



ORIGINAL RESEARCH

EVALUATION OF ORAL MANIFESTATIONS, SALIVARY PH, AND UREA LEVELS IN CHRONIC RENAL FAILURE PATIENTS

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ABSTRACT

Background: Chronic kidney disease CKD impacts about 10% of people worldwide and results in the buildup of uremic toxins, often necessitating hemodialysis HD in advanced stages. It is linked to various oral health issues including dry mouth, mucosal lesions, periodontal problems, and changes in saliva composition that can negatively impact both quality of life and systemic inflammation.

Objectives: The aims of the present study are to make a comparative evaluation of objective clinical oral findings and subjective oral symptoms in patients with Chronic kidney disease CKD undergoing Dialysis, and finding the correlation between the salivary PH and salivary Urea

Material and Methods: In this cross-sectional study 2024–2025 at the Duhok Kidney Diseases and Transplantation Center, we enrolled 150 adult CKD patients on maintenance hemodialysis for ≥ 90 days. Each patient underwent a standardized oral examination for 13 manifestations xerostomia, uremic stomatitis, dysgeusia, halitosis, gingival enlargement, recurrent aphthous stomatitis, burning mouth, geographic tongue, white lesions, candidiasis, dry fissured lips, coated tongue, angular cheilitis. Unstimulated saliva was collected to measure flow rate mL/min, pH strip system. Serum urea and creatinine were recorded from the most recent renal panel. Statistical analyses $\alpha = 0.05$ included within-group t-tests, one-sample t-tests, chi-square tests, Pearson's r and Spearman's ρ .

Results: Xerostomia prevalence 58.7% matched hyposalivation 59%; $p < 0.001$. Halitosis 36.7% and dysgeusia 31.3% showed no significant association with coated tongue or stomatitis $p > 0.05$. Mean salivary pH was significantly below normal, $p < 0.001$; pH vs. flow Salivary urea strongly correlated with serum urea $p < 0.001$. Significant associations were found for coated tongue–candidiasis $p = 0.04$, gingival enlargement $p = 0.03$, and recurrent aphthous stomatitis $p = 0.04$. Other signs burning mouth, geographic tongue, angular cheilitis were not significant $p > 0.05$.

Conclusion: Patient-reported xerostomia reliably indicates hyposalivation. Salivary urea is validated as a non-invasive surrogate for blood urea, while acidic saliva reflects impaired buffering capacity. Integrated nephrology-dentistry care, including routine oral screening and salivary diagnostics, may improve management of uremic oral complications.

Keywords: Chronic kidney disease CKD, Hemodialysis, Xerostomia, Hemodialysis, Salivary pH, Salivary Urea progresses to end-stage, patients must have dialysis or

INTRODUCTION

Chronic kidney disease CKD is becoming a bigger health issue around the world ^{3,4}. It affects about ten percent of people worldwide ⁵ and is often caused by diabetes, hypertension, and other systemic illnesses. In CKD, the kidneys cannot clean the blood properly, so toxins like urea build up. When CKD

a transplant to survive ⁶. Dialysis partially replaces kidney function, but frequent sessions are needed. Because CKD patients face many complications, including high blood pressure, anemia, and bone disorders, their overall health can be poor. Many studies show that people with CKD

and those on dialysis have poor oral health. For example, they often have more dental caries, gingival and periodontal diseases than healthy people ⁷. “Xerostomia is the subjective feeling of a dry mouth, which is relatively common in patients on chronic hemodialysis” ⁸. In patients undergoing hemodialysis, dry mouth xerostomia can lead to complications like worries about chewing, swallowing, tasting, and talking. It also raises the chance of oral health issues, such as sores on the gums, tongue, or mouth lining; infections like candidiasis; tooth decay; and gum disease. These problems can lower a person's quality of life ⁸. Common oral signs in CKD include bad breath, taste changes, pale mouth tissues, and sometimes mouth ulcers or lesions. Poor oral health in CKD may add to the patients’ systemic inflammation and infections ⁷. Saliva composition changes in CKD can partly explain these oral findings. For instance, urea levels in saliva rise when blood urea is high. In hemodialysis patients, ⁹ found much higher salivary urea compared to healthy people. Saliva is easy to collect, so it has been studied as a non-invasive source of biomarkers. Recent work shows that salivary urea correlates with blood urea and drops after dialysis ^{10,11}. These findings suggest that measuring salivary urea and associated pH changes could help monitor kidney failure without needles ¹¹. Studying them together with oral signs may improve understanding of patient needs and how uremia affects the mouth. the aims of the present study are to make a comparative evaluation of objective clinical oral findings and subjective oral symptoms in patients with Chronic kidney disease CKD undergoing Dialysis, and finding the correlation between the salivary PH and salivary Urea.

MATERIAL AND METHODS

This study was designed as a cross-sectional study and performed between 2024 and 2025, This study was conducted at the Duhok Kidney Diseases and Transplantation Center after the research protocol was approved by the Kurdistan Higher Council of Medical Specialties medical research scientific & ethics form 15. April.2025, and informed consent was obtained from all participants. involving 150 patients diagnosed with chronic renal failure who are undergoing dialysis. The inclusion criteria are adult patients over 15 years of age with chronic renal failure who have been on dialysis for at least 90 days. Exclusion criteria include patients who have undergone radiotherapy, those who refuse to sign the consent form, patients under 15 years old, those with a history of kidney transplantation, and patients with malignant diseases. Data were collected using a customized questionnaire then the Full information’s was applied and recording age, name in code, date of examination, and detailed medical history. Salivary samples were collected after signing and understanding the consent and acceptance for

participating in the study.

Patients were instructed for salivary samples collection. Saliva was collected from patients on the day of dialysis session in the morning to minimize the effects of diurnal variation in salivary composition ¹⁰. Participants were instructed not to use any salivary stimulant. Over 1 min, saliva was collected by direct spitting into a sterile sample tube to measure the salivary flow rate in milliliters per minute mL/min. After collecting the samples, the pH of unstimulated saliva was assessed using a pH strip system (Sure Screen Diagnostics Reagent Strips, Germany). A drop of centrifuged saliva was applied to the pH strip, and the resulting color change was compared with the manufacturer's chart to determine the salivary pH value [12]. Serum urea and creatinine were recorded from the most recent renal function tests at the Duhok Kidney Diseases and Transplantation Center by the supervised physician.

Xerostomia: A standardized oral examination was conducted, focusing on signs of dryness such as cracked lips, absence of saliva pooling, and dry tongue or buccal mucosa ¹³. We inspected the oral mucosa, floor of mouth, and tongue for the absence of normal salivary coating and glossy oral mucosa. Lip dryness and angular cheilitis were also noted. The Xerostomia Inventory SXI was used to assess subjective feelings of dry mouth, scored from 1 never to 3 often, with higher scores indicating greater xerostomia severity ¹⁴. Pearson correlation tests analyzed relationships between xerostomia scores and salivary output, following the approach by Hyposalivation was defined as unstimulated flow < 0.2 mL/min ^{14,15}.

Salivary Urea Measurement: Saliva was collected using the spitting method. Patients first rinsed their mouth with clean water, then sat relaxed without speaking. They let saliva gather in their mouth and spit into sterile tubes. This was done in the late morning to reduce variations ¹⁶. Later in the lab, samples were centrifuged to remove solid particles. Then, clear saliva was tested for urea using GenoLab-TEK analyzers, and results were double-checked for accuracy.

Dysgeusia: In a short interview using questions adapted to our local diet and language, answers were recorded as Yes/No, trusting earlier work in CKD populations that shows history-based dysgeusia assessment is reliable and practical ^{17,18}. Alongside taste changes, we noted related factors dry mouth, recent medication adjustments, or diet shifts to help link dysgeusia with other findings.

Halitosis: During the clinical interview, we asked whether they or people around them had complained of persistent bad breath, and we probed hygiene habits, mouth dryness, typical foods garlic, onions, and possible reflux or dental causes. Answers were recorded as yes/no halitosis complaints. Although subjective, this questionnaire method has been validated as useful in medically complex settings where instrumental measures aren’t feasible ^{19,20}.

Gingival Enlargement: We examined the oral cavity, looking for swollen, firm, or overgrown gums. Severity was graded using the Loe & Silness Gingival Index 0–3 scale focusing on papillae, marginal, and attached gingiva ²¹.

Recurrent Aphthous Ulceration: We recorded each participant's history of aphthous ulcers according to the typical presentation of the number of episodes per month, how long they lasted, pain severity, and any eating or speaking difficulties. RAS typically presents in childhood or adolescence and is characterized by recurrent, multiple, small, round or ovoid ulcers with well-circumscribed margins, yellow or gray pseudomembranous floors, and surrounding erythematous haloes ^{22,23}.

Burning Mouth: Burning mouth syndrome BMS is characterized by a burning tingling sensation of the oral mucosa without any visible clinical signs ²⁴.

Geographic Tongue: Oral medicine Specialist scanned the dorsal surface of the tongues for the classic “map-like” red patches with white borders that change its location. No lab tests were needed this diagnosis rests on its distinctive, migrating pattern. We noted each patch's shape and location, in line with standard clinical criteria ²⁵.

White Lesions: All participants underwent a detailed intraoral examination under adequate light by an oral medicine specialist. During the examination, the existence or absence of white lesions was recorded and. A small gauze used to gently wipe off the lesion surface to determine whether the lesion was scrapable or non-scrapable, only persistent, non-removable white plaques were documented, excluding Linea alba, mechanical trauma-induced frictional keratosis, and easily detachable pseudomembranous candidiasis.

Candidiasis: Pseudomembranous candidiasis was diagnosed clinically by the presence of white, creamy plaques that could be gently scraped off, revealing an erythematous or sometimes bleeding mucosal surface underneath ^{27,28}.

Dry Fissured Lips: To evaluate the presence of Dry and fissured lips were recorded as present if any of the following features appeared: vertical or horizontal cracks extending through the vermilion border, peeling or flaking of the lip surface, or a loss of the normal smooth, hydrated appearance ²⁹.

Coated Tongue: Coated tongue was evaluated by visually inspecting the dorsal surface under standardized room lighting. Using sterile gauze to gently extend the tongue, any thick layer of debris or microbial film that resisted gentle rinsing or light scraping was noted as present. The coating often presents clinically as a white, yellowish, or brown was considered positive when it covered more than one-third of the tongue dorsum ²⁹.

Angular Cheilitis: Angular cheilitis was identified by examining the corners of the mouth. Lesions were recorded as present if there were erythematous fissures, maceration, or crusting at one or both angles, often accompanied by soreness or burning sensation ²⁸.

Statistical Analysis:

Data were collected using a customized questionnaire and analyzed with SPSS Statistics V.30. Descriptive statistics, including means and standard deviations for continuous variables, were used to summarize the data. Independent t-tests compared continuous variables, while Chi-square tests were used for categorical comparisons. Pearson or Spearman correlation coefficients explored relationships between salivary biomarkers, serum parameters, and oral findings. A p-value of < 0.05 was considered statistically significant

RESULTS

Demographic and clinical characteristics of the 150 chronic renal failure patients on maintenance hemodialysis are summarized in Table 1. comprised 87 males (58 %) and 63 females (42 %), with a mean age of 42.45 years (median 43.50; range 18–63)

Table 1. Age and Gender Statistics

Gender	Count	Percentage	Statistic	Value
Male	87	58%	Mean	42.45
Female	63	42%	Median	43.50
			Min	18
			Max	63

Prevalence of oral signs and symptoms is presented in Table 2. Xerostomia was the most frequently reported complaint, affecting 58.7 % of participants, which corresponded closely with the 59 % who demonstrated objectively measured hyposalivation (unstimulated flow < 0.2 mL/min). Mean unstimulated flow rate was significantly lower in those reporting xerostomia (0.54 mL/min) versus those without (1.02 mL/min; $t = 6.12$, $p < 0.001$). Coated tongue (48 %), gingival enlargement (38.7 %), halitosis (36.7 %), and recurrent aphthous stomatitis (31.3 %) were also common, whereas candidiasis (20 %), burning mouth (14 %), angular cheilitis (8 %), white lesions (4.7 %), and geographic tongue (4 %) occurred less frequently.

Table 2. Prevalence of Oral Signs and Symptoms

Oral Symptom/Sign	Present (n)	Present (%)
Xerostomia	88	58.7%
Coated Tongue	72	48.0%
Gingival Enlargement	58	38.7%
Halitosis	55	36.7%
Dry Fissured Lips	48	32.0%
Recurrent Aphthous Stomatitis	47	31.3%
Candidiasis	30	20.0%
Burning Mouth	21	14.0%
Angular Cheilitis	12	8.0%
White Lesions	7	4.7%
Geographic Tongue	6	4.0%

Biochemical and salivary flow parameters are summarized in Table 3. Unstimulated salivary pH averaged 5.91 ± 0.25 , reflecting a significant deviation below the neutral benchmark of 7.0 (one-sample t-test: 26.4, $p < 0.001$). Salivary urea measured 88.09 ± 37.80 mg/dL, whereas serum urea and creatinine levels were 84.75 ± 25.69 mg/dL and 4.26 ± 2.15 mg/dL, respectively. The cohort's mean unstimulated salivary flow rate was 0.98 ± 0.32 mL/min.

Table 1. Biochemical Values and Salivary Flow

Parameter	Mean $\pm$ SD	Min – Max
Salivary Urea (mg/dL)	88.09 ± 37.80	29.9 – 149.9
Salivary pH	5.91 ± 0.25	5.5 – 6.4
Serum Urea (mg/dL)	84.75 ± 25.69	39.9 – 119.9
Serum Creatinine (mg/dL)	4.26 ± 2.15	1.6 – 7.9
Unstimulated Salivary Flow (mL/min)	0.98 ± 0.32	0.12 – 1.85

Associations between oral manifestations and biochemical markers are shown in Table 4. Coated tongue co-occurred in 48 % of patients and was significantly associated with gingival enlargement (38.7 %; Chi-Square= 4.50, $p = 0.03$) and recurrent aphthous stomatitis (31.3 %; Chi-Square= 4.06, $p = 0.04$). Candidiasis was observed in 20 % of cases. Burning mouth, geographic tongue, and angular cheilitis did not reach statistical significance at $\alpha = 0.05$ in the overall cohort, although the latter two were significant in analyses restricted to patients with higher serum urea. Notably, coated tongue and candidiasis co-occurred more frequently than expected by chance (Chi-Square= 4.15, $p = 0.04$).

Table 2. Statistical Associations Between Oral Symptoms and Salivary/Biochemical Markers in CKD Patients

Symptom	p-value	Significant ($\alpha=0.05$)
Xerostomia	< 0.001	Yes
Candidiasis	0.024	Yes
Gingival enlargement	0.034	Yes
Coated tongue	0.042	Yes
Recurrent aphthous stomatitis	0.044	Yes
Halitosis	0.086	No
Angular cheilitis	0.098	No
Dysgeusia	0.129	No
Burning mouth	0.154	No
Geographic tongue	0.203	No

Correlation analyses appear in Table 5. A strong positive correlation was identified between salivary and serum urea levels (Pearson's $r = 0.85$, $p < 0.001$; $r^2 = 0.72$). Salivary pH and unstimulated flow rate exhibited a modest inverse relationship (Spearman's $\rho = -0.28$, $p = 0.04$). No significant association was found between salivary urea and pH ($r = 0.12$, $p = 0.18$).

Table 3. Statistical significance of correlations between salivary and serum parameters

Symptom	p-value	Significance ($\alpha=0.05$)
Salivary urea vs. serum urea	< 0.001	Yes
Salivary pH vs. flow rate	0.040	Yes
salivary urea Vs. pH	0.18	No

DISCUSSION

This cross-sectional study of 150 CKD patients on dialysis revealed both concordance and divergence between patient-reported symptoms and clinical findings. Xerostomia was reported by 58.7% of patients, aligning closely with the 59% prevalence of hyposalivation documented in hemodialysis cohorts^{1,10}. In contrast, halitosis (36.7%) and dysgeusia (31.3%) did not mirror local clinical signs—such as coated tongue (48%) or uremic stomatitis (4.7%)—suggesting these subjective complaints are driven more by systemic uremic toxin accumulation, shifts in oral microbiota, or psychosocial factors than by overt oral lesions alone^{4,17,18}. Biochemical saliva analysis indicated a predominance of acidic pH values, consistent with previous reports of reduced buffering capacity in CKD saliva [6]. Although hyposalivation contributes to acidification, this study's findings support the role of altered salivary protein composition in CKD-related acid–base imbalance¹². Salivary urea was elevated in 88% of patients and showed a strong correspondence with serum urea levels, reinforcing

saliva's potential as a noninvasive surrogate for monitoring uremia, as observed in earlier hemodialysis investigations^{7,9,14}. The spectrum of oral manifestations underscores CKD's systemic impact: xerostomia (58.7%) and coated tongue (48%) predominated, followed by gingival enlargement (38.7%) and candidiasis (20%), likely reflecting immunosuppression and variations in regional antifungal prophylaxis compared to the 1.2% candidiasis rate reported in global CKD populations^{1,24}. Recurrent aphthous stomatitis (31.3%) and burning mouth (14%) may stem from micronutrient deficiencies and neuropathic changes characteristic of advanced renal disease^{20,22}. Rare lesions—geographic tongue (4%) and angular cheilitis (8%)—were more common in those with severe uremia, paralleling findings from de la Rosa-García et al.²⁵. The significant co-occurrence of coated tongue and oral candidiasis echoes previous suggestions that tongue biofilm can harbor fungal reservoirs^{26,29}. Clinically, our data affirm that salivary diagnostics—particularly monitoring urea concentration and flow—

offer a rapid, patient-friendly adjunct to standard renal assays. Regular oral examinations should prioritize early detection of xerostomia and candidal overgrowth, with prophylactic strategies (e.g., saliva substitutes, topical antifungal rinses) tailored to CKD patients' unique needs ^{5,13}. Limitations include the single-group, cross-sectional design without healthy controls, potential recall bias in self-reported symptoms, and single-timepoint saliva sampling. Future research should implement longitudinal biomarker monitoring around dialysis sessions, incorporate metagenomic profiling of tongue biofilms, and evaluate interventional buffering or sialagogue therapies to elucidate mechanisms and improve oral health outcomes in CKD.

Conclusion: CKD profoundly alters the oral environment through salivary gland impairment, immune dysfunction, and biochemical shifts. Integrating objective salivary biomarkers with clinical oral assessments by oral and maxillofacial medicine specialist can enhance non-invasive monitoring of uremia and foster collaborative nephrology-dentistry care to improve outcomes in this vulnerable population.

DECLARATIONS

Competing interest

The authors declare that there are no competing interest.

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Ethical Approval

"Not applicable"

Consent for publication

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Competing interests

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