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Oral Health Status in Diabetic and Non-Diabetic Patients with End-Stage Renal Disease Undergoing Haemodialysis: A Cross-Sectional Study

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Abstract

Background: *chronic kidney disease (CKD) requiring haemodialysis is associated with multiple systemic and oral manifestations. These may be compounded in patients with co-existing diabetes mellitus (DM), which alters salivary composition, immune function, and tissue healing. This study compares oral and dental manifestations among diabetic and non-diabetic patients with end-stage renal disease (ESRD) undergoing haemodialysis.*

Methods: *This hospital-based cross-sectional study was conducted at a tertiary care centre on 120 ESRD patients receiving maintenance haemodialysis, divided into diabetic (n=60) and non-diabetic (n=60) groups. Data were collected through clinical examination, structured questionnaire, salivary pH testing, DMFT index scoring, and CPI index assessment. Statistical analysis included Chi-square and Student's t-test, with $p<0.05$ considered significant.*

Results: *Xerostomia, tongue coating, candidiasis, and higher DMFT scores were significantly more prevalent in diabetics. Salivary pH was significantly lower in diabetics (mean 5.32 vs. 6.22, $p<0.01$). Periodontal status was worse in diabetics, with more CPI Code 4 findings. No significant difference was observed in serum urea and creatinine levels. Uremic fetor and dysgeusia were more common in non-diabetics.*

Conclusion: *Oral manifestations in ESRD patients on haemodialysis are more pronounced and complex in the presence of diabetes mellitus. Regular oral screening and integrated care are essential to improve quality of life and prevent complications in this vulnerable population.*

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Introduction

chronic kidney disease (CKD) is recognized as a major global health burden and a leading cause of morbidity and mortality in the 21st century [1]. Its primary risk factors include hypertension, obesity, and diabetes mellitus [2,3]. Alarmingly, over 850 million individuals worldwide are affected by various stages of CKD, with many cases diagnosed only during the advanced or terminal phases of the disease [3]. An estimated 4 million patients require some form of kidney replacement therapy (KRT) [4].

Improving Global Outcomes (KDIGO 2024) CKD Work Group was characterized by a persistent abnormality in kidney structure or function lasting over three months. This included a glomerular filtration rate (GFR) below 60 mL/min/1.73 m² or albuminuria of 30 mg or more per 24 hours [4]. As CKD advances to end-stage renal disease (ESRD), affected individuals often depend on lifelong haemodialysis for survival [3,5]. Dialysis is utilized to manage acute declines in renal function, serve as a bridge to transplantation, or as a long-term therapy in patients unsuitable for transplant. Limited availability of organ donors has led to increased dependence on dialysis, emphasizing the need to promote organ donation to enhance outcomes in patients with end-stage renal disease (ESRD) [5]. While the systemic complications of CKD and its treatment are well-recognized, their oral implications remain underappreciated [6,7].

Patients undergoing haemodialysis [figure 6] commonly present with a spectrum of oral manifestations, including xerostomia, mucosal ulcerations, dysgeusia (altered taste), and heightened vulnerability to oral infections [8-11].

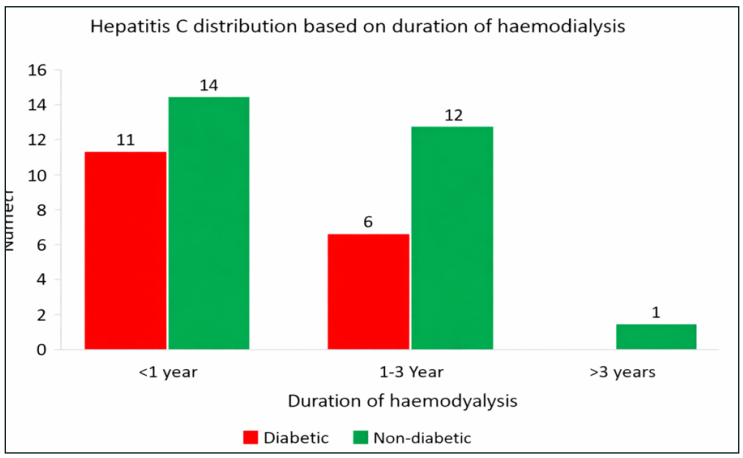

Figure 6: Prevalence of Hepatitis C

Patients reported symptoms like dry mouth, altered taste, and mucosal pain. Clinically, common findings included dental caries, periodontal issues, and various oral lesions such as pallor, uremic Odor, tongue coating, ecchymosis, petechiae, ulcers, hyperpigmentation, candidiasis, herpes labialis, enamel hypocalcification, and signs of renal osteodystrophy in the jaws [9,10,12,13]. To address the research gap, this study undertook a comprehensive evaluation of the various oral mucosal and dental health complications observed in both diabetic and non-diabetic patients undergoing haemodialysis.

It systematically investigated the complex oral and dental health challenges experienced by haemodialysis patients, whether diabetic or non-diabetic.

Materials and Methods

Study Design

This hospital-based, single-centre cross-sectional study was conducted between January 2024 and December 2024 through collaboration between the Department of Oral Medicine and Radiology and the Department of Nephrology at SCB Medical College and Hospital (SCBMCH), Cuttack, Odisha. As a gov-

ernment tertiary care institution, SCBMCH provides integrated medical, dental, and paramedical services, and serves as a referral centre for eastern India. Ethical approval was obtained from the Institutional Ethics Committee, SCB Dental College (IEC/SCBDCH/204/2023). Informed written consent was taken from all participants after explaining the study in their local language. Participation was voluntary, with assured confidentiality and the right to withdraw anytime. No added risk or cost was involved. The study followed standard infection control and complied with the Declaration of Helsinki and ICMR guidelines. The study aimed to evaluate and compare oral and dental manifestations among patients with end-stage renal disease (ESRD) undergoing maintenance haemodialysis, with and without coexisting diabetes mellitus.

Inclusion and Exclusion Criteria

For Group A (diabetic ESRD patients), inclusion criteria comprised a confirmed diagnosis of CKD Stage 3 or higher, undergoing haemodialysis for ≥3 months, with a prior diagnosis of Type 1 or Type 2 diabetes mellitus. Patients were required to be ≥18 years of age, mentally competent, and able to provide written informed consent, with recent HbA1c values available. Exclusion criteria included diabetes duration <6 months, uncontrolled complications, unrelated systemic diseases (e.g., autoimmune disorders, malignancies), medications influencing oral health, recent major dental procedures, edentulism, alternative dialysis modalities, renal transplant history, pregnancy, substance abuse, or severe psychiatric illness.

Group B shared all inclusion criteria except for the presence of diabetes. Participants were required to have no history or evidence of diabetes or prediabetes, confirmed with HbA1c <6.5%. The same exclusion criteria applied.

Study Population and Data Collection

The study included 120 participants (60 per group), recruited via consecutive convenience sampling from dialysis units and outpatient clinics at SCBMCH and SCBDCH. Data collection occurred in four structured phases: (1) medical and demographic history via questionnaire; (2) clinical examination by a calibrated examiner using DMFT and CPI indices; (3) review of laboratory data including HbA1c, serum urea, and creatinine from recent records; and (4) assessment of unstimulated salivary pH using a digital pH meter. Subjective symptoms such as xerostomia, dysgeusia, and mucosal pain were recorded using a 100-mm Visual Analogue Scale. Clinical signs including mucosal lesions, uraemic odour, and tongue changes were documented using standardised criteria. Digital panoramic radiographs were obtained to detect jaw-related osseous changes.

Statistical-Analysis

Data were entered in Microsoft Excel and analysed using SPSS version 20. Descriptive statistics (mean, standard deviation, frequencies, and percentages) were calculated. Normality was assessed using the Shapiro–Wilk test. The independent t-test compared group means, while Chi-square or Fisher's exact test was applied for categorical data. Pearson's correlation assessed relationships between variables. A P value < 0.05 was considered statistically significant.

Outcome Measures

Primary outcomes included the prevalence and severity of subjective and objective oral manifestations. Secondary outcomes included correlation with glycaemic status, duration of dialysis, and biochemical parameters.

Statistical Analysis

Data were entered in Microsoft Excel and analysed using SPSS version 20. Descriptive statistics (mean, standard deviation, frequencies, and percentages) were calculated. The normality of data was tested using the Shapiro Wilk test. An independent t-test was used to compare mean values between the two groups. Categorical variables were analysed using Chi-square or Fisher's exact test. Pearson's correlation was applied to assess relationships between variables. A P value < 0.05 was considered statistically significant.

Results

The present study included 120 participants undergoing haemodialysis, equally divided into diabetic and non-diabetic groups (n=60 each). The mean age of diabetic patients was significantly higher (58.08 ± 12.71 years) than non-diabetics (46.71 ± 15.84 years, $p < 0.001$). Gender distribution was comparable between groups, with no statistically significant difference ($p = 0.57$). Socioeconomic status differed significantly: a greater proportion of diabetics belonged to

upper and upper-middle classes, while non-diabetics were concentrated in lower and upper-lower strata ($p < 0.001$).

The mean duration of haemodialysis was significantly shorter in diabetics (8.93 ± 4.28 months) than non-diabetics (12.38 ± 6.84 months, $p = 0.001$). Among diabetics, 36.67% had HbA1c ≤6%, 35% had 6.1–9%, and 28.33% had ≥9%, indicating suboptimal glycaemic control in a considerable proportion. Salivary pH was significantly more acidic in diabetics (6.75 ± 0.32) compared to non-diabetics (7.87 ± 0.44, $p < 0.001$) [Figure 1, table 2] Within diabetics, salivary pH showed a significant inverse relationship with HbA1c levels ($p < 0.001$).

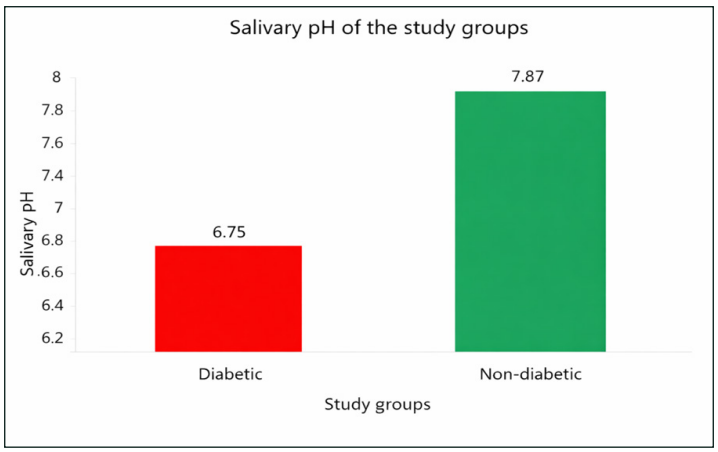

Figure 1: Bar Graph Showing Mean Salivary Ph of the Study Groups

Study groups	Mean Salivary pH	Mean DMFT	r value	P value
Diabetic	6.75±0.32	9.43±3.92	0.030	0.81 (NS)
Pearsons's correlation (r); P<0.05 (S)				

Table 2: Correlation Between Salivary Ph and Daft Among the Diabetic Group

The prevalence of hepatitis C across dialysis durations did not differ significantly between groups ($p = 0.56$). Objective uremic oral manifestations showed significantly higher rates of uremic odour (71.67%), tongue coating (58.33%), and tongue pallor (61.66%) among diabetics compared to non-diabetics, with respective p values of 0.03, 0.009, and 0.001 [Table 1].

Subjective manifestations	Diabetic (60)	Non-diabetic (60)	P value
Uremic odor	43 (71.7%)	31 (51.7%)	0.03 (S)
Tongue coating	35 (58.3%)	16 (26.7%)	0.009 (S)
Angular cheilitis	21 (35.0%)	14 (23.3%)	0.55 (NS)
Candidiasis	2 (3.33%)	0(0.0%)	0.47 (NS)
Herpes labialis	5 (8.3%)	2 (3.33%)	0.71 (NS)
Tongue pallor,	37 (61.7%)	56 (93.3%)	0.001 (S)
Mucosal petechiae	00	00	
Hyperpigmentation	34 (56.7%)	30 (50.0%)	0.86 (NS)
Uremic tongue	6(10.0%)	6(10.0%)	
Enamel hypoplasia	00	00	
Chi-Square test; P<0.05 (S)			

Table 1: Distribution Of Objective Uremic Oral Manifestations Among Study Groups

Subjective oral symptoms were also markedly different. Diabetics had a significantly higher mean VAS score for dry mouth (69.83 ± 2.24 vs. 37.16 ± 7.15, p = 0.000), whereas non-diabetics reported greater taste alteration (50.33 ± 14.15 vs. 38.33 ± 13.92, p = 0.000) [figure 2]. Tongue or mucosal pain was slightly higher in diabetics but not statistically significant (p = 0.07).

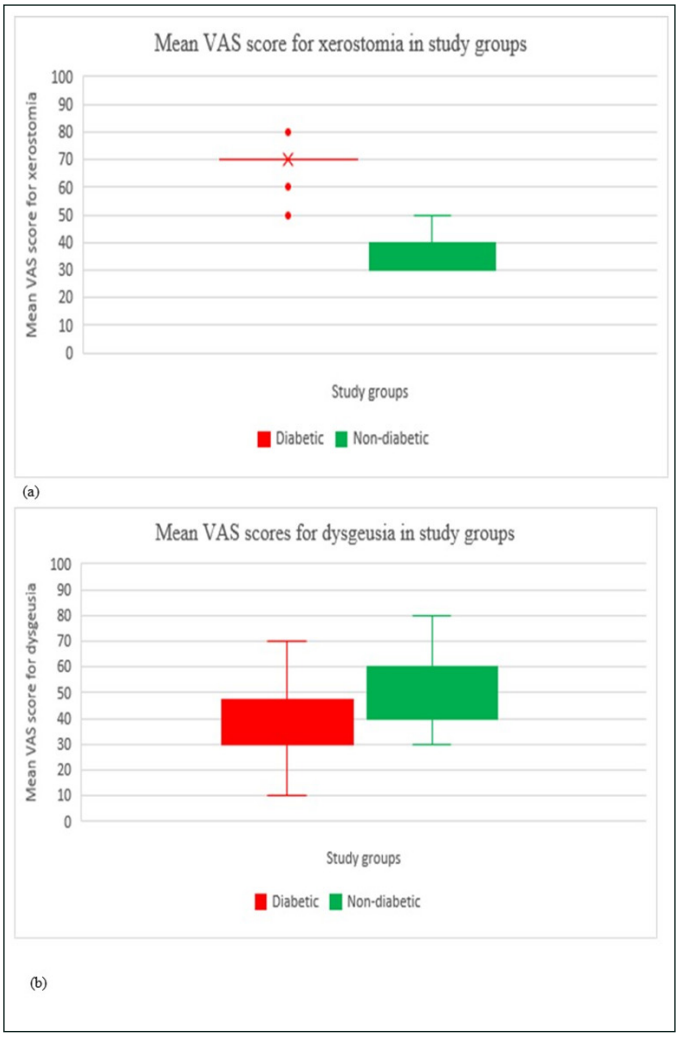

Figure 2: (a) Box plot comparing the mean Visual Analog Scale (VAS) scores for xerostomia in diabetic and non-diabetic haemodialysis patients. Diabetic patients showed significantly higher xerostomia scores (mean ≈ 70) than non-diabetic patients (mean ≈ 40), indicating more pronounced dry mouth symptoms.

(b) Box plot showing the mean VAS scores for dysgeusia in the two study groups. Non-diabetic patients exhibited higher taste alteration scores (mean ≈ 50–60) compared to diabetic patients (mean ≈ 40), suggesting greater subjective taste disturbance in non-diabetic shows Mean difference of subjective uremic oral manifestations among study groups.

Among diabetics, subjective symptoms such as dry mouth, taste changes, and mucosal pain did not significantly differ by HbA1c category (p > 0.05). Dental caries experience, measured using the DMFT index, was significantly worse in diabetics. The total DMFT score was 9.43 ± 3.92 compared to 3.18 ± 1.89 in non-diabetics (p = 0.000). Diabetics had significantly higher numbers of decayed and missing teeth, but filled teeth showed no significant difference (p = 0.06). Among diabetic subgroups, those with poor glycaemic control (HbA1c ≥9%) had higher mean DMFT (10.41 ± 3.36), although the difference among HbA1c groups was not statistically significant (p = 0.18).

Periodontal status, assessed by CPI shown in (table 3), was notably worse among diabetics. A majority (61.67%) had deep pockets (CPI=4) compared to only 3.33% of non-diabetics (p = 0.000). CPI=2 (calculus) was significantly higher in non-diabetics (53.33%) than diabetics (3.33%) (p = 0.000). Excluded sextants (CPI=X) due to tooth loss were also significantly more frequent in diabetics (p = 0.005).

CPI code	Diabetic	Non-diabetic	P value
CPI=0	0	2 (3.33%)	0.61 (NS)
CPI=1	1 (1.67%)	6 (10.00%)	0.11 (NS)
CPI=2	2 (3.33%)	32 (53.33%)	0.000 (S)
CPI=3	7 (11.67%)	16 (26.67%)	0.06 (NS)
CPI=4	37 (61.67%)	02 (3.33%)	0.000 (S)
CPI=X	13 (21.67%)	02 (3.33%)	0.005 (S)
Chi Square test; P<0.05 (S)			

Table 3: Periodontal Condition of The Study Groups Based on Cpi Status

However, among diabetic participants, CPI status did not significantly correlate with HbA1c levels (p > 0.05). Correlation analyses revealed no significant relationship between salivary pH and DMFT in either diabetics (r = 0.030, p = 0.81) or non-diabetics (r = –0.102, p = 0.43) [figure 3]. Similarly, no significant correlation was found between salivary pH and salivary urea in both groups (p = 0.80 and 0.96, re-

spectively).

Mean serum urea and creatinine levels were similar between groups, with no significant differences (p = 0.35 and 0.64, respectively) [figure 4].

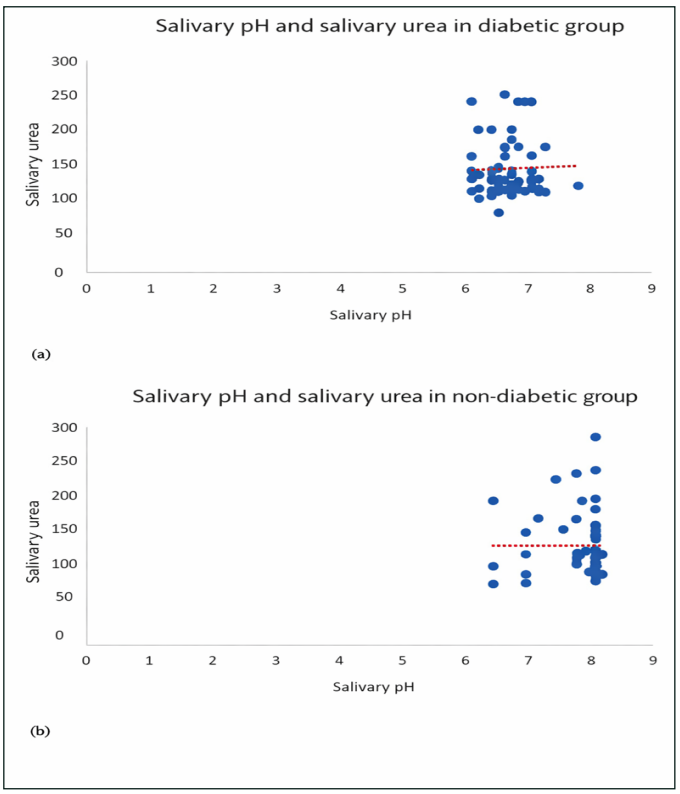

Figure 4: Scatter plots showing the relationship between salivary pH and salivary urea levels in study participants.

(a) Diabetic group: A weak positive correlation is observed, indicating that salivary urea tends to increase slightly with rising salivary ph.

(b) non-diabetic group: A near-flat trend line suggests minimal or no correlation between salivary pH and urea levels.

Discussion

chronic kidney disease (CKD), particularly in its advanced stages requiring haemodialysis, poses a significant risk for systemic and oral health complications. The added burden of diabetes mellitus (DM) further exacerbates these complications due to its metabolic, immunological, and vascular impact on multiple organ systems, including the oral cavity [14,15]. This hospital-based cross-sectional study aimed to compare the oral and dental manifestations in diabetic and non-diabetic patients undergoing maintenance hemodialysis, thereby shedding light on disease-specific oral morbidity in these populations.

In the present study, diabetic patients were significantly older than their non-diabetic counterparts, which aligns with the chronic and progressive nature of diabetic nephropathy. This age disparity is in line with the chronic, progressive course of diabetic nephropathy, often requiring a longer time to reach end-stage renal disease (ESRD). Our findings were comparable to studies by Murali and Swapna which reported similar age distributions among dialysis patients. In contrast, reported a younger mean age, possibly reflecting an earlier onset of non-diabetic renal pathologies. Male predominance was observed in both groups, consistent with epidemiological data reported by Lingam Amara et al. and Daniel Furtado Silva et al., although no statistically significant gender-based difference was noted in this study cohort [9-10, 14,16-17]. Gender distribution was similar in both groups, but our findings aligned with prior research suggesting a slight male predominance in CKD populations. This is be due to sex hormone influences on kidney injury susceptibility and disease progression, as noted in both experimental and clinical literature [15,18].

A distinct socioeconomic gradient was observed, with diabetic patients more frequently belonging to higher socioeconomic classes. This may reflect greater healthcare access and longer disease duration due to prolonged management of diabetes before reaching ESRD. Studies by Sanjeeta et al. and Rohani et al. emphasize that despite better healthcare access, diabetic patients still encounter challenges in preventing ESRD progression, underscoring the systemic burden of diabetes [6,19].

Biochemical markers, including serum urea and creatinine, showed no significant differences between the two groups. Slightly lower values in diabetics might be attributed to muscle mass reduction, altered protein metabolism, and dietary differences commonly seen in long-standing diabetic populations [16,20]. Hepatitis C virus (HCV) prevalence did not vary significantly between groups, supporting previous findings from the Dialysis Outcomes and Practice Patterns Study (DOPPS) that suggest a common nosocomial transmission risk in dialysis units regardless of comorbid conditions [21,22].

While the overall prevalence remains lower today due to better infection control, vigilance remains critical due to the immunosuppressed state of dialysis patients. Subjective symptoms, especially xerostomia, were significantly more severe in diabetic patients [figure 2]. This finding is consistent with studies, who linked diabetic xerostomia to salivary gland dysfunction due to autonomic neuropathy and hyperglycaemia-induced vascular changes [8,12,23]. Interestingly, dysgeusia was more prevalent in non-diabetics, possibly reflecting higher uremic toxin load or delayed dialysis initiation. Salivary biochemical alterations and zinc deficiency in CKD patients, regardless of diabetes status, remain key contributors. This observation contrasts with some prior studies and warrants further investigation into the pathophysiology of taste alteration in non-diabetic uremic patients [24].

Mucosal pain was similarly reported across both groups, indicating that factors beyond diabetic status may influence oral discomfort in haemodialysis patients. Objective clinical findings shown in [figure 5] such as tongue pallor and coating were more frequent among diabetics, which could be attributed to chronic anaemia, salivary changes, and microbial overgrowth in a hyperglycaemic environment [25,26]. Conversely, uremic fetor was more prevalent among non-diabetics, perhaps reflecting higher levels of unbuffered nitrogenous waste in the saliva due to delayed dialysis initiation or poorer nutritional status [10,27,28].

Figure 5: Clinical photographs depicting oral manifestations in patients with end-stage renal disease (ESRD) on maintenance hemodialysis.

(a) Tongue coating thick yellowish-white deposits on the dorsum of the tongue.
(b) Angular cheilitis erythematous fissures at the oral commissures.
(c) Oral candidiasis erythematous lesion with white slough on the hard palate.
(d) Herpes labialis crusted ulcerative lesions on the lips.
(e) Tongue pallor pale dorsum suggestive of anaemia.
(f) Hyperpigmentation diffuse brown-black discoloration of the tongue.
(g) Uremic tongue coated, dry, and discoloured dorsal tongue surface.
(h) Periodontitis visible subgingival calculus and gingival recession.

Petechiae and ecchymosis were absent in both groups, possibly indicating effective platelet management and infection control protocols in the dialysis setting. Conditions such as fissured tongue, angular cheilitis, candidiasis, and herpes labialis were more frequent in diabetics, although these differences were not statistically significant. In this study, uremic tongue appeared in 10% of both diabetic and non-diabetic patients, indicating a stronger link to uremic burden than glycaemic control. Likely caused by urea breakdown, toxin retention, and ammonia-induced irritation, it may serve as a subtle marker of systemic uraemia and merits attention during oral exams in haemodialysis patients. Their higher prevalence in diabetics is likely due to impaired immune function and elevated salivary glucose, which promote fungal and viral colonization [11,12].

Salivary pH was significantly lower in diabetic patients, contributing to a more acidic oral environment that Favors dental demineralization. This acidic environment correlated with a higher DMFT (Decayed, Missing, and Filled Teeth) score in diabetics, indicating poorer dental health. Although the correlation between salivary pH and DMFT was not statistically significant, the observed trend supports previous findings that diabetes-induced salivary alterations may increase caries risk [29,30].

Periodontal health assessment using the Community Periodontal Index (CPI) revealed more advanced periodontal disease in diabetic patients. A significantly greater proportion of diabetics were classified under CPI Code 4, indicating deep periodontal pockets. Additionally, more sextants were excluded due to missing teeth in diabetics, suggesting higher past tooth loss.

These findings are in line with research by Sharma et al. and Singh et al., who identified diabetes as a potent risk factor for periodontal destruction in CKD patients [31-33].

Radiographic evidence of renal osteodystrophy (ROD) was limited, with only one diabetic patient demonstrating jaw involvement. This finding contrasts with higher ROD prevalence reported in studies such as Akcay et al., potentially due to better metabolic management in our cohort or limitations in radiographic sensitivity. The absence of enamel hypocalcification in all participants reinforces that it is a developmental condition, not typically acquired in adult-onset CKD [34,35].

Despite the clinical insights gained, several limitations must be acknowledged. The study was conducted at a single centre, limiting generalizability. Its cross-sectional design precludes causal inference. Factors such as medication use, dietary habits, oral hygiene practices, and duration of dialysis were not fully controlled, potentially confounding the oral health outcomes observed. Subjective measures like VAS scores may also be influenced by reporting bias.

Limitations

Future studies should consider multicentric, longitudinal designs with larger sample sizes and biochemical or microbiological correlates. Incorporating salivary diagnostics, radiographic monitoring, and objective oral health indices will enhance diagnostic accuracy. Early dental screening and interprofessional collaboration between nephrologists and oral health professionals are essential to reduce morbidity in this high-risk population. Integrating oral healthcare into primary care protocols for CKD and diabetic patients could significantly improve their quality of life and clinical outcomes.

Conclusion

In conclusion, this study underscores the broader systemic and oral health challenges faced by ESRD patients on haemodialysis, particularly those with coexisting diabetes. Diabetic patients showed more severe oral manifestations, including higher caries burden, more advanced periodontal disease, and pronounced xerostomia. These findings highlight the need for integrated nephrology-dental care models and regular oral health assessments as part of comprehensive management in the haemodialysis population.

Author-Contribution: Dr. F.M.D., Dr. K.A., Dr. E.M., and Dr. P.D. contributed to the analysis and interpretation of the data. Dr. E.M. and Dr. S.M. drafted the manuscript. Dr. E.M., Dr. S.R., and Dr. S.M. were responsible for patient acquisition and clinical data collection. Dr. F.M.D. and Dr. K.A. provided critical revisions and final editing of the manuscript. All authors read and approved the final version of the manuscript Funding: This study was not supported by any funding.

Availability of data and materials: No datasets were generated or analysed during the current study

Code Availability: Not applicable

Declarations

Conflict of Interest: The authors declare that they have no conflict of interest

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for publication: Consent for publication was obtained for every individual person's data included in the study.

Consent to Participate: Informed consent was obtained from all individual participants included in the study.

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