Interconnected Health: Examining the Link Between Oral Diseases and Chronic Kidney Disease Among Patients in Lagos, Nigeria

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ABSTRACT

Background: Chronic kidney disease (CKD) is a global public health problem, characterized by a progressive and irreversible decline in renal functions, and affecting up to 22.3% of Nigerians. Oral diseases are increasingly recognized to have a bidirectional relationship with CKD, contributing to systemic inflammation, infections, protein-energy wasting, and atherosclerotic complications. Given this interconnectedness, we aimed to explore the relationship between CKD and oral conditions among LASUTH patients to better understand and address these co-occurring health issues.

Methods: This descriptive observational study was conducted in the nephrology unit of LASUTH. Patients aged >20 years with a diagnosis of CKD were enlisted and a validated questionnaire with the modified WHO oral health status proforma was utilized to record clinical data: Estimated Glomerular Filtration Rate (EGFR), End-Stage Renal Disease (ESRD), Creatinine and Urinalysis from medical records and oral examination findings, Oral Hygiene Index-Simplified (OHI-S), Gingival Index (GI), Community Periodontal Index of Treatment needs (CPITN), oral malodour, and Oral lesions. Multivariate logistic regression analysis was conducted with adjustments for covariates like age, alcohol use, and BMI to determine the association between oral diseases and CKD. The significance level (p) was set at 0.05, with a confidence interval (CI) of 95%.

Results: A total of 200 patients at different stages of CKD were included. The age range was 22–83 years. The majority were aged 31-60 years (mean age 55.22 ± 14.35 years); 69% were males; 7% were current smokers while 12% currently drank alcohol; 27% had eGFR< 15 mL/min/1.73m2 (ESRD); 27% had Creatinine values >1.3mg/dl; prevalence of Gingivitis was 72%; periodontitis was 14% (CPI score ≥3: Pocket depth of ≥4 mm); and poor OHI was 22%. The commonest oral lesions were white lesions 2%, candidiasis 4.5%, hyperpigmentation 22%, oral ulcers 5%, hemorrhagic lesions 12.5%, and Oral malodor 74.5%. Multiple logistic regression analysis revealed significantly increased odds of ESRD among uneducated respondents (OR 1.194; CI: 0.832-1.713); those >60years (OR: 1.129; CI:0.436-2.923); current alcohol drinkers (OR:1.125; CI: 0.281-4.409); and smokers (OR:2.328; CI: 0.27-20.289). The odds of low stimulated saliva flow rate (OR: 1.181; CI:0.768-4.512), oral malodor (OR:1.093; CI: 0.763-1.565), and periodontal disease (OR: 1.242; CI: 0.698-2.209) were also significantly higher among those with ESRD.

Conclusion: Individuals with CKD and ESRD may have a higher prevalence of oral diseases and conditions. There were significantly increased odds of ESRD among uneducated respondents, those over 60, current alcohol consumers, and smokers. Additionally, the odds of low stimulated saliva flow rate, oral malodor, and periodontal disease was also significantly higher among those with ESRD. This relationship may also be bidirectional, highlighting the need for appropriate oral self-care and regular dental-care utilization in patients with renal disease. The findings underscore the need for integrated healthcare approaches that consider both oral and renal health, providing a foundation for further research and targeted interventions.

INTRODUCTION

Chronic Kidney Disease (CKD) is a global public health problem that poses a substantial healthcare burden, with approximately 90% of cases remaining undiagnosed.[1] Recent systematic reviews observed a CKD prevalence of 13.9% in sub-Saharan Africa and 10.1% in West Africa, with a pooled prevalence for the entire region at 16%.[2,3] A recent epidemiological study in Nigeria reported a prevalence of 22.3%, in the South-Western region of the country.[4] CKD is characterized by a progressive decline in kidney function, which is often associated with comorbidities such as hypertension and diabetes mellitus.[5] It has been projected that, by 2040, CKD will be the 5th cause of mortality worldwide and the absolute risk for death will increase exponentially with decreasing renal function, almost doubling in populations with advanced CKD.[6] With progressive morbidity and complications, CKD eventually leads to end-stage renal disease (ESRD).[7] At this stage, patients with ESRD receive treatments such as hemodialysis, peritoneal dialysis, and kidney transplantation, which are associated with a high economic burden on the patient's family and society.[4]

While traditional risk factors for CKD are well established, recent research has identified other non-traditional risk factors, such as oral health, in the development and progression of CKD.[8] The oral cavity hosts a diverse microbiome, and emerging evidence suggests that the oral microbiome may influence systemic health.[8] Numerous systemic conditions, including cardiovascular diseases, diabetes mellitus, and respiratory diseases have been associated with poor oral health and periodontal disease.[9-10] Oral disease may also be a potential and preventable cause of poor health outcomes in people with CKD, with recent studies suggesting a link between CKD and some oral diseases.[11] The association between oral health and CKD has been investigated by several researchers. One such study among children observed a high prevalence of gingival hyperplasia but a low prevalence of periodontitis among the subjects.[12] Another study among a nationwide cohort with CKD, assessing the risk of end-stage renal disease (ESRD), observed a high prevalence of severe gingivitis or early periodontitis among those with ESRD.[13] Furthermore, another study that explored oral hygiene practices, dental profile, and dental service utilization among patients with CKD observed that about 90% of the subjects had oral diseases.[14] This suggests that the relationship between CKD and oral health may be bidirectional.[14] In addition, poor oral health is associated with inflammation and malnutrition,[15] which disproportionately affects CKD patients and is a risk factor for accelerated cardiovascular disease and mortality in this population.[16] Consequently, the potential connection between oral health and CKD has become a subject of intense interest.

However, despite a growing body of evidence on the association between oral health and CKD in various populations, there is a paucity of research on this topic in Nigeria. Lagos State, one of the most densely populated regions in Nigeria, faces the dual burden of communicable and non-communicable diseases.[17] The tertiary healthcare facilities in Lagos, including the renal units, play a pivotal role in the diagnosis and management of CKD.[18] This study, therefore, aimed to determine the association between CKD and oral health conditions among a group of patients with CKD at the renal unit of a tertiary facility in Lagos State. By assessing the oral health status of CKD patients in this specific population and exploring the potential links between oral health parameters and CKD outcomes, this research intends to provide valuable insights that may inform clinical practice, public health initiatives, and future research directions.

MATERIALS AND METHODS

Study Design: This was a cross-sectional descriptive study conducted at the renal unit of the Lagos State University College of Medicine (LASUTH). Formal approval for the study was obtained from the Research Ethics Committee of the Lagos State University Teaching Hospital. Participation of the patients was voluntary and only those who gave consent after the purpose of the study had been explained to them participated in the study. The confidentiality of information provided was ensured and patients' anonymity was preserved through the use of only the patient's unique identity number and the hospital number on all documents used in the study.

Study Setting: The study was conducted at the renal unit of Lagos State University Teaching Hospital (LASUTH) which is one of the two main referral tertiary hospitals located in Lagos State, Nigeria, with over 1000-bed capacity, that serves the people living in Lagos and neighboring states. The hospital accepts referrals from private clinics, general hospitals, military hospitals, and other government hospitals. This hospital attends to a mixture of both high, middle, and low-income patients due to the affordability of services, therefore, making it a center of choice for sampling.

Study population: This sample size (187) was scientifically determined:[19,20] A total of 200 participants, consisting of patients with CKD, were recruited for this study. A simple random sampling approach with the balloting method, using the clinic appointment register for each day as the sampling frame, was utilized.

Inclusion and Exclusion criteria: Included were adults aged 18 years and older with a confirmed diagnosis of chronic kidney disease based on established diagnostic criteria. Participants were also those without recent acute exacerbations or hospitalizations and who were willing to provide informed consent to participate in the study.

Data Collection: Two clinicians involved in data collection were trained and calibrated to maintain data consistency and reliability, with a kappa score of 0.91 for inter-examiner reliability, and 0.92 and 0.89, for intra-examiner reliability respectively. The survey utilized a face-to-face interview with pretested close-ended questionnaires adapted from previous studies. The data sources and instruments used were patients' clinical/hospital case files, the clinic appointment record book, and the validated questionnaire. The questionnaire obtained the respondents' sociodemographic information (age, sex, marital status, religion, educational level, and occupation), relevant medical (CKD stage, comorbidities), and oral health-related data.

Clinical examination: Blood pressure was measured by the digital sphygmomanometer with standard cuff (25cmx12cm), on the right arm, with participants in a sitting position after a 5 minute rest. Two measurements were taken and the average was recorded. The weight was measured with a Seca analogue weighing scale placed on a flat, hard surface with the participants wearing light clothing. The height was measured by a stadiometer with the participants standing without shoes. Body mass index (BMI) was calculated by weight (kg)/height (m2).[21] Hypertension was defined as blood pressure ≥ 140/90 mmHg or use of antihypertensive drugs,[22] diabetes as fasting plasma glucose > 7.0 mmol/L,[23] and obesity as BMI ≥30 kg/m^2.[24]

Investigation results: Serum creatinine was estimated by Jaffe's method.[25] The estimated glomerular filtration rate (eGFR) was derived from chronic disease epidemiology collaboration (CKD-EPI) and classified as: stage 1 (G1) – a normal eGFR above 9060 ml/min/1.73m^2, but other tests have detected signs of kidney damage; stage 2 (G2) – a slightly reduced eGFR of 60 to 89ml/min, with other signs of kidney damage; stage 3a (G3a) – an eGFR of 45 to 59ml/min; stage 3b (G3b) – an eGFR of 30 to 44ml/min; stage 4 (G4) – an eGFR of 15 to 29ml/min and stage 5 (G5) – an eGFR below 15ml/min, with the kidneys having lost almost all functions.

Oral examination: The same calibrated Oral Medicine specialist did all the oral soft tissue examinations while the same Periodontologist performed all the periodontal examinations for the subjects in the study. The standardized oral examination included analysis of periodontal, mucosal, and salivary health. The oral examination was conducted in the renal unit with a portable, lightweight, and comfortable chair and mobile light source, using sterile dental examination mirrors, a Williams probe and a clinical Community Periodontal Index (CPI) periodontal probe, with the clinician wearing appropriate personal protective equipment.

CPI was determined by examining six sextants of the mouth using a CPI probe to assess bleeding, calculus, and pocket depth, recording the highest score per sextant. Periodontal Probing Depth (PPD) involved measuring the depth of periodontal pockets at six sites around each tooth using a calibrated probe, while the Clinical Attachment Loss (CAL) was assessed by measuring the distance from the cementoenamel junction to the base of the pocket. The Gingival Index (GI) was determined by evaluating gingival inflammation on a scale from 0 to 3 at four sites around each index tooth, whereas the Oral Hygiene Index Simplified (OHI-S) was measured by scoring the presence of debris and calculus on six index teeth and calculating the average score.

To assess the health of the oral mucosa, a visual examination was conducted, inspecting all areas of the mouth, including the buccal mucosa, lips, tongue, floor of the mouth, and palate, for the presence of ulcers, red lesions, and other abnormalities. Suspicious areas were palpated gently to evaluate for tenderness or induration. The unstimulated salivary flow rate was measured by instructing the patient to sit quietly with their mouth slightly open, allowing saliva to accumulate for 5 minutes. The patient then expectorated saliva into a pre-weighed container. The collected volume was divided by the collection time to determine the flow rate in milliliters per minute (mL/min). For the stimulated salivary flow rate, the patient was asked to chew on paraffin wax for 5 min, during which the saliva produced was collected in a container. The total volume of saliva collected was divided by the collection time to calculate the flow rate (mL/min).

The cut-off value for hyposalivation was an unstimulated salivary flow rate of less than 0.1-0.2 mL/min, and less than 0.7 mL/min for stimulated salivary flow rate. The participant was then asked not to eat, drink, or smoke for an hour before the salivary analyses were performed. Organoleptic oral malodour was evaluated by trained examiners who smelled the exhaled air from the oral cavity after the patient had kept their mouth closed for a few minutes. The odour intensity was then rated on a standardized scale ranging from 0 to 5, where 0 indicated no detectable odour and 5 represented a severe odour. This scale allowed for a structured and consistent assessment of malodour severity.

Statistical Analyses: Data analyses were conducted using SPSS version 26.0 software (version 26.0. Armonk, NY: IBM Corp). After testing for normality using the Shapiro-Wilk Test, the Student's t-test was used for normally distributed continuous data (ie GI, OHIS, BMI) while categorical data were analyzed with cross-tabulations chi-square test and Fisher's exact test (ie CPITN). Multivariate logistic regression analysis was conducted with adjustments for covariates like age, alcohol use and cigarette smoking, which are potential confounders, and BMI to determine the association between oral diseases and CKD to estimate odds ratios (OR) and 95% confidence intervals (CI) on selected variables. The significance level (p) was set at 0.05, with a confidence interval (CI) of 95%.

RESULTS

Table 1 summarizes the baseline characteristics of the study population, consisting of 200 subjects. The mean age was 55.22 years (range 22-83), with 69% males. Educational distribution included 2% with no education, 55% with ≤12 years, and 43% with >12 years. Only 4% were covered by medical insurance. Current alcohol consumption was observed in 12% of subjects. Smoking status reveals 83% non-smokers, 10% former smokers, and 7% current smokers. Approximately 42% of respondents engaged in physical activity. The distribution of estimated glomerular filtration rate (EGFR) was 27% with <15 mL/min/1.73m^2, 23% with values between 15-29 mL/min/1.73m^2. Mean creatinine is 0.98 ± 1.31 mg/dL (range 0.21-7.10). The mean body mass index was 23.41 ± 2.9 kg/m^2, while the mean fasting blood glucose was 97.26 ± 39.68 mg/dL, the mean Oral Hygiene Index score was 1.05±0.79, and the mean Gingival Index score was 0.51 ± 0.55. Prevalence of Gingivitis periodontitis was 14% (CPI score ≥3: Pocket depth of ≥4 mm).

Table 1: Baseline characteristics of the study population.

Characteristics	Total*
No. of subjects	200
Age, years (mean/range)	55.22 ± 14.35 (22-83)
Sex	
Male	138 (69.0)
Female	62 (31.0)
Education	
None	4 (2.0)
≤ 12 years of education	110 (55.0)
> 12 years of education	86 (43.0)
Covered by medical insurance	8 (4.0)
Alcohol consumption	
Never	81 (40.5)
Former drinker	95 (47.5)
Current drinkers	24 (12.0)
Status of smoking	
Never	166 (83.0)
Former smoker	20 (10.0)
Current smoker	14 (7.0)
Physical activity	84 (42.0)
EGFR (mL/min/1.73m^2)	
<15	54 (27.0)
15-29	46 (23.0)
30-60	100 (50.0)
Creatinine Mean mg/dL (range)	0.98±1.31 (0.21-7.10)
Anthropometric / Clinical measurements	
Body mass index, kg/m^2 (mean/range)	23.41±2.9 (22.79- 33.32)
Fasting blood glucose (mean), mg/dL	97.26±39.68 (70-158)
Oral Hygiene Index (mean)	1.05±0.79 (0.52-6.00)
Gingival Index (mean/ range)	0.51±0.55 (0.6-2.12)
CPITN	
0	28 (14.0)
1	32 (16.0)
2	112 (56.0)
≥3	28 (14.0)

*Categorical variables. Data are expressed as the mean±SD, or n (%).

Table 2 presents the oral manifestations among the respondents, with 94% of the participants exhibiting oral manifestations. The distribution of specific oral manifestations included hyperemic mucosa (12%), mucosal pallor (35.5%), Oral white lesions (2%), mucosal erosion (12.5%), and oral ulcers (5%). Others were oral hemorrhagic lesions (12.5%), depapillated tongue (13%), candidiasis (4.5%), and lip pigmentation (29%). The prevalence of oral malodor was 74.5%.

Table 2. Oral manifestations observed in patients with chronic kidney disease.

Variables	n	%
Oral manifestations		
Yes	188	94.0
No	12	6.0
Types of oral lesions		
Hyperemic mucosa	24	12.0
Mucosal pallor	71	35.5
Oral white lesions	4	2.0
Mucosal erosion	24	12.0
Oral ulcers	10	5.0
Oral hemorrhagic lesions	25	12.5
Depapillated tongue	26	13.0
Candidiasis	9	4.5
Lip pigmentation	58	29.0
Dysgeusia	39	19.5
Oral Malodor	145	74.5
Burning mouth sensation	10	5.0
Hyposalivation	70	35.0
Mean Unstimulated Saliva flow rate (ml/min ± SD)	0.9±1.10	
Mean Stimulated Saliva flow rate (ml/min ± SD)	1.1±0.89	

Table 3: The association between oral diseases, sociodemographic and clinical characteristics, and estimated glomerular filtration rate (EGFR) are summarized as follows: end-stage renal disease (EGFR <15 mL/min/1.73m^2) was more prevalent among males (27.2%), those with poor blood pressure control (24.4%), those aged >60 years (29.3%), and significantly associated with diabetic nephropathy (χ^2 = 6.410, p = 0.038), current smokers (χ^2 = 5.824, p = 0.019), those uneducated (χ^2 = 12.195, p = 0.032), stimulated salivary flow (26.8%; χ^2 = 2.175, p = 0.002), periodontitis (28.6%; χ^2 = 2.175, p = 0.002), and oral malodor (χ^2 = 13.204, p = 0.029).

Table 3. Association between oral diseases, sociodemographic and clinical characteristics and estimated glomerular filtration rate.

Variables		EGFR (mL/min/1.73m^2) >60 N (%)	30 60 N (%)	15 29 N (%)	<15 N (%)
Sex	Female	2 (8.3)	10 (41.7)	6 (25.0)	6 (25.0)
	Male	58 (33.0)	30 (17.1)	40 (22.7)	48 (27.2)
		χ^2 =2.458	0.488		
Diabetes	Yes	0 (0.0)	0 (0.0)	30 (48.4)	32 (51.6)
	No	30 (21.7)	46 (33.4)	62 (44.9)	0 (0.0)
		χ^2 = 6.410	**p= 0.038***		
Blood pressure control	Yes	24 (21.8)	22 (20.0)	28 (25.5)	36 (32.7)
	No	24 (26.8)	22 (24.4)	22 (24.4)	22 (24.4)
		χ^2 = 0.748	P=0.858		
Drinks alcohol	Yes	2 (8.3)	10 (41.7)	6 (25.0)	6 (25.0)
	No	58 (33.0)	30 (17.1)	40 (22.7)	48 (27.2)
		χ^2 =5.163	P=0.140		
Current smoker	Yes	0 (0.0)	6 (42.8)	4 (28.6)	4 (28.6)
	No	60 (32.3)	34 (18.3)	42 (22.6)	50 (26.8)
		χ^2 =5.824	**p= 0.019***		
Age (years)	18-30	6 (75.0)	2 (25.0)	0 (0.0)	0 (0.0)
	31-60	26 (23.6)	26 (23.6)	16 (13.6)	30 (25.4)
	>60	28 (34.1)	12 (14.6)	18 (22.0)	24 (29.3)
		χ^2 =5.824	P= 0.166		
Education (years)	None	0 (0.0)	2 (50.0)	0 (0.0)	2 (50.0)
	<12 years	32 (29.1)	14 (12.7)	30 (27.3)	34 (30.9)
	>12 years	28 (32.6)	24 (27.9)	16 (18.6)	18 (20.9)
		χ^2 =12.195	**p= 0.032***		
Stimulated Saliva flow (mL/min)	Low/ Hyposalivation	30 (23.4)	30 (23.4)	38 (23.4)	38 (26.8)
	Normal	30 (41.7)	10 (13.9)	16 (22.2)	16 (22.2)
		χ^2 =0.254	**p=0.004***		
Periodontitis#	Absent	50 (25.0)	38 (19.0)	38 (19.0)	46 (23.0)
	Present	10 (35.7)	2 (7.1)	8 (28.6)	8 (28.6)
		χ^2 =2.175	**P= 0.002***		
Oral Malodour	Yes	32 (21.5)	26 (17.5)	37 (24.8)	54(36.2)
	No	28 (54.9)	14 (27.4)	9 (17.7)	0 (0.0)
		X^2 =13.204	**P= 0.029***		

Fishers exact, χ^2 Statistically significant value (p<0.05) * # CPI score ≥3

Table 4 presents the risk factors for chronic kidney disease (CKD) determined by multiple logistic regressions, including adjusted odds ratios (aOR), 95% confidence intervals (C.I.), and p-values. Multiple logistic regression analysis revealed significantly increased odds of ESRD among uneducated respondents (OR 1.194; CI: 0.832-1.713); those >60years (OR: 1.129; CI:0.436-2.923); current alcohol drinkers (OR:1.125; CI: 0.281-4.409) and smokers (OR:2.328; CI: 0.27-20.289). The odds of low stimulated saliva flow rate (OR: 1.181; CI:0.768-4.512); oral malodor (OR:1.093; CI: 0.763-1.565); and periodontal disease (OR: 1.242; CI: 0.698-2.209) were also significantly higher among those with ESRD.

Table 4: Independent risk factors for CKD determined by multiple logistic regressions.

	aOR	95% C.I.	p value
Age			
21-40 *(ref)*	1		
>60years	1.129	0.436-2.923	**0.008***
Alcohol use			
No *(ref)*	1		
Yes	1.125	0.281-4.409	**0.009***
Cigarette smoking			
No *(ref)*	1		
Yes	2.328	0.27-20.289	**0.045***
Stimulated Saliva flow			
No *(ref)*	1		
Yes	1.181	0.768-4.512	**0.016***
Oral Malodour			
No *(ref)*	1		
Yes	1.093	0.763-1.565	**0.019***
Clinical Attachment Loss			
None (ref)	1		
>4mm	1.242	0.698-2.209	**0.004***
Oral Hygiene			
Good (ref)	1		
Poor	0.731	0.455-1.738	**0.073**
Education			
Educated	1		
None	1.194	0.832-1.713	**0.001***
BMI			
Normal (ref)	1		
Obese	0.819	0.500-1.341	**0.428**

Statistically significant value (p<0.05) *

DISCUSSION

The aim of this study was to assess the association between oral health and CKD. Understanding the interplay between oral health and CKD in the context of Lagos State, a microcosm of Nigeria, has the potential to advance our understanding of CKD risk factors, facilitate early detection and prevention strategies, and ultimately enhance the overall care and well-being of CKD-affected individuals in this region. The mean age of 55.22 years reflects the tendency for an increase in CKD in older ages, and the majority being male contradicts the existing literature highlighting sex-specific health disparities in CKD, with a higher prevalence observed in women.[26] The effects of longer life expectancy on the natural decline of glomerular filtration rate (GFR) with age, a greater health seeking behavior in women, the potential effect of hormones and pregnancy on kidney function, as well as potential overdiagnosis of CKD in females through the inappropriate use of GFR equations, might be partly responsible for the greater prevalence of CKD in women.[27]

The distribution of educational levels and low medical insurance coverage among the respondents underscores potential socioeconomic influences on health outcomes, a well-established factor in health disparity research.[28] Individuals with lower educational levels have an increased likelihood of developing risk factors for chronic CKD, compared to those with higher educational attainment.[29,30] Meanwhile, CKD is independently associated with education after controlling for other known health-relevant risk factors, such as older age, higher body mass index, low income, and smoking, including comorbidities such as prevalent CVD.[31] This elevated risk may contribute to higher incidence rates of CKD and subsequent kidney failure.[32] Additionally, lower education levels may promote the development of specific CKD types, such as diabetic nephropathy, owing to the heightened prevalence of diabetes mellitus among individuals with lower educational attainment.[31]

There was a high prevalence of oral manifestations among participants, suggesting a substantial burden of oral health issues. These findings corroborate existing literature highlighting the relationship between kidney disease and oral health, which could be bidirectional.[33] Hyposalivation, as observed in this study, is highly prevalent in CKD patients, and even though it is also present in the adult population,[34] it is more prevalent in ESRD patients than in healthy controls. The compromised immune response in CKD exacerbates bacterial proliferation in the oral cavity, whereas metabolic acidosis and disrupted calcium-phosphate homeostasis contribute to alveolar bone resorption and dental complications. Additionally, pharmacological interventions for CKD may decrease salivary flow, thereby increasing the risk of oral infection and mucosal lesions.[35,36] Consequently, systemic alterations induced by CKD exert a significant influence on oral health, underscoring the bidirectional relationship between renal and oral pathologies.[35,36] Moreover, due to hyposalivation, increased urea levels in the oral environment of patients with CKD, at >6 mg/dL, can contribute to different oral alterations. These patients may present with uremic stomatitis and halitosis, alterations in salivary composition and pH, dysgeusia, pale oral mucosa, oral mucosa pigmentation, dental enamel hypoplasia, osteodystrophy, amyloidosis, ecchymosis, and oral malodour.[37]

Notably, the prevalence of oral malodor among the study participants was high at 74.5%, indicating a significant association between CKD and oral malodor. This high prevalence is linked to factors such as accumulation of uremic toxins, reduced salivary flow, and altered oral microbiota. Urea, a key uremic toxin, is broken down in the oral cavity to produce ammonia and other nitrogenous compounds, which contribute to halitosis. Additionally, metabolic acidosis and systemic inflammation, which are common in CKD patients, further exacerbate oral malodor by promoting periodontal disease and altering the oral environment.[37,38] Some studies have corroborated the high incidence of oral malodor in patients with CKD. For instance, Santaella et al.[38] reported a high prevalence rate, attributing it to production of volatile sulfur compounds. In addition, Gulsahi et al emphasized the role of decreased salivary flow rate and an increased pH of the biofilm matrix in aetiology of oral malodor in patients with CKD.[39] However, Silva et al opined that proper oral hygiene and periodontal care could significantly reduce the prevalence of oral malodor among patients with CKD.[40]

This periodontal care is indicated among these patients with CKD since we observed a prevalence of 14% for established periodontitis, while 72% had gingivitis evidenced by a CPI score of 1 or 2, as corroborated by previous researchers.[41,42] The pathogenesis of periodontitis in CKD involves systemic inflammation, endothelial dysfunction, imbalance of oxidative stress, immune dysfunction, and metabolic disturbances, leading to elevated levels of pro-inflammatory cytokines and tissue destruction.[43] Metabolic acidosis also contributes to increased bone resorption and worsening of periodontal bone loss, while the altered salivary composition in patients with CKD favors the growth of pathogenic bacteria, further promoting periodontal disease.[42] This multifactorial interplay increases the susceptibility to and severity of periodontitis in patients with CKD.

Current alcohol consumption and tobacco use among the respondents is a relevant finding given the known impact of alcohol and cigarettes on kidney health. In a United States-based population cohort study, consuming four or more servings daily was autonomously linked to an elevated risk of chronic kidney disease.[44] Additionally, a case control study conducted in the United States revealed that the consumption of over two alcoholic drinks per day was connected to a heightened risk of end-stage renal disease (ESRD), and a lower alcohol intake did not seem to pose a risk.[45] However, another prospective cohort study found a notable decrease in the risk of CKD among men who consumed a minimum of 30g of alcohol daily.[46] Nonetheless, the strength of the association between smoking and CKD, its independence from other traditional CKD risk factors, and the evidence of a dose-response relationship,[46] suggest that these findings are less likely to be due to chance. Furthermore, several biological mechanisms by which smoking can result in kidney damage have been identified, including the promotion of renal atherosclerosis, alterations in systemic and renal hemodynamics, and effects on endothelial function.[47]

Further exploration of the association between oral diseases, sociodemographic and clinical characteristics, and CKD categories through regression models showed a significantly higher prevalence of ESRD among males, those with poor blood pressure control, diabetic nephropathy, current smokers, uneducated respondents, individuals with low stimulated salivary flow, those with periodontitis, and those experiencing oral malodor, consistent with previous research on these factors and renal health.[48] The significantly increased odds of ESRD among uneducated respondents, those aged >60 years, current alcohol drinkers, and smokers resonate with the existing literature linking these factors to CKD.[49] Diabetes, hypertension, and older age are significant risk factors for developing CKD and ESRD.[50]

CKD often progresses to ESRD and requires dialysis, hemodialysis, peritoneal dialysis, or kidney transplantation. These treatments significantly affect individuals physically, financially, socially, and psychologically. Early identification of patients with modifiable risk factors is, therefore, crucial for reducing the economic and psychosocial burden of ESRD. Due to the bidirectional association between CKD and oral conditions, dentists are well positioned to promote early diagnosis. The elevated odds associated with a low stimulated saliva flow rate, oral malodor, and periodontal disease emphasize the potential role of oral health indicators as early markers of kidney dysfunction.[51]

Conclusion: Individuals with CKD and ESRD may have a higher prevalence of oral diseases and conditions. This relationship may be bidirectional, highlighting the need for appropriate oral self-care and regular dental-care utilization in patients with renal disease. This study contributes significantly to the understanding of the intricate relationship between oral health, sociodemographic factors, and chronic kidney disease. The findings underscore the need for integrated healthcare approaches that consider both oral and renal health, providing a foundation for further research and targeted interventions.

REFERENCES

1. Levey AS, Gansevoort RT, Coresh J, Inker LA, Heerspink HL, Grams ME, et al. Change in albuminuria and subsequent risk of end-stage kidney disease: an individual participant-level consortium meta-analysis of observational studies. Lancet Diabetes Endocrinol. 2020;8(10):875-887.

2. Stanifer JW, Jing B, Tolan S, Helmke N, Mukerjee R, Naicker S, et al. The epidemiology of chronic kidney disease in sub-Saharan Africa: a systematic review and meta-analysis. Lancet Glob Health. 2014;2(3):e174–e81.

3. Abd ElHafeez S, Bolignano D, D'Arrigo G, Dounousi E, Tripepi G, Zoccali C. Prevalence and burden of chronic kidney disease among the general population and high-risk groups in Africa: a systematic review. BMJ Open. 2018;8(1):e015069.

4. Ibitoba FA, Akpor OA, Akpor OB. Prevalence and risk factors of chronic kidney disease among commercial motorcyclists in Ado-Ekiti, Ekiti State, Nigeria. Scientific African. 2022;16:e01136.

5. Jha V, Garcia-Garcia G, Iseki K, Li Z, Naicker S, Plattner B, et al. Chronic kidney disease: global dimension and perspectives. Lancet. 2013 Jul 27;382(9888):260-272.

6. Tonelli, M.; Wiebe, N.; Culleton, B.; House, A.; Rabbat, C.; Fok, M.; McAlister, F.; Garg, A.X. Chronic Kidney Disease and Mortality Risk: A Systematic Review. J. Am. Soc.

Nephrol. 2006, 17, 2034–2047.

7. Levin A., Tonelli M., Bonventre J., Coresh J., Donner J.A., Fogo A.B.et al.. (2017) Global kidney health 2017 and beyond: a roadmap for closing gaps in care, research, and policy. Lancet 390, 1888–1917 10.1016/S0140-6736(17)30788-2.

8. Ferreira SMSP, Gomes-Filho IS, Costa MDCN, Cruz SSD, Neves CL, Silva CALD, Andrade KVF, Moreira MBA, Hintz AM, Vianna MIP. Periodontitis and systemic parameters in chronic kidney disease: Systematic review and meta-analysis. Oral Dis. 2024.

9. Oyapero A, Enone LL, Moronkola R, Ojikutu RO. Relationship between Periodontal Disease, Dental Caries and the Risk Indicators for Cardiovascular Disease in Lagos, Nigeria. West Afr J Med. 2023;40(4):404-413.

10. Chapple IL, Genco R, Working group 2 of the joint EFP/AAP workshop. Diabetes and periodontal diseases: consensus report of the Joint EFP/AAP Workshop on Periodontitis and Systemic Diseases. J Clin Periodontol. 2017 ; 44(Suppl 18):S127-S135.

11. U. El-Shinnawi, M. Soory Associations between periodontitis and systemic inflammatory diseases: response to treatment Recent Pat Endocr Metab Immune Drug Discov, 2013:7: 169-188.

12. Nunn J., Sharp J., Lambert H., Plant N., & Coulthard M.. Oral health in children with renal disease. Pediatric Nephrology 2000;14(10-11):997-1001.

13. Han K. and Park J. Tooth loss and risk of end-stage renal disease: a nationwide cohort study. Journal of Periodontology 2020;92(3):371-377.

14. Omotunde S Omotunde O. Oral hygiene practice, dental profile and dental service utilization of chronic kidney disease patients. Magna Scientia Advanced Research and Reviews 2022;4(1):068-077.

15. Akar H, Akar GC, Carrero JJ, et al. Systemic consequences of poor oral health in chronic kidney disease patients, Clin J Am Soc Nephrol 2011; 6: 218-226. 10.2215/CJN.05470610

16. Liu Y, Coresh J, Eustace JA, Longenecker JC, Jaar B, Fink NE, Tracy RP, Powe NR, Klag MJ. Association between cholesterol level and mortality in dialysis patients: role of inflammation and malnutrition. JAMA. 2004;291(4):451-9.

17. Oyeyemi AL, Oyeyemi AY, Adegoke BO, Oyetoke FO. Pattern of noncommunicable diseases among medical admissions in Lagos University Teaching Hospital, Lagos, Nigeria. J Public Health Afr. 2019;10(1):1010.

18. Arogundade FA, Sanusi AA, Hassan MO, Akinsola A. The pattern, clinical characteristics and outcome of ESRD in Ile-Ife, Nigeria: is there a change in trend? Afr Health Sci. 2011;11(4):594-601.

19. Fisher, R.A. (1934). Statistical Methods for Research Workers. Oliver and Boyd, Edinburgh.

20. Chukwuonye II, Ogah OS, Anyabolu EN, Ohagwu KA, Nwabuko OC, Onwuchekwa U, Chukwuonye ME, Obi EC, Oviasu E. Prevalence of chronic kidney disease in Nigeria: systematic review of population-based studies. Int J Nephrol Renovasc Dis. 2018; 11:165-172.

21. National Heart, Lung, and Blood Institute. Calculating and Interpreting Body Mass Index. NIH. 2021 Available at: https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi-metrics.htm Accessed on 02/08/2024

22. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension. 2018;71(6):e13-e115.

23. American Diabetes Association. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes-2021. Diabetes Care. 2021;44(Suppl 1):S15-S33. Erratum in: Diabetes Care. 2021;44(9):2182.

24. World Health Organization. (2021). Obesity and overweight. WHO Fact Sheet. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Accessed on 02/08/2024

25. Levey AS, Coresh J, Balk E, Kausz AT, Levin A, Steffes MW, Hogg RJ, Perrone RD, Lau J, Eknoyan G; National Kidney Foundation. National Kidney Foundation practice guidelines for chronic kidney disease: evaluation, classification, and stratification.

Ann Intern Med. 2003;139(2):137-47.

26. Tong A, Evangelidis N, Kurnikowski A, Lewandowski M, Bretschneider P, Oberbauer R, Baumgart A, Scholes-Robertson N, Stamm T, Carrero JJ, Pecoits-Filho R, Hecking M. Nephrologists' Perspectives on Gender Disparities in CKD and Dialysis. Kidney Int Rep. 2021;7(3):424-435.

27. Carrero JJ, Hecking M, Chesnaye NC, Jager KJ. Sex and gender disparities in the epidemiology and outcomes of chronic kidney disease. Nat Rev Nephrol. 2018;14(3):151-164.

28. Braveman PA, Cubbin C, Egerter S, Williams DR, Pamuk E. Socioeconomic disparities in health in the United States: what the patterns tell us. Am J Public Health. 2010;100 Suppl 1(Suppl 1):S186-96.

29. G. Wolf, M. Busch, N. Müller, U.A. Müller. Association between socioeconomic status and renal function in a population of German patients with diabetic nephropathy treated at a tertiary centre. Nephrol Dial Transplant 2011;26: 4017-4023, 10.1093/ndt/gfr185

30. Vart P, Grams ME, Ballew SH, Woodward M, Coresh J, Matsushita K. Socioeconomic status and risk of kidney dysfunction: the Atherosclerosis Risk in Communities study. Nephrol Dial Transplant. 2019; 34(8):1361-1368.

31. Thio CHL, Vart P, Kieneker LM, Snieder H, Gansevoort RT, Bültmann U. Educational level and risk of chronic kidney disease: longitudinal data from the PREVEND study. Nephrol Dial Transplant. 2020; 35(7):1211-1218.

32. Winitzki D, Zacharias HU, Nadal J, Baid-Agrawal S, Schaeffner E, Schmid M, et al. Educational Attainment Is Associated With Kidney and Cardiovascular Outcomes in the German CKD (GCKD) Cohort. Kidney Int Rep. 2022;7(5):1004-1015.

33. Ling L, Yang M, Ding W, Gu Y. Ghrelin attenuates UUO-induced renal fibrosis via attenuation of Nlrp3 inflammasome and endoplasmic reticulum stress. Am J Transl Res. 2019;11(1):131-141.

34. Jamieson LM, Thomson WM. Xerostomia: its prevalence and associations in the adult Australian population. Aust Dent J. 2020;65 Suppl 1:S67-S70.

35. Laheij A, Rooijers W, Bidar L, Haidari L, Neradova A, de Vries R, Rozema F. Oral health in patients with end-stage renal disease: A scoping review. Clin Exp Dent Res. 2022;8(1):54-67.

36. Bossola M, Tazza L. Xerostomia in patients on chronic hemodialysis. Nat Rev Nephrol. 2012;8(3):176-82.

37. Silva DF, Ramos Oliveira IC, Medeiros S, Baeder FM, Lyra de Albuquerque AC, Lima EO, Oral health challenges in patients with chronic kidney disease: A comprehensive clinical assessment. Silva DF, Oliveira IC, de Assis Medeiros S, Baeder FM, de Albuquerque AC, de Oliveira Lima E. Oral health challenges in patients with chronic kidney disease: A comprehensive clinical assessment. The Saudi Dental Journal. 2024;36(2):364-7.

38. Santaella NG, Simpione G, Maciel AP, Lauris JR, da Silva Santos PS. Volatile sulphur compounds in people with chronic kidney disease and the impact on quality of life. Odontology. 2021;109(3):561–7.

39. Gulsahi A, Evirgen S, Öztaş B, Genç Y, Çetinel Y. Volatile sulphur compound levels and related factors in patients with chronic renal failure. J Clin Periodontol. 2014 Aug;41(8):814-9.

40. Silva DF, Oliveira ICR, Medeiros SA, Baeder FM, Albuquerque ACL, Lima EO. Oral health challenges in patients with chronic kidney disease: A comprehensive clinical assessment. Saudi Dent J. 2024;36(2):364-367.

41. Ausavarungnirun R, Wisetsin S, Rongkiettechakorn N, Chaichalermsak S, Udompol U, Rattanasompattikul M. Association of dental and periodontal disease with chronic kidney disease in patients of a single, tertiary care centre in Thailand. BMJ Open. 2016 Jul 27;6(7):e011836.

42. Cholewa M, Madziarska K, Radwan-Oczko M. The association between periodontal conditions, inflammation, nutritional status and calcium-phosphate metabolism disorders in hemodialysis patients. J Appl Oral Sci. 2018 Jul 23;26:e20170495.

43. Baciu SF, Mesaroș AȘ, Kacso IM. Chronic Kidney Disease and Periodontitis Interplay-A Narrative Review. Int J Environ Res Public Health. 2023;20(2):1298.

44. Shankar A, Klein R, Klein BE. The association among smoking, heavy drinking, and chronic kidney disease. Am J Epidemiol 2006; 164: 263–271.

45. Perneger TV, Whelton PK, Puddey IB, Klag MJ. Risk of end-stage renal disease associated with alcohol consumption. Am J Epidemiol 1999; 150: 1275–1281.

46. White SL, Polkinghorne KR, Cass A, Shaw JE, Atkins RC, Chadban SJ. Alcohol consumption and 5-year onset of chronic kidney disease: the AusDiab study. Nephrol Dial Transplant 2009; 24: 2464–2472.

47. Cooper RG. Effect of tobacco smoking on renal function. Indian J Med Res. 2006;124(3):261-8.

48. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS, Hobbs FD. Global Prevalence of Chronic Kidney Disease - A Systematic Review and Meta-Analysis. PLoS One. 2016;11(7):e0158765.

49. Chang Y, Lee JS, Woo HG, Ryu DR, Kim JW, Song TJ. Improved oral hygiene care and chronic kidney disease occurrence: A nationwide population-based retrospective cohort study. Medicine (Baltimore). 2021;100(47):e27845

50. Sarafidis PA, Ruilope LM, Loutradis C, Gorostidi M, de la Sierra A, de la Cruz JJ, Vinyoles E, Divisón-Garrote JA, Segura J, Banegas JR. Blood pressure variability increases with advancing chronic kidney disease stage: a cross-sectional analysis of 16 546 hypertensive patients. J Hypertens. 2018;36(5):1076-1085.

51. Grubbs V, Vittinghoff E, Beck JD, Kshirsagar AV, Wang W, Griswold ME, Powe NR, Correa A, Young B. Association Between Periodontal Disease and Kidney Function Decline in African Americans: The Jackson Heart Study. J Periodontol. 2015;86(10):1126-32.