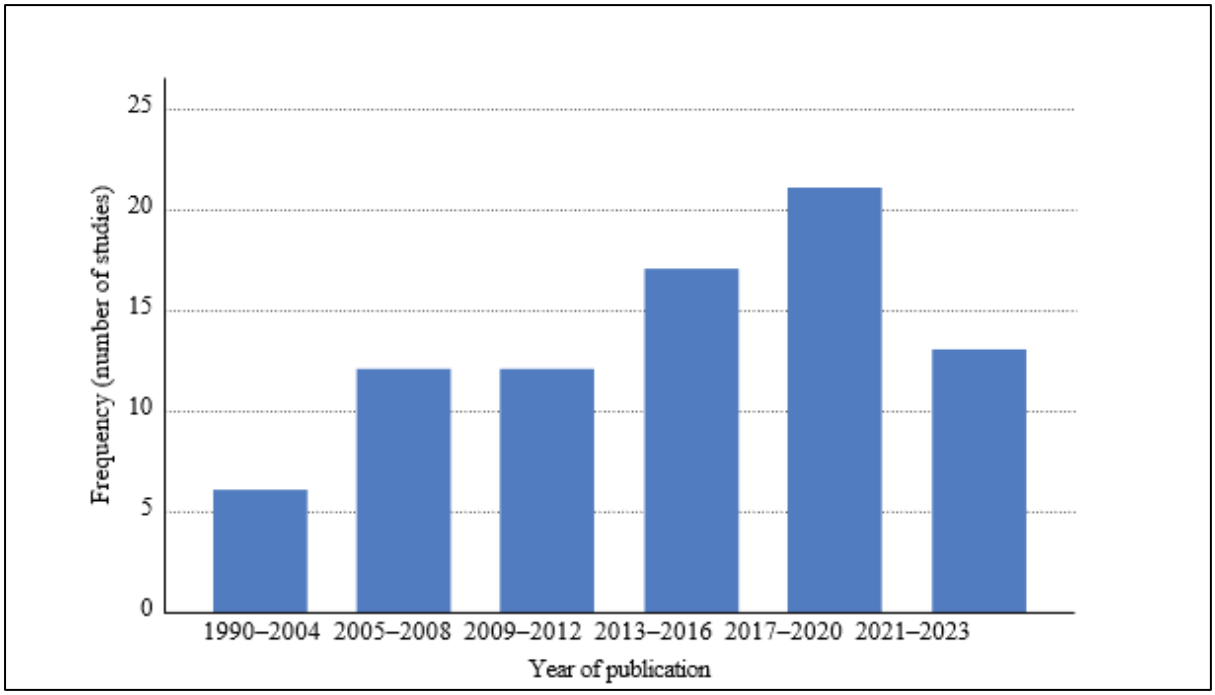

FIGURE 3: Distribution by publication year.

1.1. Search Strategy. This scoping review followed the Joanna Briggs Institute (JBI) Scoping Review Methodology and reported using PRISMA-ScR [21]. Med-line, Embase, and Scopus were searched systematically for relevant English-language literature up to December 2023. In addition to the database search, grey literature was searched. We picked primary research on people, including interventional (e.g., clinical trials) and observational (e.g., cohort and case-control studies). In-vitro, animal, review, and editorial research were omitted. To cover the vast literature, no data constraints were used. MeSH terms and keywords including periodontal disease, periodontitis, health, alveolar bone loss, dialysis, HD, and renal dialysis were employed using wildcards and Boolean operators (Figure S1).

1.2. Selection Process. Duplicates were deleted from database-searched records in EndNote. Two reviewers independently checked the titles and abstracts of the chosen publications for research relevance. Reviewers independently read selected entire texts and resolved differences with two more. were studies were patients with renal failure on HD and those with periodontitis or peri-odontal characteristics. Patients not on HD, those on HD without chronic renal failure, such as acute kidney damage, and those without periodontal health markers were excluded. The PRISMA flowchart (Figure 1) shows search and study selection outcomes.

Data Extraction and Analysis (1.3). Four independent reviewers used Excel to extract data from chosen papers. Name of first author, year of publication, place of origin, research design, participant characteristics, renal and peri-odontal parameters are retrieved from chosen papers. Differences were settled via conversation. Google Sheets generated article summaries. Data was analyzed thematically and summarized into five categories.

2. RESULTS

2.1. Summary of Studies. This review comprised 81 papers from the article selection process (Figure 1, Table S1). Figure 2A shows that Asia (29.6%) and Europe (23.5%) were studied more than the Middle East (22.2%), South America (14.8%), North America (4.9%), Africa (2.5%), and multi-region (2.5%). Cross-sectional (69%), case–control (13.6%), cohort (11.1%), and clinical trials (6.2%) were the most prevalent research designs (Figure 2B).

The publication year analysis showed that most were published between 2013 and 2023, with a concentration between 2017 and 2020 (Figure 3).

2.2. Periodontitis prevalence and severity. In HD patients, periodontitis prevalence ranges from 36.27% to 99.06% (Table S2) [23–37]. Table S1 shows that these studies diagnosed periodontitis using distinct case criteria. Different periodontal measures and classifications may explain the large variance in prevalence reported. Patients' ages also affected periodontitis prevalence. In one research, periodontitis was rare in 30–39-year-olds but 88.9% in 70–79-year-olds [38]. In another research, younger participants aged 16-19 had lower Community Periodontal Index treatment needs (CPITN) scores compared to older patients aged ≥45 [39].

Studies have shown that HD patients had more periodontal disease than healthy controls in terms of probing pocket depth (PPD), attachment loss, gingival bleeding, bone loss, and periodontal inflamed surface area [40–44]. A Chinese research found that HD patients had 2.5-fold more sextants with PPD ≥4 mm and fourfold more clinical attachment loss (CAL) ≥6 mm compared to healthy controls [45]. Another Polish investigation found that HD patients had more severe peri-dontis than the normal population [25].

Some investigations found no significant link between HD and periodontitis, with no significant variations in periodontal measures between HD and non-HD ESRD patients [46, 47]. Interestingly, numerous studies have shown a positive correlation between HD duration and periodontitis severity [27, 48–51], whereas others have found contradicting data [52–54].

Oral Complications (2.3). HD patients with periodontitis often have xerostomia, increased plaque and calculus, and dental caries (Table S3) [55–60]. A large international, prospective research indicated 40% of HD patients with moderate-to-severe periodontitis had high DMFT scores, dental erosion, dry mouth, and oral discomfort [23]. Oral problems also occurred.

Thrush, oral herpes, precancerous mucosal leukoplakia, and erythroplakia [42]. Additionally, salivary pH and red complex bacteria were raised, reducing salivary flow rates [23, 61, 62]. In addition, HD patients exhibit greater amounts of pro-inflammatory cytokines such TNF-α and IL-8 in their gingival crevicular fluid (GCF) compared to healthy controls [63]. These inflammatory cytokines were also positively correlated with clinical periodontal measures in HD patients [63]. This review likewise found no significant variations in inflammatory cytokine levels between HD-treated and non-treated CKD patients [46]. Another research found that HD patients had more HSV-1 in saliva and GCF than healthy individuals [42].

2.4. Comorbidities and Mortality. Periodontal health and other systemic health issues in HD patients have been linked to unfavorable outcomes, including higher mortality (Table S4) [64–66]. Some studies have linked HD patients with moderate-to-severe periodontitis to higher all-cause mortality, whereas others have not [67, 68]. A research found that HD patients with moderate-to-severe periodontitis had 5.3 times the risk of CVD mortality compared to those with mild or healthy periodontium [69]. Diabetics also have lower periodontal health [70]. Additionally, HD patients with moderate-to-severe periodonti-tis had a 2.736-fold greater incidence of metabolic syndrome than healthy controls [71, 72]. HD patients with periodontitis had higher CRP, IL-6, and IL-8 levels, according to many studies [46, 63, 73, 74]. HD patients with severe periodontitis had a 2.64 times higher risk of malnutrition and inflammation.

MIA components [75] and lower serum albumin levels [76–78] than individuals without significant pain. Poor nutritional status, measured by higher subjective global assessment (SGA) ratings, was associated with increased mortality, with each one-unit increase equating to a 62% greater risk of death [79]. A research on HD patients and sarcopenia and periodonti-tis found no correlation [80].

1.2. 2.5. Overall Health Quality of Life. Periodontitis may cause alveolar bone resorption, tooth mobility, and tooth loss, affecting mastication, speech, and OHRQoL (Table S5) [9]. Studies show that HD patients have significant rates of edentulism and poor oral hygiene [58]. HD patients also scored significantly worse on the Geriatric Oral Health Assessment Index (GOHAI-1), typically scoring around 40 (25th percentile [81]). Multiple studies have shown worse oral hygiene and decreased QoL in HD patients with severe periodontitis [31, 32, 82]. HD individuals with periodontitis exhibited lower SF-36 health survey ratings and higher probing depth (PD), gingival index (GI), and plaque index scores [26, 83, 84]. The Oral Health Impact Profile (OHIP-14) also showed poorer ratings for HD patients than healthy controls [26]. Importantly, a research found that HD patients with periodontitis prioritize systemic health above dental health [53]. Mental health issues including sadness and anxiety are also common in this demographic [26].

2.6. Periodontal Treatment Effects. HD periodontal therapy reduces systemic inflammation. Multiple studies have shown that periodontal treatment lowers serum CRP, blood urea nitrogen, and serum albumin (Table S6) [77, 85–88]. A few studies have shown

no significant effect of periodontal therapy on mortality, albumin, or creatinine [89, 90]. Periodontal therapy also improved HD patients' estimated glomerular filtration rates (eGFR) and decreased endothelial function marker asymmetric dimethylarginine (ADMA) [91]. In addition, extensive periodontal care reduces the incidence of infectious illnesses such acute and subacute infective endocarditis, pneumonia, and osteomyelitis in HD patients [13]. Studies show that HD patients struggle to maintain dental health and manage periodontitis [44, 92].

3. DISCUSSION

Most HD patients had moderate-to-severe periodontitis, according to this scoping study. Existing evidence shows that HD patients are more likely to develop xerostomia and dental caries. Periodontitis in HD patients has been linked to systemic complications, mortality, and OHRQoL. Due to these oral health concerns, specific oral care techniques are needed to reduce health and QoL risks. The beneficial health benefits of periodontal therapy on HD patients indicate a way to manage oral and systemic health. Due to inconsistent and poor-quality data and high variability of periodontitis case definitions in the included studies, the existing evidence cannot make causal conclusions or provide evidence-based therapeutic recommendations.

CKD and periodontitis prevalence rises with age [93, 94]. CKD-related systemic inflammation and immune dysregulation can accelerate periodontal destruction, while chronic periodontal infection further contributes to systemic inflammation in older adults, according to previous studies.

renal deterioration and inflammation [95]. This may explain why older HD patients have more periodontitis than younger ones. Periodontitis in HD patients increases mortality risks, CVD mortality, metabolic syndrome mortality, and pneumonia-related mortality, which are similarly linked with advanced age [66, 67, 69, 71]. Even though data is inconsistent, integrated dental care techniques in HD patient treatment may lower comorbidities, mortality, and OHRQoL [77, 85–88]. Comorbidities, age-related oral health issues, and patients' attitudes and perceptions of oral hygiene might make treating oral health difficult [71, 81].

The literature was hampered by periodontitis case definition heterogeneity. Most studies did not provide diagnostic criteria or employ uneven PPD/CAL levels. This discrepancy hinders study comparability and may explain the significant prevalence range. To improve results synthesis, future study should use current categories as the 2017 Classification of Peri-odontal and Peri-Implant Diseases and Conditions [96]. Confounders, such as systemic comorbidities in HD patients with ESRD, are not considered or adjusted for, which lowers the quality of the data given in these trials. The prevalence of cross-sectional and observational research restricts causal conclusions and evidence-based therapeutic recommendations. Despite Australia and New Zealand's high CKD rates, Oceania has few studies [96]. Future research should prioritize varied groups like indigenous peoples. had excessive CKD and periodontitis rates [96, 97].

Most HD patients had moderate-to-severe periodontitis, according to this scoping study. Existing evidence shows that HD patients are more likely to develop xerostomia and dental caries. Periodontitis in HD patients has been linked to systemic complications, mortality, and OHRQoL. Due to these oral health concerns, specific oral care techniques are needed to reduce health and QoL risks. The beneficial health benefits of periodontal therapy on HD patients indicate a way to manage oral and systemic health. Due to inconsistent and poor-quality data and high variability of periodontitis case definitions in the included studies, the existing evidence cannot make causal conclusions or provide evidence-based

therapeutic recommendations.
CKD and periodontitis prevalence rises with age [93, 94]. CKD-related systemic inflammation and immune dysregulation can accelerate periodontal destruction, while chronic periodontal infection further contributes to systemic inflammation in older adults, according to previous studies.
renal deterioration and inflammation [95]. This may explain why older HD patients have more periodontitis than younger ones. Periodontitis in HD patients increases mortality risks, CVD mortality, metabolic syndrome mortality, and pneumonia-related mortality, which are similarly linked with advanced age [66, 67, 69, 71]. Even though data is inconsistent, integrated dental care techniques in HD patient treatment may lower comorbidities, mortality, and OHRQoL [77, 85–88]. Comorbidities, age-related oral health issues, and patients' attitudes and perceptions of oral hygiene might make treating oral health difficult [71, 81].
The literature was hampered by periodontitis case definition heterogeneity. Most studies did not provide diagnostic criteria or employ uneven PPD/CAL levels. This discrepancy hinders study comparability and may explain the significant prevalence range. To improve results synthesis, future study should use current categories as the 2017 Classification of Peri-odontal and Peri-Implant Diseases and Conditions [96]. Confounders, such as systemic comorbidities in HD patients with ESRD, are not considered or adjusted for, which lowers the quality of the data given in these trials. The prevalence of cross-sectional and observational research restricts causal conclusions and evidence-based therapeutic recommendations. Despite Australia and New Zealand's high CKD rates, Oceania has few studies [96]. Future research should prioritize varied groups like indigenous peoples. had excessive CKD and periodontitis rates [96, 97].
Most HD patients had moderate-to-severe periodontitis, according to this scoping study. Existing evidence shows that HD patients are more likely to develop xerostomia and dental caries. Periodontitis in HD patients has been linked to systemic complications, mortality, and OHRQoL. Due to these oral health concerns, specific oral care techniques are needed to reduce health and QoL risks. The beneficial health benefits of periodontal therapy on HD patients indicate a way to manage oral and systemic health. Due to inconsistent and poor-quality data and high variability of periodontitis case definitions in the included studies, the existing evidence cannot make causal conclusions or provide evidence-based therapeutic recommendations.
CKD and periodontitis prevalence rises with age [93, 94]. CKD-related systemic inflammation and immune dysregulation can accelerate periodontal destruction, while chronic periodontal infection further contributes to systemic inflammation in older adults, according to previous studies. renal deterioration and inflammation [95]. This may explain why older HD patients have more periodontitis than younger ones. Periodontitis in HD patients increases mortality risks, CVD mortality, metabolic syndrome mortality, and pneumonia-related mortality, which are similarly linked with advanced age [66, 67, 69, 71]. Even though data is inconsistent, integrated dental care techniques in HD patient treatment may lower comorbidities, mortality, and OHRQoL [77, 85–88]. Comorbidities, age-related oral health issues, and patients' attitudes and perceptions of oral hygiene might make treating oral health difficult [71, 81].
The literature was hampered by periodontitis case definition heterogeneity. Most studies did not provide diagnostic criteria or employ uneven PPD/CAL levels. This discrepancy hinders study comparability and may explain the significant prevalence range. To improve results synthesis, future study should use current categories as the 2017 Classification of Peri-odontal and Peri-Implant Diseases and Conditions [96]. Confounders, such as systemic comorbidities in HD patients with ESRD, are not considered or adjusted for,

which lowers the quality of the data given in these trials. The prevalence of cross-sectional and observational research restricts causal conclusions and evidence-based therapeutic recommendations. Despite Australia and New Zealand's high CKD rates, Oceania has few studies [96]. Future research should prioritize varied groups like indigenous peoples. had excessive CKD and periodontitis rates [96, 97].

Most HD patients had moderate-to-severe periodontitis, according to this scoping study. Existing evidence shows that HD patients are more likely to develop xerostomia and dental caries. Periodontitis in HD patients has been linked to systemic complications, mortality, and OHRQoL. Due to these oral health concerns, specific oral care techniques are needed to reduce health and QoL risks. The beneficial health benefits of periodontal therapy on HD patients indicate a way to manage oral and systemic health. Due to inconsistent and poor-quality data and high variability of periodontitis case definitions in the included studies, the existing evidence cannot make causal conclusions or provide evidence-based therapeutic recommendations.

CKD and periodontitis prevalence rises with age [93, 94]. CKD-related systemic inflammation and immune dysregulation can accelerate periodontal destruction, while chronic periodontal infection further contributes to systemic inflammation in older adults, according to previous studies.

renal deterioration and inflammation [95]. This may explain why older HD patients have more periodontitis than younger ones. Periodontitis in HD patients increases mortality risks, CVD mortality, metabolic syndrome mortality, and pneumonia-related mortality, which are similarly linked with advanced age [66, 67, 69, 71]. Even though data is inconsistent, integrated dental care techniques in HD patient treatment may lower comorbidities, mortality, and OHRQoL [77, 85–88]. Comorbidities, age-related oral health issues, and patients' attitudes and perceptions of oral hygiene might make treating oral health difficult [71, 81].

The literature was hampered by periodontitis case definition heterogeneity. Most studies did not provide diagnostic criteria or employ

uneven PPD/CAL levels. This discrepancy hinders study comparability and may explain the significant prevalence range. To improve results synthesis, future study should use current categories as the 2017 Classification of Peri-odontal and Peri-Implant Diseases and Conditions [96]. Confounders, such as systemic comorbidities in HD patients with ESRD, are not considered or adjusted for, which lowers the quality of the data given in these trials. The prevalence of cross-sectional and observational research restricts causal conclusions and evidence-based therapeutic recommendations. Despite Australia and New Zealand's high CKD rates, Oceania has few studies [96]. Future research should prioritize varied groups like indigenous peoples. had excessive CKD and periodontitis rates [96, 97].

Most HD patients had moderate-to-severe periodontitis, according to this scoping study. Existing evidence shows

that HD patients are more likely to develop xerostomia and dental caries. Periodontitis in HD patients has been linked to systemic complications, mortality, and OHRQoL. Due to these oral health concerns, specific oral care techniques are needed to reduce health and QoL risks. The beneficial health benefits of periodontal therapy on HD patients indicate a way to manage oral and systemic health. Due to inconsistent and poor-quality data and high variability of periodontitis case definitions in the included studies, the existing evidence cannot make causal conclusions or provide evidence-based therapeutic recommendations.

CKD and periodontitis prevalence rises with age [93, 94]. CKD-related systemic inflammation and immune dysregulation can accelerate periodontal destruction, while chronic periodontal infection further contributes to systemic inflammation in older

adults, according to previous studies.
renal deterioration and inflammation [95]. This may explain why older HD patients have more periodontitis than younger ones. Periodontitis in HD patients increases mortality risks, CVD mortality, metabolic syndrome mortality, and pneumonia-related mortality, which are similarly linked with advanced age [66, 67, 69, 71]. Even though data is inconsistent, integrated dental care techniques in HD patient treatment may lower comorbidities, mortality, and OHRQoL [77, 85–88]. Comorbidities, age-related oral health issues, and patients' attitudes and perceptions of oral hygiene might make treating oral health difficult [71, 81].
The literature was hampered by periodontitis case definition heterogeneity. Most studies did not provide diagnostic criteria or employ
uneven PPD/CAL levels. This discrepancy hinders study comparability and may explain the significant prevalence range. To improve results synthesis, future study should use current categories as the 2017 Classification of Peri-odontal and Peri-Implant Diseases and Conditions [96]. Confounders, such as systemic comorbidities in HD patients with ESRD, are not considered or adjusted for, which lowers the quality of the data given in these trials. The prevalence of cross-sectional and observational research restricts causal conclusions and evidence-based therapeutic recommendations. Despite Australia and New Zealand's high CKD rates, Oceania has few studies [96]. Future research should prioritize varied groups like indigenous peoples. had excessive CKD and periodontitis rates [96, 97].

4. CONCLUSION

Periodontitis is shown to be more prevalent among patients with end-stage renal disease (ESRD) who are receiving HD, and it is associated with comorbid diseases, overall health-related quality of life (OHRQoL), and death. The evidence shows that periodontal therapy in HD patients may help lower inflammatory indicators and improve biological parameters, despite the fact that this evidence is limited. An interdisciplinary approach may be helpful in reducing complications and improving outcomes; however, there are inconsistencies in the case definition of periodontitis in the current literature, as well as a lack of clinical trials and longitudinal studies, as well as conflicting evidence. These factors highlight the necessity of well-designed prospective studies that use standardised periodontal assessment protocols in order to improve the understanding of the causal relationship between periodontitis and HD, as well as the underlying biological mechanisms.

Data Availability Statement: It is possible to get the data that backs up the conclusions of this research by looking through the supporting material that is included in this article.

Ethics:There is nothing that the writers have to report.

Confticts of Interest: None of the writers have any conflicts of interest to disclose.

Funding: This project has not been supported by any funding source that has been available.

References

[1] T. K. Chen, D. H. Knicely, and M. E. Grams, "Chronic Kidney Disease Diagnosis and Management: A Review," *JAMA* 322, no. 13 (2019): 1294–1304.
[2] S. Brown, J. J. G. Sanchez, H. Guiang, et al., "IMPACT CKD: Holistic Disease Model

Projecting 10-Year Population Burdens," *Kidney International Reports* 9, no. 11 (2024): 3156–3166.
[3] Chronic Kidney Disease: Australian Facts, https://www.aihw.gov.au/reports/chronic-kidney-disease/chronic-kidney-disease/contents/summary.
[4] A. K. Bello, I. G. Okpechi, M. A. Osman, et al., "Epidemiology of Haemodialysis Outcomes," *Nature Reviews Nephrology* 18, no. 6 (2022): 378–395.
[5] S. S. Hejazi, M. Hosseini, A. Ebadi, and H. Alavi Majd, "Components of Quality of Life in Hemodialysis Patients From Family Caregivers' Perspective: A Qualitative Study," *BMC Nephrology* 22, no. 1 (2021): 379.
[6] M. S. Tonetti, H. Greenwell, and K. S. Kornman, "Staging and Grading of Periodontitis: Framework and Proposal of a New Classification and Case Definition," *Journal of Periodontology* 89 (2018): S159–S172.
[7] D. Trindade, R. Carvalho, V. Machado, L. Chambrone, J. J. Mendes, and J. Botelho, "Prevalence of Periodontitis in Dentate People Between 2011 and 2020: A Systematic Review and Meta-Analysis of Epidemiological Studies," *Journal of Clinical Periodontology* 50, no. 5 (2023): 604–626.
[8] G. G. Nascimento, S. Alves-Costa, and M. Romandini, "Burden of Severe Periodontitis and Edentulism in 2021, With Projections up to 2050: The Global Burden of Disease 2021 Study," *Journal of Periodontal Research* 59, no. 5 (2024): 823–867.
[9] A. Łasica, P. Golec, A. Laskus, M. Zalewska, M. Gędaj, and M. Popowska, "Periodontitis: Etiology, Conventional Treat- ments, and Emerging Bacteriophage and Predatory Bacteria Therapies," *Frontiers in Microbiology* 15 (2024): 1469414.
[10] T. Vos, A. A. Abajobir, K. H. Abate, et al., "Abera SF: Global, Regional, and National Incidence, Prevalence, and Years Lived With Disability for 328 Diseases and Injuries for 195 countries, 1990–2016: A Systematic Analysis for the Global Burden of Disease Study 2016," *The Lancet* 390, no. 10100 (2017): 1211–1259.
[11] D. Huang, Y.-Y. Wang, B.-H. Li, et al., "Association Between Periodontal Disease and Systemic Diseases: A Cross-Sectional Analysis of Current Evidence," *Military Medical Research* 11, no. 1 (2024): 74.
[12] Y. Miyata, Y. Obata, Y. Mochizuki, et al., "Periodontal Disease in Patients Receiving Dialysis," *International Journal of Molecular Sciences* 20, no. 15 (2019): 3805.
[13] S.-T. Huang, C.-L. Lin, and C.-H. Kao, "Periodontal Treatment Reduces Risks of Hospitalisation for Infectious Diseasesin the Hemodialysis Patients," *Nephrology Dialysis Transplantation* 30, no. suppl_3 (2015): iii328-iii329.
[14] H. Lu, H. Wu, Y. Yang, et al., "Relationship Between Chronic Periodontitis and Inflammatory Cytokines in Patients Undergoing Maintenance Hemodialysis," *Clinical Oral Investigations* 26, no. 11 (2022): 6699–6709.
[15] S. Deschamps-Lenhardt, R. Martin-Cabezas, T. Hannedouche, and O. Huck, "Association Between Periodontitis and Chronic Kidney Disease: Systematic Review and Meta-Analysis," *Oral Diseases* 25, no. 2 (2019): 385–402.
[16] J. T. Klassen and B. M. Krasko, "The Dental Health Status of Dialysis Patients," *Journal (Canadian Dental Association)* 68, no. 1 (2002): 34–38.
[17] F. M. Iorember, "Malnutrition in Chronic Kidney Disease," *Frontiers in Pediatrics* 6 (2018): 161.
[18] J. Limeres, J. Garcez, J. Marinho, A. Loureiro, M. Diniz, and P. Diz, "Early Tooth Loss in End-Stage Renal Disease Patients on Haemodialysis," *Oral*

Diseases 22, no. 6 (2016): 530–535.
[19] R. Craig, "Interactions Between Chronic Renal Disease and Periodontal Disease," *Oral Diseases* 14, no. 1 (2008): 1–7.
[20] J. Šedý, E. Horká, R. Foltán, J. Špačková, and J. Dušková,
"Mechanism of Increased Mortality in Hemodialysed Patients With Periodontitis," *Medical Hypotheses* 74, no. 2 (2010):
374–376.
[21] A. C. Tricco, E. Lillie, W. Zarin, et al., "PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation," *Annals of Internal Medicine* 169, no. 7 (2018): 467–473.
[22] M. J. Page, J. E. McKenzie, P. M. Bossuyt, et al., "Statement: An Updated Guideline for Reporting Systematic Reviews," *BMJ* 2021 (2020): 372.
[23] Y. Takeuchi, H. Ishikawa, M. Inada, O. Shinozuka, M. Umeda, and T. Yamazaki, "Study of the Oral Microbial Flora in Patients With Renal Disease," *Nephrology* 12, no. 2 (2007): 182–190.
[24] E. Dembowska, A. Jaroń, J. Rasławska-Socha, et al., "The Evaluation of the Periodontal Status of Hemodialysis Patients With End-Stage Renal Disease," *Journal of Clinical Medicine* 11, no. 4 (2022): 975.
[25] J. Borawski, M. Wilczyńska-Borawska, W. Stokowska, and
M. Myśliwiec, "The Periodontal Status of Pre-Dialysis Chronic Kidney Disease and Maintenance Dialysis Patients," *Nephrol- ogy Dialysis Transplantation* 22, no. 2 (2007): 457–464.
[26] F. Camacho-Alonso, C. Cánovas-García, C. Martínez-Ortiz, et al., "Oral Status, Quality of Life, and Anxiety and Depression in Hemodialysis Patients and the Effect of the Duration of Treatment by Dialysis on These Variables," *Odontology* 106, no. 2 (2018): 194–201.
[27] M. Cengiz, P. Sümer, S. Cengiz, and U. Yavuz, "The Effect of the Duration of the Dialysis in Hemodialysis Patients on Dental and Periodontal Findings," *Oral Diseases* 15, no. 5 (2009): 336–341.
[28] E. Guzeldemir, H. U. Toygar, B. Tasdelen, and D. Torun, "Oral Health–related Quality of Life and Periodontal Health Status in Patients Undergoing Hemodialysis," *The Journal of the American Dental Association* 140, no. 10 (2009): 1283–
1293.
[29] K. Kotecha, R. Ridout, M. Shah, et al., "High Prevalence of Periodontal Disease Observed in Patients on Hemodialysis: A Call for Equitable Access to Dental Care," *Kidney International Reports* 7, no. 9 (2022): 2097–2100.
[30] G. Schmalz, N. Schiffers, S. Schwabe, et al., "Dental and Periodontal Health, and Microbiological and Salivary Conditions in Patients With or Without Diabetes Undergoing Haemodialysis," *International Dental Journal* 67, no. 3 (2017):
186–193.
[31] G. Veisa, A. Tasmoc, I. Nistor, et al., "The Impact of Periodontal Disease on Physical and Psychological Domains in Long-Term Hemodialysis Patients: A Cross-Sectional Study," *International Urology and Nephrology* 49, no. 7 (2017):
1261–1266.
[32] G. Schmalz, O. Kollmar, R. Vasko, G. A. Müller, R. Haak, and
D. Ziebolz, "Oral Health-Related Quality of Life in Patients on Chronic Haemodialysis and After Kidney Transplantation," *Oral Diseases* 22, no. 7 (2016): 665–672.
[33] A. Abou-Bakr, R. R. Hussein, E. Khalil, and E. Ahmed, "The Frequency of Periodontitis in End-Stage Renal Disease on Hemodialysis in a Sample of Egyptian Population: Multi- Center Clinical Cross-Sectional Study," *BMC Oral Health* 22, no. 1

(2022): 1.
[34] Y. J. Kim, Moura LMd, C. P. Caldas, C. Perozini, G. F. Ruivo, and D. Pallos, "Evaluation of Periodontal Condition and Risk in Patients With Chronic Kidney Disease on Hemodialysis," *Einstein* 15, no. 2 (2017): 173–177.
[35] S. C. Palmer, M. Ruospo, G. Wong, et al., "Patterns of Oral Disease in Adults With Chronic Kidney Disease Treated With Hemodialysis," *Nephrology Dialysis Transplantation* 31, no. 10 (2016): 1647–1653.
[36] S. Parkar and C. Ajithkrishnan, "Periodontal Status in Patients Undergoing Hemodialysis," *Indian Journal of Nephrology* 22, no. 4 (2012): 246–250.
[37] F. Kiany Yazdi, N. Karimi, M. Rasouli, and J. Roozbeh, "Effect of Nonsurgical Periodontal Treatment on C-Reactive Protein Levels in Maintenance Hemodialysis Patients," *Renal Failure* 35, no. 5 (2013): 711–717.
[38] Y. Hou, X. Wang, C. X. Zhang, et al., "Risk Factors of Periodontal Disease in Maintenance Hemodialysis Patients," *Medicine* 96, no. 35 (2017): e7892.
[39] I. Duran and E. O. Erdemir, "Periodontal Treatment Needs of Patients With Renal Disease Receiving Haemodialysis," *International Dental Journal* 54, no. 5 (2004): 274–278.
[40] D. M. Ghalwash, A. A.-B. Ras, E. Khalil, and E. Ahmed, "Assessment of Serum and Gingival Crevicular Fluid Level of Fibroblast Growth Factor 23 in Patients Having Diseased Periodontium with and without End-Stage Renal Disease: A Cross-Sectional Analytical Study," *Journal of International Oral Health* 14, no. 6 (2022): 603–611.
[41] L. Ma, X. Jin, Y. Cao, Z. Xu, S. Xing, and B. Xu, "Periodontal Status of Patients Undergoing Peritoneal Dialysis or Hemodialysis," *International Journal of Clinical and Experimental Medicine* 9, no. 8 (2016): 16759–16764.
[42] D. Pallos, G. F. Ruivo, S. H. Ferrari-Junior, et al., "Periodontal Disease and Detection of Human Herpesviruses in Saliva and Gingival Crevicular Fluid of Chronic Kidney Disease Patients," *Journal of Periodontology* 91, no. 9 (2020): 1139–1147.
[43] V. Raeesi, M. Mohammadi Moghaddam, A. Naghavi, and
G. Mozafari, "The Effect of Scaling and Root Planning on the Periodontal Condition in Hemodialysis Patients: A Clinical Trial Study," *Health Science Reports* 6, no. 8 (2023): e1520.
[44] B. Križan Smojver, K. Altabas, M. Knotek, N. Bašić Jukić, and
A. Aurer, "Periodontal Inflamed Surface Area in Patients on Haemodialysis and Peritoneal Dialysis: A Croatian Cross- Sectional Study," *BMC Oral Health* 20, no. 1 (2020): 95.
[45] D. Zhao, S. Zhang, X. Chen, et al., "Evaluation of Periodontitis and Bone Loss in Patients Undergoing Hemodialysis," *Journal of Periodontology* 85, no. 11 (2014): 1515–1520.
[46] V. Kopić, J. Barbić, S. Petrović, et al., "Periodontal Disease in Different Stages of Chronic Kidney Disease," *Acta Clinica Croatica* 58 (2019): 709–715.
[47] S. Frankenthal, F. Nakhoul, E. Machtei, et al., "The Effect of Secondary Hyperparathyroidism and Hemodialysis Therapy on Alveolar Bone and Periodontium," *Journal of Clinical Periodontology* 29, no. 6 (2002): 479–483.
[48] N. Jenabian, A. M. G. Mirsaeed, H. Ehsani, and A. Kiakojori, "Periodontal Status of Patient's Underwent Hemodialysis Therapy," *Caspian Journal of Internal Medicine* 4, no. 2 (2013): 658.
[49] G. Bayraktar, I. Kurtulus, A. Duraduryan, et al., "Dental and Periodontal Findings in Hemodialysis Patients," *Oral Diseases* 13, no. 4 (2007): 393–397.
[50] L.-P. Chen, C.-K. Chiang, C.-P. Chan, K.-Y. Hung, and C.-
S. Huang, "Does Periodontitis Reflect Inflammation and Malnutrition Status in Hemodialysis Patients?" *American Journal of Kidney Diseases* 47, no. 5 (2006): 815–822.
[51] R. T. Sekiguchi, C. M. Pannuti, H. T. Silva Jr, J. O. Medina- Pestana, and G. A. Romito, "Decrease in Oral Health May be Associated With Length of Time since Beginning

Dialysis," *Special Care in Dentistry* 32, no. 1 (2012): 6–10.
[52] I. Marakoglu, U. K. Gursoy, S. Demirer, and H. Sezer, "Periodontal Status of Chronic Renal Failure Patients Receiving Hemodialysis," *Yonsei Medical Journal* 44, no. 4 (2003): 648–652.
[53] A. Hajian-Tilaki, F. Oliae, N. Jenabian, K. Hajian-Tilaki, and
M. Motallebnejad, "Oral Health-Related Quality of Life and Periodontal and Dental Health Status in Iranian Hemodialysis Patients," *The Journal of Contemporary Dental Practice* 15, no. 4 (2015): 482–490.
[54] A. Castillo, F. Mesa, J. Liébana, et al., "Periodontal and Oral Microbiological Status of an Adult Population Undergoing Haemodialysis: A Cross-Sectional Study," *Oral Diseases* 13, no. 2 (2007): 198–205.
[55] C. Gavalda, J. Bagán, C. Scully, F. Silvestre, M. Milián, and
Y. Jimenez, "Renal Hemodialysis Patients: Oral, Salivary, Dental and Periodontal Findings in 105 Adult Cases," *Oral Diseases* 5, no. 4 (1999): 299–302.
[56] G. Bayraktar, I. Kurtulus, R. Kazancioglu, et al., "Evaluation of Periodontal Parameters in Patients Undergoing Peritoneal Dialysis or Hemodialysis," *Oral Diseases* 14, no. 2 (2008): 185–189.
[57] I. T. Parente, Z. R. Lima, L. H. Teixeira, et al., "Gingivitis, Increased Probing Depth, Clinical Attachment Loss and Tooth Loss Among Patients With End-Stage Chronic Kidney Disease: A Case-Control Study," *Journal of Public Health* 26, no. 1 (2018): 75–80.
[58] F. L. Cunha, E. P. Tagliaferro, A. C. Pereira, M. C. Meneghim, and E. Hebling, "Oral Health of a Brazilian Population on Renal Dialysis," *Special Care in Dentistry* 27, no. 6 (2007): 227–231.
[59] G. Teratani, S. Awano, I. Soh, et al., "Oral Health in Patients on Haemodialysis for Diabetic Nephropathy and Chronic Glomerulonephritis," *Clinical Oral Investigations* 17, no. 2 (2013): 483–489.
[60] S. A. Torres, O. P. D. S. Rosa, M. F. Hayacibara,
M. D. C. M. Guimarães, R. M. Hayacibara, and W. A. Bretz, "Periodontal Parameters and BANA Test in Patients With Chronic Renal Failure Undergoing Hemodialysis," *Journal of Applied Oral Science* 18, no. 3 (2010): 297–302.
[61] A. Tawfig, B. Jamal, R. Eskandrani, et al., "Assessment of Periodontal Disease Severity Among Patients at Different Stages of Chronic Kidney Disease," *Journal of International Oral Health* 8, no. 3 (2016): 307–312.
[62] X. Duan, X. Chen, M. Gupta, et al., "Salivary Microbiome in Patients Undergoing Hemodialysis and Its Associations With the Duration of the Dialysis," *BMC Nephrology* 21, no. 1 (2020): 414.
[63] A. Dağ, E. Fırat, A. Kadiroğlu, E. Kale, and M. Yılmaz, "Significance of Elevated Gingival Crevicular Fluid Tumor Necrosis Factor-α and Interleukin-8 Levels in Chronic Hemodialysis Patients With Periodontal Disease," *Journal of Periodontal Research* 45, no. 4 (2010): 445–450.
[64] C. M. De Souza, APR. Braosi, S. M. Luczyszyn, et al., "Association Among Oral Health Parameters, Periodontitis, and Its Treatment and Mortality in Patients Undergoing
[65] Hemodialysis," *Journal of Periodontology* 85, no. 6 (2014): e169–e178.
[66] K. Mizutani, R. Mikami, T. Gohda, et al., "Poor Oral Hygiene and Dental Caries Predict High Mortality Rate in Hemodialy- sis: A 3-Year Cohort Study," *Scientific Reports* 10, no. 1 (2020): 21872.
[67] M. Iwasaki, G. W. Taylor, S. Awano, et al., "Periodontal Disease and Pneumonia Mortality in Haemodialysis Patients: A 7-Year Cohort Study," *Journal of Clinical Periodontology* 45, no. 1 (2018): 38–45.

[68] L.-P. Chen, C.-K. Chiang, Y.-S. Peng, et al., "Relationship Between Periodontal Disease and Mortality in Patients Treated With Maintenance Hemodialysis," *American Journal of Kidney Diseases* 57, no. 2 (2011): 276–282.
[69] M. Ruospo, S. C. Palmer, G. Wong, et al., "Periodontitis and Early Mortality Among Adults Treated With Hemodialysis: A Multinational Propensity-Matched Cohort Study," *BMC Nephrology* 18, no. 1 (2017): 166.
[70] A. V. Kshirsagar, R. G. Craig, K. L. Moss, et al., "Periodontal Disease Adversely Affects the Survival of Patients With End- Stage Renal Disease," *Kidney International* 75, no. 7 (2009):746–751.
[71] L. A. Swapna, R. S. Reddy, T. Ramesh, et al., "Oral Health Status in Haemodialysis Patients," *Journal of Clinical and Diagnostic Research* 7, no. 9 (2013): 2047.
[72] L.-P. Chen, S.-P. Hsu, Y.-S. Peng, C.-K. Chiang, and K.-
Y. Hung, "Periodontal Disease is Associated With Metabolic Syndrome in Hemodialysis Patients," *Nephrology Dialysis Transplantation* 26, no. 12 (2011): 4068–4073.
[73] M. Tavakoli, M. Izadi, J. Yaghini, A. Rastegari, and
A. M. Abed, "A Survey on the Effects of Metabolic Syndrome on the Periodontal Indices of Hemodialysis Patients," *Dental Research Journal* 13, no. 4 (2016): 333–337.
[74] C. Baioni, C. De Souza, A. Ribeiro Braosi, et al., "Analysis of the Association of Polymorphism in the Osteoprotegerin Gene With Susceptibility to Chronic Kidney Disease and Periodonti- tis," *Journal of Periodontal Research* 43, no. 5 (2008): 578–584.
[75] L. Sharma, R. K. Sharma, V. K. Reddy, et al., "Dental and Periodontal Disease in Hemodialysis Patients is Associated With Inflammation; A Study From North India," *Journal of Renal Injury Prevention* 7, no. 4 (2018): 301–306.
[76] R. Mikami, K. Mizutani, T. Gohda, et al., "Malnutrition- Inflammation-Atherosclerosis (MIA) Syndrome Associates With Periodontitis in End-Stage Renal Disease Patients Undergoing Hemodialysis: A Cross-Sectional Study," *Scientific Reports* 13, no. 1 (2023): 11805.
[77] A. V. Kshirsagar, R. G. Craig, J. D. Beck, et al., "Severe Periodontitis is Associated With Low Serum Albumin Among Patients on Maintenance Hemodialysis Therapy," *Clinical Journal of the American Society of Nephrology* 2, no. 2 (2007): 239–244.
[78] N. Naghsh, N. K. Sabet, F. Vahidi, A. Mogharehabed, and
J. Yaghini, "Relationship Between Periodontal Disease and Serum Factors in Patients Undergoing Hemodialysis," *The Open Dentistry Journal* 11, no. 1 (2017): 701–709.
[79] V. P. Rodrigues, S. A. Libério, F. F. Lopes, et al., "Periodontal Status and Serum Biomarkers Levels in Haemodialysis Patients," *Journal of Clinical Periodontology* 41, no. 9 (2014):862–868.
[80] G. Veisa, M.-D. Donciu, L. Segal, et al., "Albumin as a Prognostic Factor for Malnutrition and Inflammation in Chronic Kidney Disease," *Revista de Chimie* 67, no. 1 (2016): 103–105.
[81] P. Kovačević, M. Maver Bišćanin, S. Cvijetić Avdagić,
K. Kovačević, V. Altabas, and K. Altabas, "Correlation of Sarcopenia and Periodontitis in Patients on Chronic Hemodialysis," *Acta Clinica Croatica* 60, no. Supplement 1 (2021): 57–63.
[82] P. Kahar, C. A. Chapman, S. Brahmbhatt, and D. Khanna, "Assessment of the Effects of Occluding Pairs of Teeth on Oral Health-Related Quality of Life Among Dialysis Patients," *The Journal of Contemporary Dental Practice* 22, no. 2 (2021):
156–161.
[83] E. Dembowska, A. Jaroń, E. Gabrysz-Trybek, J. Bladowska,
S. Gacek, and G. Trybek, "Quality of Life in Patients With End-Stage Renal Disease Undergoing Hemodialysis," *Journal of Clinical Medicine* 11, no. 6 (2022): 1584.

[84] M. Iwasaki, W. S. Borgnakke, S. Awano, et al., "Periodontitis and Health-Related Quality of Life in Hemodialysis Patients," *Clinical and Experimental Dental Research* 3, no. 1 (2017): 13–18.
[85] B. F. Oduncuoğlu, E. E. Alaaddinoğlu, T. Colak, A. Akdur, and M. Haberal, "Effects of Renal Transplantation and Hemodialysis on Patient's General Health Perception and Oral Health–Related Quality of Life: A Single-Center Cross- Sectional Study," in *Transplantation Proceedings*, (Elsevier, 2020): 785–792.
[86] M. Siribamrungwong and K. Puangpanngam, "Treatment of Periodontal Diseases Reduces Chronic Systemic Inflammation in Maintenance Hemodialysis Patients," *Renal Failure* 34, no. 2 (2012): 171–175.
[87] S. M. Vrinda, A. Sadasivan, E. Koshi, B. Unnikrishnan,
N. D. Chandradas, and I. R. Saraswathi, "Effect of Nonsurgi- cal Periodontal Therapy on C-Reactive Protein and Iron Indices in Hemodialysis Patients," *Journal of Indian Society of Periodontology* 25, no. 6 (2021): 485–490.
[88] A. K. Kadiroglu, E. T. Kadiroglu, D. Sit, A. Dag, and
M. E. Yilmaz, "Periodontitis is an Important and Occult Source of Inflammation in Hemodialysis Patients," *Blood Purification* 24, no. 4 (2006): 400–404.
[89] F. Fang, B. Wu, Q. Qu, et al., "The Clinical Response and Systemic Effects of Non-Surgical Periodontal Therapy in End- Stage Renal Disease Patients: A 6-Month Randomized Controlled Clinical Trial," *Journal of Clinical Periodontology* 42, no. 6 (2015): 537–546.
[90] W.-C. Chung, C.-C. Kao, C.-F. Huang, C.-Y. Lee, H.-K. Lu,
and M.-S. Wu, "Effects of Periodontal Treatment in Patients With Periodontitis and Kidney Failure: A Pilot Study," *International Journal of Environmental Research and Public Health* 19, no. 3 (2022): 1533.
[91] B. Rapone, I. Converti, L. Santacroce, et al., "Impact of Periodontal Inflammation on Nutrition and Inflammation Markers in Hemodialysis Patients," *Antibiotics* 8, no. 4 (2019): 209.
[92] S. Almeida, C. Figueredo, C. Lemos, R. Bregman, and
R. Fischer, "Periodontal Treatment in Patients With Chronic Kidney Disease: A Pilot Study," *Journal of Periodontal Research* 52, no. 2 (2017): 262–267.
[93] F. Brito, S. Almeida, C. Figueredo, R. Bregman, J. Suassuna, and R. Fischer, "Extent and Severity of Chronic Periodontitis in Chronic Kidney Disease Patients," *Journal of Periodontal Research* 47, no. 4 (2012): 426–430.
[94] J. Gu and H. You, "Global and Regional Drivers of Chronic Kidney Disease Burden in Older Adults: The Dominant Role of High Fasting Plasma Glucose and the Rise of Obesity in
China," *Archives of Gerontology and Geriatrics* 139 (2025): 106006.
[95] X. Ju, J. Harford, L. Luzzi, and L. M. Jamieson, "Prevalence, Extent, and Severity of Periodontitis Among Australian Older Adults: Comparison of Two Generations," *Journal of Periodontology* 93, no. 9 (2022): 1387–1400.
[96] L. Chambrone, A. M. Foz, M. R. Guglielmetti, et al., "Periodontitis and Chronic Kidney Disease: A Systematic Review of the Association of Diseases and the Effect of Periodontal Treatment on Estimated Glomerular Filtration Rate," *Journal of Clinical Periodontology* 40, no. 5 (2013): 443–
456.
[97] J. G. Caton, G. Armitage, T. Berglundh, et al., *A New Classification Scheme for Periodontal and Peri-Implant Diseases and Conditions–Introduction and Key Changes From the 1999 Classification*,