OPEN ACCESS

ISSN: 2676-7473

RBMS.2024;29(1):e16



ORIGINAL RESEARCH

# End-Stage Renal Disease-Related Oral Manifestations and Its Respective Factors in an Iranian Population

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*Date Received: August, 2024* *Date Accepted: September, 2024* *Online Publication: October 15, 2024*

## Abstract

**Introduction:** Patients with end-stage renal disease (ESRD) suffer from various complications, including oral manifestations, which have a detrimental impact on the quality of life of these patients. We aimed to determine the prevalence of oral manifestations and the related factors in patients with ESRD undergoing hemodialysis.
**Materials and Methods:** This descriptive-analytical and cross-sectional study was conducted in 2022 on 105 hemodialytic ESRD patients, aging 16-90 years old in Amir Al-Momenin hospital in Tehran. The binary logistic regression model and IBM SPSS 16 software were used to determine the relevant factors' effect (p-value <0.05).
**Results:** Oral manifestations included coated tongue (30.5%), xerostomia (28.6%), sublingual varices (24.8%), mucosal pallor (14.3%), metallic taste (13.3%), oral candidiasis (11.4%), petechiae-ecchymosis (10.5%), burning mouth sensation (5.7%), mucosal ulcers (3.8%) and lichenoid lesions (0.95%). The DMFT (decayed, missing, and filled teeth) and O'Leary indices were 21.37±7.96 and 83.84±22.47, respectively.
**Conclusions**: Oral manifestations seem to be highly prevalent among ESRD patients; Coated tongue, xerostomia, and sublingual varices are the most widespread lesions in ESRD individuals. Health care providers should be aware of ESRD-related oral manifestations and their management to enhance patients' quality of life.
**Keywords:** Chronic kidney disease, End stage renal disease, Hemodialysis, Oral manifestation, Xerostomia

## Introduction

Chronic kidney disease (CKD) is caused by the gradual and chronic degeneration of nephrons with a concurrent drop in the GFR (glomerular filtration rate) that, if progress, would lead to end-stage renal disease (ESRD). This progression necessitates extra-renal blood filtering methods like dialysis or hemodialysis or alternative treatment modalities like renal transplants [1,2]. ESRD is the world's 12th leading cause of mortality and the 17th leading cause of disability, accounting for around 850,000 deaths annually and 15 million lives with a disability [3,4]. The incidence and prevalence of ESRD patients appear to be rising globally [5]. As a result, systemic dysfunctions caused by ESRD, such as oral manifestations, are likely to increase.

It is estimated that oral manifestations occur in 90% of ESRD patients. Furthermore, these manifestations can have a wide range because of hemodialysis or the primary etiological factors causing CKD [4,6]. The most popular treatment option for ESRD is hemodialysis. This procedure artificially removes nitrogenous and harmful metabolism products from the blood using a hemodializing system [7]. Typical oral lesions in ESRD patients include xerostomia, coated tongue, mucosal pallor, petechiae or ecchymosis, metallic taste, mucosal ulcers, sublingual varices (SLVs), oral candidiasis, burning mouth sensation (BMS), and periodontal diseases [2,8–10].

Physicians, dentists, and health care workers may significantly impact the early detection of CKD since oral symptoms and indications are sometimes the sole observable markers of systemic disorders [11]. Moreover, untreated oral lesions in CKD lead to a higher graft rejection risk in kidney transplant recipients and an elevation in systemic inflammatory load, aggravating the underlying systemic illness [12]. Screening and evaluating these issues can help implement suitable interventions to eliminate such lesions in these subjects.

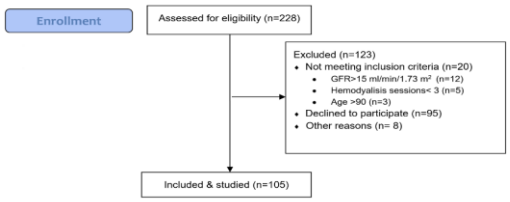
Previous studies examining oral manifestations in ESRD patients have reached different outcomes regarding the prevalence and the contributing factors [13–15]. Recent studies have suggested the role of blood type in several diseases, including renal failure [16]. A few studies have assessed the prevalence of blood types in ESRD populations of other countries [17–19]; thus, to our knowledge, such a study has not been conducted in Iran.

Due to the differences between the findings, and the lack of information about the effect of factors related to the incidence of manifestations, we aimed to assess the prevalence of oral manifestations and the probable related factors in patients with ESRD in a hospital in Tehran, Iran.

## Materials and Methods

This descriptive-analytical and cross-sectional study was performed on dialysis subjects referred to Amir Al-Momenin Hospital in 2022 in Tehran, Iran. Using the confidence interval for one proportion option in PASS 11 software, considering $\alpha$=0.05, p optimum=0.5 and d=0.1, the minimum required sample size was calculated to be 104 samples. the study was conducted on 105 patients diagnosed with ESRD undergoing hemodialysis whose GFR was less than 15 ml/min/1.73 $m^2$ ( Figure 1) [20]. These patients were being treated for hemodialysis for 4 hours per session and three times a week with a maximum age of 90 years old.

**Figure 1. Patient enrollment flow diagram.**




The continuous and purpose-based sampling method was carried out. Demographic information of the patient and all related factors, including age, gender, weight, height, blood type, body mass index (BMI), duration of kidney disease, duration of hemodialysis treatment, dialysis adequacy (Kt/V), ultrafiltration (UF), underlying causes of ESRD, literacy, number of dental visits per year, and serum chemical composition (including sodium, calcium, phosphorus, potassium, creatinine, parathyroid hormone, blood urea nitrogen (BUN), vitamin D, HbA1c, uric acid and albumin, hemoglobin, hematocrit, white blood cell (WBC) and platelet count) were carefully recorded in the information form according to the patient's statements and their last three months of hospital records.

A senior dentistry student carefully examined patients' oral cavity under the supervision of an oral medicine specialist using a dental mirror, explorer, cotton roll, cotton pliers, and dental chair headlight as the light source. Lichenoid lesions, mucosal ulcers, SLVs, and oral candidiasis, were diagnosed using the observed clinical features based on the reference book of oral diseases [21]. However, oral lesions were treated with antifungal agents to rule out candidiasis by the lack of response to the antifungal treatment. Also, BMS and metallic taste were recorded according to the patient's statements. Xerostomia diagnosis was done subjectively using patients' complaints and objectively by the tongue blade test [15,22].

O'Leary index and DMFT (decayed, missing, filled teeth) index were calculated and recorded to evaluate the oral health status of patients. For the DMFT index, the total number of decayed, restored, and teeth extracted due to caries was counted and recorded in the patient's file [23]. For recording the O'Leary index, the patient chewed the disclosing tablet. Then four facial, lingual, mesial, and distal surfaces of each tooth were examined for stain, and the total number of stained surfaces was divided by the total of the teeth surfaces multiplied by 100, which was recorded in the patients' files [24].

The binary logistic regression model was used by SPSS v.16 (SPSS Inc., Chicago, IL, USA), and the criterion of having a statistically significant relationship of p-value less than 0.05 was considered to evaluate the effect of demographic indicators, serum chemical compositions, blood variables, and other related factors on oral manifestations.

## Results

Of the 105 people who contributed to the study, 72 were men (68.6%), and 33 were women (31.4%). The subjects' mean age was 59.89±13.89 years. The prevalence of various oral lesions based on the underlying cause of ESRD has been shown in Table 1. The mean time for kidney problems was 5.73±7.56 years (minimum one month and maximum 65 years), and the mean time of dialysis patients was 3.51±3.45 years (minimum one month and maximum 15 years).

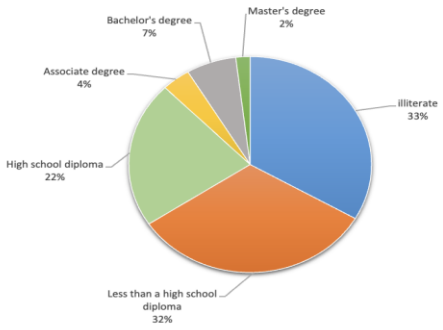
**Table 1. Oral lesions prevalence based on the underlying cause of ESRD.**

| | Diabetes Mellitus | | | | Hypertension | | | | Glomerulonephritis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yes (55=100%) | | No (50=100%) | | Yes (76=100%) | | No (29=100%) | | Yes (2=100%) | | No (103=100%) | |
| Xerostomia | 21 | 38.18% | 9 | 18.00% | 23 | 30.26% | 7 | 24.14% | 0 | 0.00% | 30 | 29.13% |
| Coated tongue | 19 | 34.55% | 13 | 26.00% | 25 | 32.89% | 7 | 24.14% | 1 | 50.00% | 31 | 30.10% |
| Pallor mucosa | 7 | 12.73% | 8 | 16.00% | 12 | 15.79% | 3 | 10.34% | 0 | 0.00% | 15 | 14.56% |
| Petechiae & ecchymosis | 8 | 14.55% | 3 | 6.00% | 8 | 10.53% | 3 | 10.34% | 0 | 0.00% | 11 | 10.68% |
| Metallic taste | 10 | 18.18% | 4 | 8.00% | 11 | 14.47% | 3 | 10.34% | 0 | 0.00% | 14 | 13.59% |
| Lichenoid lesions | 1 | 1.82% | 0 | 0.00% | 1 | 1.32% | 0 | 0.00% | 0 | 0.00% | 1 | 0.97% |
| Mucosal ulcer | 1 | 1.82% | 3 | 6.00% | 2 | 2.63% | 2 | 6.90% | 0 | 0.00% | 4 | 3.88% |
| Sublingual varices | 11 | 20.00% | 15 | 30.00% | 20 | 26.32% | 6 | 20.69% | 1 | 50.00% | 25 | 24.27% |
| Oral Candidiasis | 10 | 18.18% | 2 | 4.00% | 10 | 13.16% | 2 | 6.90% | 0 | 0.00% | 12 | 11.65% |
| Burning mouth sensation | 4 | 7.27% | 2 | 4.00% | 6 | 7.89% | 0 | 0.00% | 0 | 0.00% | 6 | 5.83% |
| DMFT | 24.00±6.56 | | 18.48±8.41 | | 21.45±8.09 | | 21.17±7.76 | | 14.50±4.95 | | 21.50±7.96 | |
| O'Leary index | 88.70±18.83 | | 79.89±24.58 | | 83.56±20.68 | | 84.53±27.07 | | 89.00±15.56 | | 83.68±22.71 | |

DMFT, decayed, missing due to caries, and filled teeth.

ESRD-patients education level is demonstrated in Figure 2. While 85 patients had no dental visits in the past year, 18 visited their dentist once (17.1), and 2 visited their dentists for more than one session (1.9%).

**Figure 2. Education levels of the study population.**




The mean BMI was 26.75±5.07. The mean of KT/V and UF indices were measured at 1.37±0.31 and 2.76±0.89, respectively. Serum chemical composition and blood indices are demonstrated in Table 2.

**Table 2. Serum chemical composition and blood indices of ESRD patients.**

| Blood index | Normal range | | mean±SD |
|---|---|---|---|
| Na (mEq/L) | 135-145 | | 137.45±2.55 |
| Ca (mEq/L) | 8.4-11 | | 8.54±0.63 |
| P (mEq/L) | 1.8-2.3 | | 4.49±0.98 |
| K (mEq/L) | 3.5-5.3 | | 4.86±0.71 |
| PTH (pg/mL) | 150-600 † | | 495.07±390.50 |
| BUN (mg/dL) | 7-20 | | 48.82±10.40 |
| Vitamin D (ng/mL) | >30 | | 37.54±21.04 |
| HbA1c (%) | 4-6 | | 6.92±1.63 |
| Uric acid (mg/dL) | 3.5-7.2 | | 6.05±1.12 |
| Albumin (g/dL) | 3.5-5.4 | | 3.96±0.32 |
| WBCs (x10$^9$/L) | 3.6-11 | | 7.31±2.45 |
| Platelets (x10$^9$/L) | 140-400 | | 185.24±63.97 |
| | Male | Female | |
| Hemoglobin (g/dL) | 13-18 | 11.5-16.6 | 11.43±1.51 |
| Hematocrit (%) | 40-54 | 37-47 | 35.53±4.41 |
| Creatinine (ng/mL) | 0.6-1.2 | 0.5-0.9 | 7.22±2.01 |

PTH, parathyroid hormone; BUN, blood urea nitrogen; WBC, white blood cell.

†Normal range in dialytic patients

**Figure 4. Prevalence of ESRD-related oral manifestations based on the individuals' blood groups.**

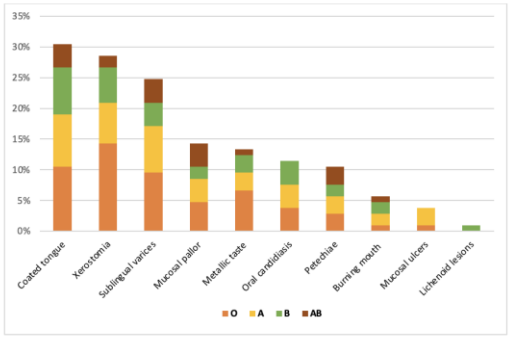
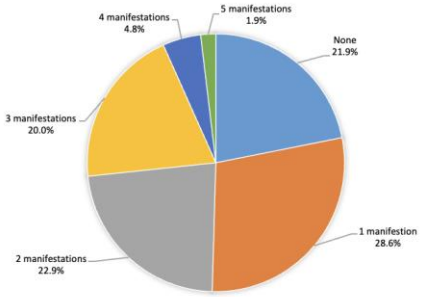



Figure 3 demonstrates the number of oral manifestations among the study population. On average, each person had 1.63±1.27 oral lesions. The participants' oral manifestations were as follows: 32 coated tongue (30.5%), 30 xerostomia (28.6%), 26 SLVs (24.8%), 15 mucosal pallor (14.3%), 14 metallic taste (13.3%), 12 oral candidiasis (11.4%), 11 petechiae-ecchymosis (10.5%), 6 BMS (5.7%), 4 mucosal ulcers (3.8%) and 1 lichenoid lesion (0.95%).

**Figure 3. Frequency of ESRD-related oral manifestations in the study populations.**




Apart from 38 patients (36.2%) who were edentulous, for O'Leary and DMFT index, the mean was 83.84±22.47 (min: 0, max: 100) and 21.37±7.96 (min: 4, max: 28), respectively. Regarding blood type, 31 patients had blood type A (29.5%), 28 patients had blood type B (26.7%), nine patients had blood type AB (8.6%), and 37 patients had blood type O (35.2%), while 92 patients were RH positive (87.6%), and 13 patients were RH negative (12.4%). Oral manifestations distribution based on blood group is shown in Figure 4 and indicates that ESRD patients with AB blood group have the highest prevalence of oral manifestations.

Incidence of oral manifestations was associated with AB blood group ($p<0.05$), diabetes ($p<0.05$), and increased UF ($p<0.05$)**.**Table 3 demonstrates factors associated with different oral manifestations in ESRD patients. Increased DMFT had a significant correlation with negative RH ($p<0.05$), age ($p<0.001$), KT/V ($p<0.05$), HbA1c ($p<0.05$), WBC count ($p<0.05$) and decreased platelets ($p <0.001$), literacy ($p<0.001$), number of dental visits in the last year ($p<0.05$) and uric acid ($p<0.05$). O'Leary indices increased with RH negative ($p<0.05$), decreased BUN ($p< 0.05$), and WBC count ($p<0.05$), while O'Leary reduction was correlated with B blood type ($p<0.05$). In addition, mucosal pallor and metallic taste occurrences did not show a statistically significant relationship with any investigated variables ($P>0.1$). Statistical analysis was not possible for lichenoid lesions due to the low incidence (1 case).

Table 3. Factors associated with various ESRD-related oral manifestations (p<0.05).

| Increased incidence | Correlated factors |
|---|---|
| Coated tongue | Glomerulonephritis<br>↑ age<br>↑ BMI<br>↑ creatinine<br>↑ platelets<br>↓ hematocrit |
| Xerostomia | female gender<br>↑ UF<br>↓ education levels<br>↓ creatinine |
| Sublingual varices | ↑ age<br>↑ UF<br>↑ education level<br>↓ calcium decrease |
| Oral candidiasis | hypertension<br>↑ disease duration<br>↑ HbA1c<br>↑ uric acid<br>↑ hematocrit<br>↓ age<br>↓ phosphorus<br>↓ parathyroid hormone<br>↓ hemoglobin<br>↓ WBC count |
| Petechiae-ecchymosis | negative RH<br>diabetes<br>↑ KT/V<br>↑ education level<br>↓ parathyroid h<br>↓WBC count<br>↓ platelets |
| Burning mouth sensation | hypertension<br>↑ disease duration<br>↑ HbA1c<br>↑ uric acid<br>↑ hematocrit<br>↓ age<br>↓ phosphorus<br>↓ parathyroid hormone<br>↓ hemoglobin<br>↓ WBC count |
| Mucosal ulcers | negative RH<br>female gender<br>↑ UF<br>↑ albumin<br>↑ hemoglobin<br>↓ BMI<br>↓ calcium<br>↓ parathyroid hormone<br>↓ WBC count |

## Discussion

Our research showed that in the study population, only 21.9% of patients had no oral manifestations, while 78.1% suffered from at least one oral lesion. Oral manifestations, including coated tongue (30.5%), xerostomia (28.6%), and SLVs (24.8%), were the most common. High DMFT and O'Leary indices among patients indicate poor oral hygiene among these patients, which lowers the quality of life for these individuals.

Diabetic nephropathy (35.2%), hypertensive nephrosclerosis (19.2%), and chronic glomerulonephritis (11.3%) have been reported as the most frequent causes of ESRD in Iran [25], which conforms with our findings. However, the most prevalent cause of renal failure in Africans is glomerulonephritis, which usually arises from infections [12,26]. Different etiologies of renal failure in various geographical regions may be attributed to the conflicting prevalence reported in divergent ESRD populations. Besides, except for stage of renal disease and dialysis, which are almost the same in the patients studied in these similar studies, factors such as oral hygiene, smoking, oral habits, mean age, the period they have renal disease and under hemodialysis, underlying diseases, medication intake, and sample size significantly impact the results presented by different studies.

The coated tongue contains bacteria, large amounts of epithelial cells of the oral mucosa, leukocytes of the periodontal pocket, blood metabolites, and various nutrients. In a study conducted by Danser et al. aimed at the need for tongue hygiene as part of daily oral hygiene, there was a clear relationship between poor oral hygiene and coated tongue [27]. According to one study, only 15% of hemodialytic patients had oral hygiene of a good standard [15], indicating poor oral hygiene and possibly explaining the high frequency of coated tongue. In previous studies, coated tongue's prevalence was 10, 19, 23.3, 37.5 and 73.4% [1,13,14,22,28], which is consistent with our findings. Age significantly correlated with the coated tongue incidence, which is also clinically justified. Gupta et al. reported the prevalence of coated tongue at 10%, while 52.5% of their samples were under 40. However, in our study population, with a mean age of 59.89, 30.5% had coated tongues [1]. This wide range of results can be due to candida infection and its association with smoking and the difference in the occurrence of xerostomia in the studied population [22]. The higher prevalence of coated tongue in the current study may be due to the greater incidence of xerostomia, poorer oral hygiene of these patients, or the difference in the measurement method of coated tongue in this study.

Dembowska, and colleagues demonstrated that Xerostomia was observed in 22% of hemodialysis patients and in no one in the control group. Taste disorder was represented by 14% of hemodialysis patients and 1% of the control group [3].

Decreased unstimulated salivary flow rate, particularly hyposalivation, should be viewed as a crucial sign of CKD in the stages before dialysis treatment [11]. ESRD patients may have xerostomia due to restricted fluid intake,

mental stress, medication side effects (mostly from antihypertensive medications), potential salivary gland fibrosis, diabetic autonomic neuropathy, toxic effects of uremic chemicals, and mouth breathing as a result of pulmonary perfusion issues [11,29,30]. Additionally, a higher risk of dental caries, sore mouth, more candida infections, and dysgeusia are all linked to xerostomia [31,32].

A prevalence of 20, 36, 42, 46.7, 54.66, 62.5, 66.7, 76.1 and 100% have been reported [13–15,22,28,33,34], which are relatively consistent with the outcomes of our study. The subjective or objective approach to diagnosing xerostomia can also substantially impact the reported prevalence. According to Omidpanah et al., the incidence of xerostomia was significantly correlated with age [22]. The mean age of the population of 30 people studied by Ghadimi et al. was 59.9, which reported a 100% prevalence of xerostomia [13]; while the mean age of the population of 144 people studied by Afroozi et al. was 49, which was reported to be 36% of dry mouth [33]. However, we found no statistically significant correlation between age and xerostomia.

According to research findings, diabetic individuals who receive hemodialysis experience more intense subjective symptoms, such as xerostomia, dysgeusia, and mucosal discomfort [35]. Chuang et al. reported that the severity of xerostomia is higher in diabetic subjects undergoing hemodialysis. Also, there is a possible relationship between the severity of xerostomia and glycemic control in these subjects [35]. Our results, however, did not indicate such correlations.

No studies have studied the SLV prevalence in an ESRD population. Since SLVs are more common among the elderly and hypertensive patients [36,37], 72.4% of the study population had hypertension, and the mean age of our samples was 59.89 years, an SLVs prevalence of 24.8% was expected. Based on our findings, the incidence of SLVs significantly correlated with aging, but there was no statistically significant correlation with hypertension, confirming previous results [38].

Mucosal pallor is observed in the oral mucosa as a result of anemia. This condition may be brought on by the kidneys producing less erythropoietin, renal loss of RBCs, and greater RBC fragility with consequent early destruction [39]. The prevalence was 27.5, 42.2, 45, 48.61 and 60.6% in previous studies [14,15,28,34,40], which differs from the present study's findings. Ethnic and racial differences affect the pigmentation of the skin and mucous membranes and can be a possible explanation for various outcomes of various studies. The amount and variety of foods consumed can also affect the incidence of mucosal pallor, in addition to issues such as hemodialysis duration and the use of drugs.

The main reasons for this unpleasant metallic taste are urea content in patients' saliva and its breakdown into ammonia and carbon dioxide by bacterial urease [41]. Moreover, both generalized neurological impairment of CKD and zinc insufficiency has been linked to abnormal taste perception [42]. Metallic taste prevalence has been 12, 13, 30.8, 43.3, 46, 50, 52.5 and 64.2%, in the literature [3,14,15,22,28,33,34,43]. Multiple reasons for the difference in the reported prevalence of studies can be issues that affect the amount of serum urea and consequently in the patient's saliva, such as dialysis adequacy, hygiene, medication, nutrition, and reduction in the number of taste buds and patient's activity.

Poor oral hygiene along with immune suppression makes the oral cavity suitable for opportunistic infections like candidiasis. The causes that provide conditions for immune suppression in dialysis patients are uremia, malnutrition, and impaired cellular immune function. Other known risk factors for oral candidiasis include xerostomia, denture wearing, age, and diabetes [44]. In prior research, oral candidiasis prevalence has been stated to be 5, 8.3, 10, 10.8, 11.7, and 23% [13,14,22,28,43,45], which is relatively consistent with the prevalence of our study. The environmental causes and genetic disparities may explain the little difference between our study and the studies mentioned above.

Our findings showed that oral candidiasis correlated with increasing the disease duration and decreasing the number of WBCs, which is also clinically justified. Oral candidiasis occurred in 5% of the population who were on dialysis for an average of 3.81 years [45]. In another study in the sample who were dialyzed for an average of 5.38 years, oral candidiasis had an 11.7% prevalence [22]. These outcomes raise the possibility of a relationship

between the dialysis duration and oral candidiasis incidence, which requires further investigation.

Petechiae-ecchymosis lesions in the oral cavity of ESRD patients may be attributed to the underlying increased vascular fragility, declined platelet adhesion, increased prostacyclin activity, and reduced availability of platelet factor 3, and renal anemia (secondary to deficient erythropoiesis). They may also be related to hemodialysis procedure, which lowers platelet count caused by mechanical damage and heparin anticoagulation to maintain the arteriovenous fistula. These lesions have 18, 20.2, 35, and 40% [13,14,22,28] prevalence, which is relatively consistent with the prevalence results found in our study. As previously reported, our findings indicated that the occurrence of petechiae-ecchymosis was statistically correlated with diabetes [22]. Moreover, the petechiae-ecchymosis incidence was statistically correlated with decreased WBCs and platelets.

Mucosal ulcers can be caused by the direct damage of accumulated uremic acid in the saliva of ESRD patients, or they can be secondary to the teeth caries caused by the systemic effects of ESRD. In any case, the rate of occurrence of this complication in these patients is such that it should be taken seriously and investigated in routine examinations. The prevalence of mucosal ulcers was 0, 8.33, 17.5, and 25% in the previous literature [13,22,34,45]. Conclusively, according to Ruospo et al. meta-analysis, 8.6% of dialytic ESRD populations presented mucosal ulcerations [46]. The prevalences mentioned above are relatively consistent with the prevalence of our study.

In patients with kidney failure, the accumulation of ammonia may irritate the mucosa and cause mucosal inflammation. Also, reducing the mucin coating of saliva in the oral mucosa causes vulnerability to infection, inflammation, and tissue damage, which leads to tongue and mucosal pain [29]. BMS is linked to medication side effects, xerostomia, and peripheral nerve injury caused by uremic toxins [12]..Burning mouth was reported in 11% of the patients[3]. According to a systematic review, 18.7% of ESRD patients reported experiencing BMS [46], which despite being unrelated to age, gender, or location, the prevalence of BMS increased with the length of dialysis, confirming our findings.

Lichenoid lesions are primarily observable in renal transplant patients due to medication-induced immunosuppression. They are also not common among ESRD patients, as their prevalence in ESRD individuals has been reported to be 0-7% [14,28,33], which is relatively consistent with the prevalence of our study.

Urea increases the buffering capacity of saliva, preventing the decrease of pH and bacterial growth, which reduces dental caries occurrence. Therefore, extensive caries in ESRD patients are related to the time before the renal disease and the patient's poor oral hygiene [45]. The current study's DMFT score has shown an increased incidence of caries potentially due to poor dental hygiene, xerostomia, and an increase in cariogenic *Streptococcus mutans*, the most critical microbiota in caries development [29].

Various studies have had different approaches and indices to investigate oral hygiene in ESRD populations. Afroozi et al. study among ESRD patients showed that 50.7% had poor oral hygiene, and 18.7% had tooth loss due to periodontal disease [33]. Our finding suggests DMFT index increases with aging, decreased literacy, and fewer regular annual dental visits. Also, an increase in the O'Leary index was significantly correlated with aging.

Non-diabetic ESRD individuals might have lower amounts of cariogenic bacteria in their mouths than those with diabetes, who are known to have greater levels of dental caries [47]. Additionally, due to lower salivary flow rates and periodontal attachment loss, diabetic individuals have an increased risk for caries development [48]. In the present study, patients with higher HbA1c levels showed higher rates of missing teeth and DMFT index, as previously reported [35].

Recent studies have suggested that blood group antigens located on the surface of red

blood cells (RBCs) can affect the likelihood of diseases such as sickle cell anemia, tuberculosis, diabetes mellitus, hypertension, hyperlipidemia and cancers [49]. According to a study in Jordan, 45.7% of the population with renal failure had type A blood, 30.4% had blood group O, 17.3% had B blood type, and 6.6% had blood type AB [17]; thus, to our knowledge, such study has not been conducted in Iran.

Regarding blood types, ESRD patients with AB blood type had a higher occurrence of ESRD-associated oral lesions. RH-negative patients were more likely to develop mucosal ulcers, petechiae-ecchymotic lesions, and higher DMFT and O'leary indices. Furthermore, xerostomia had a significantly higher prevalence among patients with blood types A and B, while individuals with blood group B had lower rates of O'Leary index.

The Hamed et al. study showed that there were substantially more renal patients in the B and O blood groups than in the normal population [19]. Results of the Naser et al. study conducted in Iraq showed that 55% of hemodialytic patients had blood type O, 25% B blood type, 10% A blood group, and 10% blood type AB [18]. In Alhawary et al. study, blood types A and O were more frequently seen in individuals with renal failure, whereas blood group AB was the blood group least likely to cause renal failure [50]. In all reviewed studies and our study, blood group AB was the least linked blood type with kidney failure.

Covid-19 outbreak and patients' refusal to participate were the substantial limitations of the present study. This weakness can be compensated in future studies with larger sample sizes and more diverse variables. Moreover, ESRD-related radiographic changes in jaw bones, including "ground-glass" appearance, reduced trabeculation, secondary hyperparathyroidism, loss of lamina dura, hypercementosis, and calcified pulp chambers [31], were not investigated in our study.

Providing more accurate information to the treatment staff and patients to diagnose and start treatment of these lesions as soon as possible, as well as observing the health of patients to increase their quality of life, is an important issue that needs addressing. Also, due to the complexity of the causes of some lesions and limited and occasionally contradictory information obtained from various research, investing in more comprehensive and accurate interdisciplinary research with larger statistical communities is strongly suggested [10].

Oral manifestations seem to be highly common among hemodialytic ESRD patients; coated tongue, xerostomia, and SLVs appeared to be the most prevalent lesions in ESRD individuals.

**Acknowledgments**

The authors report no conflicts of interest in the matter of study. We received no funding for conducting this study. We would like to thank the patients and Amir Al-Momenin Hospital officials for cooperating in conducting this study. The authors report no conflicts of interest in the matter of study.

**Conflict of interest**

Author declares no conflict of interest.

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