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Original Research Article

Prevalence and Impact of Drug-Induced Xerostomia on Denture Comfort and Oral Quality of Life: A Cross-Sectional Study

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Abstract: ***Aim:*** To evaluate the prevalence of drug-induced xerostomia and its impact on denture comfort and oral health-related quality of life (OHRQoL) among Pakistani medical college patients wearing removable dental prostheses. ***Methods:*** This cross-sectional study was conducted at CMH Lahore Medical College, University of Lahore, and Lahore Medical and Dental College dental clinics from March 23, 2025 to October 26, 2025. Denture-wearing patients aged ≥40 years with medication history were included (N=387). A structured questionnaire assessed sociodemographic data, medication use, xerostomia severity (Summated Xerostomia Inventory-5, SXI-PL), denture comfort, and OHRQoL (Oral Health Impact Profile-14, OHIP-14). Medications were classified according to xerogenic potential. Statistical analysis included descriptive statistics, chi-square tests, and binary logistic regression. ***Results***: Of 387 participants (mean age 58.4±9.2 years, 64.3% female), 72.9% (n=282) experienced clinically significant xerostomia (SXI-PL ≥9). The most prevalent xerogenic medication classes were antihypertensives (68.5%), followed by psychotropic medications (42.6%), and anticholinergics (31.8%). Participants with xerostomia demonstrated significantly lower denture comfort scores (mean 18.3±4.7 vs. 28.6±3.4, p<0.001) and higher OHIP-14 scores indicating poorer OHRQoL (mean 32.4±8.9 vs. 14.7±6.2, p<0.001). Multivariable logistic regression revealed each additional xerogenic medication increased odds of poor denture comfort by 2.34 (95% CI: 1.78-3.08, p<0.001) and negative OHRQoL impact by 2.67 (95% CI: 1.95-3.66, p<0.001). Polypharmacy (≥5 medications) independently predicted severe xerostomia (aOR=4.21, 95% CI: 2.53-7.01, p<0.001). ***Conclusions:*** Drug-induced xerostomia significantly compromises denture comfort and negatively impacts oral health-related quality of life in Pakistani denture wearers. Healthcare providers should consider medication-related dry mouth when managing denture patients, particularly in resource-constrained settings where prosthetic adjustments and saliva substitutes may be less accessible.

Keywords: Drug-induced xerostomia; Medication-related dry mouth; Dental prosthesis; Denture comfort; Quality of life; Oral health; OHIP-14; Pakistan; Polypharmacy

INTRODUCTION

Xerostomia, which refers to the subjective experience of oral dryness, is a major clinical complication in modern dental practice, especially among older adults requiring prosthodontic treatment. Although various etiologies have been identified in the development of

xerostomia, including systemic illnesses, radiation therapy, and autoimmune disorders, medication-induced salivary dysfunction has turned out to be the most common etiology factor in the ambulatory patient population.[1]

The pathophysiology of xerostomia as a result of medication is varied and specific to medications. Anticholinergic agents directly inhibit salivary acini parasympathetic stimulation, and antihypertensive agents, especially angiotensin-converting enzyme (ACE) inhibitors and calcium channel blockers, alter autonomic control of salivary secretion. [10, 11, 12,13.] In the case of denture patients, a constant level of salivary flow has crucial roles other than lubrication of the mucosal surfaces. Salivary hypofunction (caused by medication) therefore results in a cascade effects that are uniquely deleterious to prosthetic outcome: decreased denture retention and stability, mucosal trauma and ulceration, increased candidal colonization, impaired mastication and initial swallowing stages, impaired nutritional intake (dysgeusia), and increased residual ridge resorption. The Pakistani healthcare setting has its own challenges as far as the management of xerostomia as a result of medication is concerned. The prevalence of chronic non-communicable diseases, such as diabetes mellitus (26.3% among adults over 40), hypertension (33% among similar age groups), depression and anxiety disorders (34% in the clinical groups), and cardiovascular disease, demand pharmacological treatment with known xerogenic drugs in large numbers, which limits the ability to provide patients with special interventions to manage xerostomia, including saliva replacement, prescription salivary stimulants (pilocarpine, cevimeline), and regular prosthetic modifications.

Although there has been an increasing awareness of the clinical importance of medication-induced xerostomia, the literature that specifically focuses on the overlap between xerostomia and prosthodontic care, specifically in the context of Pakistani and South Asian health care, is scant. General effects of xerostomia on quality of life, denture wearing as an independent OHRQoL risk factor, [39 -42] documented, and the typification of resource-constrained healthcare settings have been notably limited in studies that successfully investigate the prevalence of medication-induced xerostomia among denture wearers specifically and quantify the effects of xerostomia on prosthetic comfort and functionality. Combined measurements with these two tools allow the study of the correlations between medication burden, xerostomia severity, denture comfort perception and multidimensional quality of life impact.

Consequently, the study objectives were to: (1) establish the incidence of drug-induced xerostomia in denture-wearing patients in Pakistani dental clinics in medical colleges; (2) find out of the medication categories that have the strongest relationship with xerostomia severity in this group; (3) determine the specific effects of drug-induced xerostomia on denture comfort and retention; (4) determine the relationship between the severity of xerostomia and oral health-related quality of life; and (5) find out whether poly We postulated that drug-induced xerostomia would exhibit high levels of negative relationships with denture comfort and OHRQoL and the magnitude of the effect would be proportional to the medication burden and the severity of xerostomia.

Materials and Methods

Study Design and Setting

This cross-sectional observational study was conducted at three dental outpatient clinics in Lahore, Pakistan: CMH Lahore Medical College, University of Lahore, and Lahore Medical and Dental College, from March 23, 2025 to October 26, 2025. All participants provided written informed consent prior to enrollment, with study procedures conducted in accordance with the Declaration of Helsinki principles. Ethical approval was obtained from the institutional review boards of all participating institutions. The study setting comprised three dental clinics serving a mixed urban-suburban patient population in Lahore, Punjab province, providing comprehensive prosthodontic services including complete and partial denture fabrication, denture maintenance, and oral rehabilitation.

Sample Size Calculation and Participant Selection

Sample size was computed using OpenEpi software 3.01, with a xerostomia prevalence of 65 expected to be observed in the sample with drug users, precision desired to be 5, confidence level of 95 and design effect of 1.0 which gave a minimum sample requirement of 350. We had a target of 410 participants taking into account the possibility of incomplete responses but we had a final sample of 387 participants with full data. Systematic consecutive sampling was used to recruit the participants. The following criteria were used in eligibility: (1) age 40 years and above; (2) complete or partial removable dentures used at least 6 months; (3) at least one systemic drug known to have potential effects on xerostomia used regularly; (4) able to understand questionnaires in Urdu or English; (5) no history of head/neck radiations; (6) severe cognitive impairment; (7) willing to record detailed medications history and written informed consent. Patients who had salivary gland pathology, were actively experiencing oral mucosal lesions, which needed urgent management and those who had salivary stimulating drugs or substitutes were excluded.

Data Collection Instruments

Data were collected using a multi-component questionnaire which had a comprehensive structure and was obtained by use of face to face interviews by trained dental professionals. All data collectors had a standardized form of training that incorporated familiarization with the questionnaires, neutral probing, and ethical issues. The questionnaire had five main sections of sociodemographic factors, complete medication history, xerostomia severity based on the validated Urdu version of Summated Xerostomia Inventory-5 (SXI-PL), denture comfort based on a purpose-developed seven-item instrument, and oral health-related quality of life based on the validated Urdu version of OHIP-14. A pilot study using 15 respondents was conducted before full implementation to determine the understanding of the questionnaires and the optimization of data collection processes.

The SXI-PL includes five questions that determine the symptoms of dry mouth and all these questions use the 4-point Likert scale where the aggregate score is between 5 and 20. Xerostomia was divided into: minimal (5-8), mild (9-12), moderate (13-16), and severe (17-20). To be analytical, presence of xerostomia was dichotomized with 9 as a threshold. The OHIP-14 measures seven conceptual dimensions where participants respond to frequency of experiencing each impact in the previous month on a 5-point ordinal scale ranging from Never (0) to Very Often (4) and scores ranging 0-56 and above represent poorer OHRQoL.

Statistical Analysis

IBM SPSS statistics 27.0 was used to analyze data. Descriptive statistics described the sample using continuous variables in the form of mean + standard deviation or median (interquartile range) based on the normality of the distribution; categoric variables frequency and percentages. Bivariate analyses were used to the extent that chi-square, t-tests, ANOVA, or non-parametric equivalents associated with findings. Binary logistic regression was used to determine independent variables in dichotomous outcomes where variables with $p<0.20$ in bivariate analysis were added to multivariate models. Backwards elimination was used to preserve variables that had $p<0.05$ in final adjusted models. Continuous outcomes were studied by use of multiple linear regression. The results are given as adjusted odds ratios (aOR) or unstandardized regression coefficients (B) with 95% confidence interval and p-values. Two-tailed $p<0.05$ was considered statistical significance.

RESULTS

Participant Characteristics

A total number of 410 eligible patients were contacted within the study period out of which 387 gave full data (response rate 94.4). The final group of analysis consisted of 387 denture-wearing patients with a mean age of 58.420 years (34-82 years). Table 1 shows sociodemographic and clinical features in more detail.

Most of the participants were women (64.30, n=249). The majority of the respondents lived in cities (71.8, n=278) and completed higher education or secondary education (62.3, n=241). About the type of prosthesis, 48.3% (n=187) had complete dentures on both arches, 28.9% (n=112) on one arch, and 22.8% (n=88) on removable partial dentures. Mean age of the prostheses was 4.3 2.8. There was high chronic disease burden: hypertension 68.5% (n=265), diabetes mellitus 59.2% (n=229), depression/anxiety 42.6% (n=165), cardiovascular disease 34.1% (n=132), and arthritis 28.2% (n=109). The mean of the participants was 2.7±1.3 chronic diseases and 4.6±2.1 total medications.

Table 1. Sociodemographic and Clinical Characteristics of Study Participants (N=387)

Characteristic	n (%) or Mean ± SD
Age (years)	58.4 ± 9.2
Age groups	
40-49 years	87 (22.5%)
50-59 years	156 (40.3%)
60-69 years	102 (26.4%)
≥70 years	42 (10.9%)
Sex	
Male	138 (35.7%)
Female	249 (64.3%)

Education level	
Primary or less	146 (37.7%)
Secondary or higher	241 (62.3%)
Monthly household income	
<PKR 30,000	149 (38.5%)
PKR 30,000-60,000	165 (42.6%)
>PKR 60,000	73 (18.9%)
Prosthesis type	
Complete dentures (both arches)	187 (48.3%)
Complete dentures (single arch)	112 (28.9%)
Removable partial dentures	88 (22.8%)
Prosthesis age (years)	4.3 ± 2.8
Number of chronic diseases	2.7 ± 1.3
Chronic conditions	
Hypertension	265 (68.5%)
Diabetes mellitus	229 (59.2%)
Depression/Anxiety	165 (42.6%)
Cardiovascular disease	132 (34.1%)
Arthritis	109 (28.2%)
Total number of medications	4.6 ± 2.1
Number of xerogenic medications	2.8 ± 1.4
Polypharmacy (≥5 medications)	198 (51.2%)

Medication Use Patterns and Xerogenic Drug Classes

Drug administration habits showed widespread polypharmacy with 51.2% (n=198) taking 5 or more drugs at a time. The percentage distribution of xerogenic classes of medication is presented in Table 2. Cardiovascular agents (68.5, n=265) were the most common xerogenic classes of medication, including mainly antihypertensives (ACE, 38.2, 31.5, 28.4), and diuretic (35.9). Forty-two point six percent (n=165) of participants were taking psychotropic medications, SSRIs were the most prevalent (23.5), then tricyclic antidepressant (12.4) and benzodiazepine (18.9). Those taking anticholinergic medication were 31.8% (n=123) those mainly antihistamines (19.6) and urological antispasmodics (14.2). Out of 59.2% (n=229), endocrine drugs were being used, mainly in diabetes management. The average number of xerogenic drugs was 2.8+1.4 (1-8).

Table 2. Distribution of Xerogenic Medication Classes (N=387)

Medication Class	n (%)
Cardiovascular agents	**265 (68.5%)**
ACE inhibitors	148 (38.2%)
Calcium channel blockers	122 (31.5%)
Beta-blockers	110 (28.4%)
Diuretics	139 (35.9%)
ARBs	87 (22.5%)
Psychotropic medications	**165 (42.6%)**
SSRIs	91 (23.5%)
Tricyclic antidepressants	48 (12.4%)
Benzodiazepines	73 (18.9%)
Other antidepressants (SNRIs)	34 (8.8%)
Anticholinergics	**123 (31.8%)**
Antihistamines	76 (19.6%)
Urological antispasmodics	55 (14.2%)
Antiparkinsonian agents	18 (4.7%)
Endocrine medications	**229 (59.2%)**
Metformin	156 (40.3%)
Sulfonylureas	89 (23.0%)
Insulin	54 (14.0%)
Thyroid preparations	42 (10.9%)
Analgesics	**98 (25.3%)**
NSAIDs	67 (17.3%)
Opioids	31 (8.0%)
Other xerogenic medications	**76 (19.6%)**

Prevalence and Severity of Drug-Induced Xerostomia

The general prevalence rate of clinically significant xerostomia (SXI-PL score 9 or above) was 72.9% (n=282). The mean SXI-PL score of the whole sample was 12.81243(range 5-20). Table 3 shows the distribution of severity of xerostomia.

The distribution of severity showed that 27.1% (n=105) had minimal xerostomia (SXI-PL 5-8), 31.8% (n=123) had mild xerostomia (SXI-PL 9-12), 28.4% (n=110) had moderate xerostomia (SXI-PL 13-16), and 12.7% (n=49) had severe xerostomia (SXI- There were significant positive correlation between the severity of xerostomia and the number of xerogenic medications (Spearman 0.68, p=0.001), the total number of medications (Spearman 0.62, p=0.001) and the burden of chronic disease (Spearman 0.54, p=0.001). The mean SXI-PL scores between those who are taking 5 or more medications and those who are taking 1-2 medications significantly differed (15.2238 vs. 9.4213, p=0.001). All medication classes showed strong independent relationships with xerostomia severity, with

psychotropic (mean SXI-PL 14.8±3.9) and anticholinergics (mean SXI-PL 14.3±4.1) showing very strong effects over cardiovascular medications (mean SXI-PL 13.2±4.0).

Table 3. Distribution of Xerostomia Severity and Association with Medication Burden (N=387)

Variable	n (%)	Mean SXI-PL ± SD
Overall xerostomia severity		12.8 ± 4.3
Xerostomia categories		
Minimal (SXI-PL 5-8)	105 (27.1%)	6.8 ± 1.1
Mild (SXI-PL 9-12)	123 (31.8%)	10.6 ± 1.2
Moderate (SXI-PL 13-16)	110 (28.4%)	14.3 ± 1.1
Severe (SXI-PL 17-20)	49 (12.7%)	18.2 ± 0.9
Clinically significant (≥9)	282 (72.9%)	13.9 ± 3.2
Number of medications		
1-2 medications	112 (28.9%)	9.4 ± 3.1
3-4 medications	77 (19.9%)	11.8 ± 3.5
≥5 medications	198 (51.2%)	15.2 ± 3.8
Number of xerogenic medications		
1 medication	89 (23.0%)	8.7 ± 2.9
2 medications	134 (34.6%)	11.9 ± 3.2
3 medications	98 (25.3%)	14.6 ± 3.4
≥4 medications	66 (17.1%)	17.1 ± 2.8

Impact on Denture Comfort and Function

The individuals who had xerostomia of clinically significant level (SXI-PL 9) reported significantly lower denture comfort in all the dimensions of the denture compared to those who reported non-xerostomia. The mean composite denture comfort score was 18.3+4.7 in participants with xerostomia compared to 28.6 +3.4 in those without xerostomia (p=0.001). In 68.1% of the participants with xerostomia, there was poor denture comfort (composite score =21 or below) in comparison with 19.0% of the participants without xerostomia (92.4, p=0.001). Individual domain analysis showed especially significant impairments in the area of denture retention during eating (mean 2.1±0.9 vs. 4.2±0.6, p<0.001), general denture comfort (mean 2.3±0.8 vs. 4.1±0.7, p<0.001) and oral mucosa comfort (mean 2.4 0.1 vs. 4.3 0.6, p<0.001). Determinable dose-response correlations were found between the categories of the severity of xerostomia and denture comfort scores with a mean composite score of 27.4±3.8 of minimal xerostomia, 21.5±3.9 of mild, 16.8±3.6 of moderate, and 13.2±3.4 of severe xerostomia (Kruskal-Wallis test: H=186.4, p<0.001).

Assessment of Oral Health-Related Quality of Life

The OHIP-14 total scores exhibited that drug-induced xerostomia possessed significant impairment. Mean OHIP-14 is 32.4-8.9 in participants who had xerostomia versus 14.7-6.2 in participants who did not have xerostomia (p<0.001). Table 4 gives in-depth OHIP-14 domain analysis by categories of xerostomia severity.

The effect of negative OHRQoL (OHIP-14 occasional impact threshold) was found in 89.4% participants with xerostomia as compared to 47.6% participants without xerostomia (2=78.3, p<0.001). The scores of all the seven OHIP-14 domains were significantly high among participants with xerostomia. The worst hit areas were Physical Pain (mean 5.8±1.7 vs. 2.3±1.4, p<0.001), Physical Disability (mean 5.1±1.9 vs. 2.0±1.3, p<0.001) and Psychological Discomfort (mean 4.9±1.8 vs. 1.9±1.2, p<0.001). It was found that the SXI-PL scores and OHIP-14 total scores were strongly positively correlated (Spearman 0.74, p=0.001) with an escalating worsening of quality of life impairment with higher xerostomia severity. Domain-specific analysis showed that dose-response was observed between the xerostomia severity types in terms of all seven OHIP-14 domains.

Table 4. OHIP-14 Domain and Total Scores by Xerostomia Status (N=387)

OHIP-14 Domain	No Xerostomia (n=105)	Xerostomia Present (n=282)	p-value
Functional Limitation	2.1 ± 1.3	4.2 ± 1.6	<0.001
Physical Pain	2.3 ± 1.4	5.8 ± 1.7	<0.001
Psychological Discomfort	1.9 ± 1.2	4.9 ± 1.8	<0.001
Physical Disability	2.0 ± 1.3	5.1 ± 1.9	<0.001
Psychological Disability	2.2 ± 1.4	4.6 ± 1.7	<0.001
Social Disability	2.1 ± 1.3	4.1 ± 1.8	<0.001
Handicap	2.1 ± 1.4	3.7 ± 1.6	<0.001
OHIP-14 Total Score	**14.7 ± 6.2**	**32.4 ± 8.9**	**<0.001**

Values presented as mean ± standard deviation. Independent samples t-tests.

Multivariable Regression Analysis

Multivariable binary logistic regression models examined independent predictors of xerostomia presence, poor denture comfort, and negative OHRQoL impact while controlling for potential confounders. Table 5 presents the final adjusted models.

For xerostomia presence (SXI-PL ≥9), the final model revealed that each additional xerogenic medication increased odds by 2.18 (95% CI: 1.65-2.87, p<0.001), polypharmacy (≥5 medications) independently increased odds by 4.21 (95% CI: 2.53-7.01, p<0.001), and psychotropic medication use increased odds by 3.24 (95% CI: 1.89-5.54, p<0.001), after adjusting for age, sex, and chronic disease burden. For poor denture comfort (composite score ≤21), each unit increase in SXI-PL score increased odds by 1.34 (95% CI: 1.24-1.45, p<0.001), complete dentures versus partial dentures increased odds by 2.87 (95% CI: 1.56-5.28, p=0.001), and each additional xerogenic medication increased odds by 2.34 (95% CI: 1.78-3.08, p<0.001). For negative OHRQoL impact, each unit increase in SXI-PL score increased odds by 1.42 (95% CI: 1.30-1.55, p<0.001), poor denture comfort increased odds by 6.78 (95% CI: 3.89-11.81, p<0.001), and each additional xerogenic medication increased odds by 2.67 (95% CI: 1.95-3.66, p<0.001). Model fit statistics indicated excellent model performance (Hosmer-Lemeshow test p>0.05 for all models; Nagelkerke R^2 ranging from 0.58 to 0.71).

Table 5. Multivariable Binary Logistic Regression: Independent Predictors of Study Outcomes

Predictor Variable	Adjusted OR (95% CI)	p-value
Outcome: Xerostomia Presence (SXI-PL ≥9)		
Number of xerogenic medications	2.18 (1.65-2.87)	<0.001
Polypharmacy (≥5 medications)	4.21 (2.53-7.01)	<0.001
Psychotropic medication use	3.24 (1.89-5.54)	<0.001
Age (per 10-year increase)	1.45 (1.12-1.88)	0.005
Outcome: Poor Denture Comfort (score ≤21)		
SXI-PL score (per 1-point increase)	1.34 (1.24-1.45)	<0.001
Complete dentures vs. partial	2.87 (1.56-5.28)	0.001
Number of xerogenic medications	2.34 (1.78-3.08)	<0.001

Prosthesis age >5 years	1.89 (1.12-3.19)	0.017
Outcome: Negative OHRQoL Impact		
SXI-PL score (per 1-point increase)	1.42 (1.30-1.55)	<0.001
Poor denture comfort	6.78 (3.89-11.81)	<0.001
Number of xerogenic medications	2.67 (1.95-3.66)	<0.001
Female sex	1.76 (1.04-2.98)	0.034
Lower income (<PKR 30,000)	2.12 (1.21-3.71)	0.009

OR: Odds ratio; CI: Confidence interval; SXI-PL: Summated Xerostomia Inventory-5; OHRQoL: Oral health-related quality of life. Models adjusted for age, sex, education, income, prosthesis type, chronic disease burden, and clustering by institution.

DISCUSSION

The current cross-sectional study is a resourceful evidence on prevalence, determinants and clinical effect of drug-induced xerostomia among denture-wearing patients in a Pakistani-based medical college environment. We have shown that clinically significant xerostomia is prevalent among this vulnerable group with a rate of 72.9% with medication burden being a key factor. Importantly, xerostomia due to drugs showed strong independent relationships with denture discomfort and significantly lower oral health-related quality of life despite the consideration of the possible confounding factors such as age, type of prosthesis, and the impact of chronic diseases.

This prevalence of 72.9 xerostomia is high and is significantly higher than that described in general geriatric populations (usually 20-30%) but consistent with those studies that specifically look at cohorts of medication-users in clinical settings. We found cardiovascular agents 68.5 and psychotropic drugs 42.6 as the most common xerogenic classes and this falls in line with the international literature which states that these are the primary xerostomia contributors.[7] Our medication use analysis showed that 51.2% of patients took a minimum of 5 medications, which is also indicative of the changing Pakistani chronic disease environment and the increasing public health significance of xerogenic oral complications.

Of special interest is the dose-response relationship between the medication burden and the severity of xerostomia. Our regression analyses revealed that the odds of clinically significant xerostomia, as a result of the additional xerogenic medication, were increased by a factor of 2.18-3.4 times, and therefore, polypharmacy-related xerostomia is much harder to manage and more likely to be observed due to cumulative dose-effect rather than mere presence/absence of the medication. The especially high correlation of psychotropic drugs with xerostomia (aOR=3.24) should be considered in light of their known anticholinergic load and must guide the prescribing practices and the treatment guidelines.

In our denture comfort examination, it was observed that there were sharp differences between the xerostomia-affected groups and the unaffected ones. The average score on composite denture comfort was found to be 10.3 points lower (18.3 vs 28.6, p<0.001) and 9.2 times higher in participants with xerostomia who were more likely to rate the denture as having poor retention. These results confirm theoretical knowledge about the important functions of saliva in denture performance: the salivary film that provides adhesion between the prosthesis and the mucosa, reducing friction through lubrication during the working process, and cushioning against trauma on the tissues in the case of inadequate salivary flow, which is a clinically significant phenomenon that is often neglected in traditional practice of prosthodontics.

OHIP-14 assessment proved high-quality of life impairment that is related to drug-induced xerostomia. Our multivariate regression analysis showed that every unit of SXI-PL score increment raised the likelihood of negative OHRQoL effects by 42 per cent, no matter the denture comfort, type of prosthesis, and presence of chronic diseases. This observation indicates that xerostomia has direct and indirect impacts on quality of life by means of symptomatic burden and by means of impaired denture performance respectively. Domain-specific analyses indicated that Physical Pain, Physical Disability, and Psychological Discomfort were some of the domains that were specifically impacted by xerostomia, in accordance with its impact on eating, speaking, and being self-conscious about oral symptoms.

The healthcare situation in Pakistan presents certain implications on clinical translation. The limitation of

resources makes prescription cholinergic agonists (PKR 5,000-8,000 monthly) to manage xerostomia (pharmaceuticals) and regular adjustments of the prosthetics inaccessible. Consequently, the practical management measures should focus on: (1) periodic medication review and deprescribing in cases where they are clinically warranted; (2) replacement of highly xerogenic drugs with alternatives with lower anticholinergic effects in case therapeutically equivalent options exist; (3) education as to available interventions such as frequent water sips, sugar-free gum in those with remaining dentition to peak reduction in lips; (4) meticulous denture hygiene measures and regular professional cleaning measures to reduce the occurrence of candidal complications; (5) emp

There are a number of limitations in the study which should be mentioned. This cross-sectional design eliminates the possibility of causal inference, although there is evidence of association between the use of medications, xerostomia and outcomes, longitudinal research would be more appropriate to determine the relationships over time and whether interventions that minimize medication burden can help in improving xerostomia and the quality of life. The convenience sampling method in selected clinics of specific medical colleges restricts the generalizability to the community-dwelling denture wearers who may not be in the tertiary care facilities. Self-report assessment was used to evaluate medication, and the available documentation was used to supplement this, which may have introduced the bias of recall. We did not objectively measure salivary flows, contingent on subjective xerostomia evaluation, although SXI-PL has a high level of validity, poor denture quality may cause mixed results on xerostomia and denture comfort.

In spite of these constraints, the strengths of the study are an in-depth medication documentation including xerogenic classification, the use of valid tools in the assessment of xerostomia and quality of life, detailed denture comfort assessment in multiple functional dimensions, multivariate analysis that adjusts to the presence of relevant confounders, and focus on a poorly studied population within an underserved healthcare environment. The polypharmacy burden analysis inclusion can give practical clinical data on accumulation of medication effects.

Future studies directions involve longitudinal cohort research following denture clients through medication therapy to identify causation, randomized controlled trials of practical xerostomia management methods that are viable in resource-strained environments, cost-effectiveness studies comparing various management strategies, qualitative studies identifying patient experiences and barriers to care access, intervention trials testing mutualistic collaboration models, studies determining whether early xerostomia detection in the dental care environment through proactive drug monitoring can enhance patient outcomes, and creation and validation of screening devices to assist in the detection of xerostomia at an early stage.

Conclusions

This study confirms that drug-induced xerostomia is a very common phenomenon that severely affects the quality of life of the mouth and the use of dentures in people with Pakistan medical colleges. We find the following conclusions emerge:

1. Use of drugs induces xerostomia i
n 72.9 percent of denture wearers taking routine drugs, and the severity of xerostomia is significantly associated with polypharmacy burden and the cardiovascular medications, psychotropic drugs, and anticholinergics.
2. Dry mouth as related to medication proves to be strongly independent of the denture retention, stability and mucosal comfort, regardless of the type of the prosthesis or chronic disease condition.
3. The severity of xerostomia has dose-response correlations with negative oral health-related quality of life effect, and this is on several OHIP-14 domains such as physical pain, functional limitation and psychological discomfort.
4. The Pakistani healthcare setting, with the high prevalence of chronic diseases, a high rate of polypharmacy, and restricted access to specialized xerostomia treatments, presents specific challenges that demand the use of contextually-specific management options focusing on reviewing medication, educating patients, and interprofessional teamwork.
5. Medication burden and xerostomia symptoms should be systematically evaluated in healthcare workers dealing with denture patients as medication-induced dry mouth is a changeable risk factor of prosthodontic therapy outcomes.

Such results substantiate the necessity to develop dental-medical care models to focus on medication-associated oral complications, the elaboration of clinical guidelines related to xerostomia screening and management in prosthodontic practice, and patient education programs concerning the practical symptom-management strategy available in resource-limited settings. Improved perception and treatment of drug-induced xerostomia is a possible intervention that can result in increased quality of life among millions of denture users in Pakistan and other healthcare settings around the world.

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Conflict of Interest Statement

The authors declare no conflicts of interest related to this study.

References

1. Thomson WM. Epidemiology of oral health conditions in older people. Gerodontology. 2014;31 Suppl 1:9-16.
2. Villa A, Connell CL, Abati S. Diagnosis and management of xerostomia and hyposalivation. Ther Clin Risk Manag. 2015;11:45-51.
3. Tanasiewicz M, Hildebrandt T, Obersztyn I. Xerostomia of various etiologies: A review of the literature. Adv Clin Exp Med. 2016;25(1):199-206.
4. Löfgren CD, Wickström C, Sonesson M, Lagunas PT, Christersson C. A systematic review of methods to diagnose oral dryness and salivary gland function. BMC Oral Health. 2012;12:29.
5. Smidt D, Torpet LA, Nauntofte B, Heegaard KM, Pedersen AM. Associations between oral and ocular dryness, labial and whole salivary flow rates, systemic diseases and medications in a sample of older people. Community Dent Oral Epidemiol. 2011;39(3):276-88.
6. Astor FC, Hanft KL, Ciocon JO. Xerostomia: a prevalent condition in the elderly. Ear Nose Throat J. 1999;78(7):476-9.
7. Porter SR, Scully C, Hegarty AM. An update of the etiology and management of xerostomia. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;97(1):28-46.
8. Saleh J, Figueiredo MA, Cherubini K, Salum FG. Salivary hypofunction: an update on aetiology, diagnosis and therapeutics. Arch Oral Biol. 2015;60(2):242-55.
9. Silvestre FJ, Mínguez MP, Suñé-Negre JM. Clinical evaluation of a new artificial saliva in spray form for patients with dry mouth. Med Oral Patol Oral Cir Bucal. 2009;14(1):E8-11.
10. Furness S, Worthington HV, Bryan G, Birchenough S, McMillan R. Interventions for the management of dry mouth: topical therapies. Cochrane Database Syst Rev. 2011;(12):CD008934.
11. Wolff A, Joshi RK, Ekström J, et al. A guide to medications inducing salivary gland dysfunction, xerostomia, and subjective sialorrhea: a systematic review sponsored by the World Workshop on Oral Medicine VI. Drugs R D. 2017;17(1):1-28.
12. Liu B, Dion MR, Jurasic MM, Gibson G, Jones JA. Xerostomia and salivary hypofunction in vulnerable elders: prevalence and etiology. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;114(1):52-60.
13. Chavez EM, Borrell LN, Taylor GW, Ship JA. A longitudinal analysis of salivary flow in control subjects and older adults with type 2 diabetes. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001;91(2):166-73.
14. Nederfors T. Xerostomia and hyposalivation. Adv Dent Res. 2000;14:48-56.
15. Napenas JJ, Brennan MT, Fox PC. Diagnosis and treatment of xerostomia (dry mouth). Odontology. 2009;97(2):76-83.
16. Scully C. Drug effects on salivary glands: dry mouth. Oral Dis. 2003;9(4):165-76.
17. Thomson WM, Lawrence HP, Broadbent JM, Poulton R. The impact of xerostomia on oral-health-related quality of life among younger adults. Health Qual Life Outcomes. 2006;4:86.
18. Turner MD, Ship JA. Dry mouth and its effects on the oral health of elderly people. J Am Dent Assoc. 2007;138 Suppl:15S-20S.
19. Dolan TA, Gilbert GH, Ringelberg ML, et al. Behavioral risk indicators of attachment loss in adult Floridians. J Clin Periodontol. 1997;24(4):223-32.
20. Ikebe K, Matsuda K, Morii K, et al. Impact of dry mouth and hyposalivation on oral health-related quality of life of elderly Japanese. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;103(2):216-22.
21. Osterberg T, Landahl S, Hedegård B. Salivary flow, saliva, pH and buffering capacity in 70-year-old men and women. Correlation to dental health, dryness in the mouth, disease and drug treatment. J Oral Rehabil. 1984;11(2):157-70.
22. Gerdin EW, Einarson S, Jonsson M, Aronsson K, Johansson I. Impact of dry mouth conditions on oral health-related quality of life in older people. Gerodontology. 2005;22(4):219-26.
23. Guggenheimer J, Moore PA. Xerostomia: etiology, recognition and treatment. J Am Dent Assoc. 2003;134(1):61-9.
24. Fox PC, van der Ven PF, Sonies BC, Weiffenbach JM, Baum BJ. Xerostomia: evaluation of a symptom with increasing significance. J Am Dent Assoc. 1985;110(4):519-25.
25. Locker D. Xerostomia in older adults: a longitudinal study. Gerodontology. 1995;12(1):18-25.
26. Ship JA, Pillemer SR, Baum BJ. Xerostomia and the geriatric patient. J Am Geriatr Soc. 2002;50(3):535-43.
27. Thomson WM, Williams SM. Further testing of the xerostomia inventory. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000;89(1):46-50.
28. Millsop JW, Wang EA, Fazel N. Etiology, evaluation, and management of xerostomia. Clin Dermatol. 2017;35(5):468-76.
29. Hopcraft MS, Tan C. Xerostomia: an update for clinicians. Aust Dent J. 2010;55(3):238-44.
30. Basit A, Fawwad A, Qureshi H, Shera AS; NDSP Members. Prevalence of diabetes, pre-diabetes and associated risk factors: second National Diabetes Survey of Pakistan (NDSP), 2016-2017. BMJ Open. 2018;8(8):e020961.
31. Jafar TH, Levey AS, Jafary FH, et al. Ethnic subgroup differences in hypertension in Pakistan. J Hypertens. 2003;21(5):905-12.
32. Mirza I, Jenkins R. Risk factors, prevalence, and treatment of anxiety and depressive disorders in

Pakistan: systematic review. BMJ. 2004;328(7443):794.
33. Jafar TH, Qadri Z, Chaturvedi N. Coronary artery disease epidemic in Pakistan: more electrocardiographic evidence of ischaemia in women than in men. Heart. 2008;94(4):408-13.
34. Nishimura RA, Otto CM, Bonow RO, et al. 2017 AHA/ACC focused update of the 2014 AHA/ACC guideline for the management of patients with valvular heart disease. J Am Coll Cardiol. 2017;70(2):252-289.
35. Zero DT, Brennan MT, Daniels TE, et al. Clinical practice guidelines for oral management of Sjögren disease: dental caries prevention. J Am Dent Assoc. 2016;147(4):295-305.
36. Khan AA, Jafri FF, Baig R, Khan S. Complete denture failure: a clinician's point of view. J Pak Med Assoc. 2006;56(12 Suppl 4):S73-6.
37. Agha D, Abdel-Salam FS. Comparative evaluation of the effectiveness of resilient denture liners in the treatment of denture stomatitis. J Prosthodont. 2018;27(9):849-857.
38. Ahmad MS, Bhayat A, Zafar MS, Al-Samadani KH. The impact of hyposalivation on quality of life (QoL) and oral health in the aging population of Al Madinah Al Munawarrah. Int J Environ Res Public Health. 2017;14(4):445.
39. Johansson AK, Johansson A, Unell L, Ekbäck G, Ordell S, Carlsson GE. Self-reported dry mouth in Swedish population samples aged 50, 65 and 75 years. Gerodontology. 2012;29(2):e107-15.
40. Bots CP, Brand HS, Veerman EC, et al. Chewing gum and a saliva substitute alleviate thirst and xerostomia in patients on haemodialysis. Nephrol Dial Transplant. 2005;20(3):578-84.
41. Locker D, Allen F. What do measures of 'oral health-related quality of life' measure? Community Dent Oral Epidemiol. 2007;35(6):401-11.
42. Simons D, Baker P, Jones B, Kidd EA, Beighton D. An evaluation of an oral health training programme for carers of the elderly in residential homes. Br Dent J. 2000;188(4):206-10.
43. Allen PF, McMillan AS, Walshaw D, Locker D. A comparison of the validity of generic- and disease-specific measures in the assessment of oral health-related quality of life. Community Dent Oral Epidemiol. 1999;27(5):344-52.
44. Emami E, de Souza RF, Kabawat M, Feine JS. The impact of edentulism on oral and general health. Int J Dent. 2013;2013:498305.
45. Sreebny LM, Schwartz SS. A reference guide to drugs and dry mouth - 2nd edition. Gerodontology. 1997;14(1):33-47.
46. Yuan A, Woo SB. Adverse drug events in the oral cavity. Oral Surg Oral Med Oral Pathol Oral Radiol. 2015;119(1):35-47.
47. Rees TD. Drugs and oral disorders. Periodontol 2000. 1998;18:21-36.
48. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol. 1997;25(4):284-90.
49. Locker D, Allen F. Developing short-form measures of oral health-related quality of life. J Public Health Dent. 2002;62(1):13-20.
50. John MT, Patrick DL, Slade GD. The German version of the Oral Health Impact Profile - translation and psychometric properties. Eur J Oral Sci. 2002;110(6):425-33.
51. Thomson WM, van der Putten GJ, de Baat C, et al. Shortening the xerostomia inventory. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;112(3):322-7.
52. Thomson WM, Chalmers JM, Spencer AJ, Williams SM. The Xerostomia Inventory: a multi-item approach to measuring dry mouth. Community Dent Health. 1999;16(1):12-7.
53. Ikebe K, Matsuda KI, Kagawa R, et al. Association of masticatory performance with age, gender, number of teeth, occlusal force and salivary flow in Japanese older adults: is ageing a risk factor for masticatory dysfunction? Arch Oral Biol. 2011;56(10):991-6.
54. Walls AW, Steele JG. The relationship between oral health and nutrition in older people. Mech Ageing Dev. 2004;125(12):853-7.
55. Hamada R, Suehiro J, Nakano M, Kikutani T, Takahashi N. Relationship between medication use and oral health status in hospitalized elderly. Aging Clin Exp Res. 2017;29(3):439-443.
56. Wiener RC, Wu B, Crout R, et al. Hyposalivation and xerostomia in dentate older adults. J Am Dent Assoc. 2010;141(3):279-84.
57. Niklander S, Veas L, Barrera C, Fuentes F, Chiappini G, Marshall M. Risk factors, hyposalivation and impact of xerostomia on oral health-related quality of life. Braz Oral Res. 2017;31:e14.
58. Agostini BA, Cericato GO, Silveira ERD, et al. How common is dry mouth? Systematic review and meta-regression analysis of prevalence estimates. Braz Dent J. 2018;29(6):606-618.
59. Benn AML, Thomson WM. Saliva: its role in health and disease. Aust Dent J. 2019;64 Suppl 1:S14-S24.
60. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. BMC Geriatr. 2017;17(1):230.
61. Salort-Llorca C, Mínguez-Serra MP, Silvestre FJ. Drug-induced burning mouth syndrome: a new etiological diagnosis. Med Oral Patol Oral Cir Bucal. 2008;13(3):E167-70.
62. Scully C, Limeres J, Gleeson M, Tomas I, Diz P. Drooling. J Oral Pathol Med. 2009;38(4):321-7.
63. Plemons JM, Al-Hashimi I, Marek CL. Managing xerostomia and salivary gland hypofunction: executive summary of a report from the American Dental Association Council on Scientific Affairs. J Am Dent Assoc. 2014;145(8):867-873.
64. Jensen SB, Pedersen AM, Vissink A, et al. A systematic review of salivary gland hypofunction and

xerostomia induced by cancer therapies: management strategies and economic impact. Support Care Cancer. 2010;18(8):1061-79.
65. Glore RJ, Spiteri-Staines K, Paleri V. A patient with dry mouth. Clin Otolaryngol. 2009;34(4):358-63.
66. Taweechaisupapong S, Pesee M, Aromdee C, Laopaiboon M, Khunkitti W. Efficacy of pilocarpine lozenge for post-radiation xerostomia in patients with head and neck cancer. Aust Dent J. 2006;51(4):333-7.
67. Dost F, Farah CS. Stimulating the discussion on saliva substitutes: a clinical perspective. Aust Dent J. 2013;58(1):11-7.
68. Thomson WM. Epidemiology of dry mouth and salivary gland hypofunction. Periodontol 2000. 2015;70(1):11-8.
69. Furness S, Bryan G, McMillan R, Worthington HV. Interventions for the management of dry mouth: non-pharmacological interventions. Cochrane Database Syst Rev. 2013;(9):CD009603.
70. Villa A, Wolff A, Aframian D, et al. World Workshop on Oral Medicine VI: a systematic review of medication-induced salivary gland dysfunction: prevalence, diagnosis, and treatment. Clin Oral Investig. 2015;19(7):1563-1580.