



Patterns of Restorative Failure among Khat and Shammah Users in Jazan City, Kingdom of Saudi Arabia: A Cross-sectional Survey

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ABSTRACT

Introduction: The effect of Khat and Shammah habits, with the parafunctional jaw activities that accompany them, on the integrity of the natural dentition, dental restorations, and prostheses has not yet been investigated. This study is the first attempt to identify the patterns of restorative failure among Khat chewers and Shammah users in Jazan City, Kingdom of Saudi Arabia.

Materials and methods: A cross-sectional study was conducted in 294 recruits among dental clinics in Jazan City, Kingdom of Saudi Arabia, from October 1, 2015, to April 30, 2016. The patients were surveyed and examined to identify the type of restorations/prosthesis they had and their failures. Bivariate analysis was conducted to investigate the association of the restorative failure with the demographic variables. General linear model was performed to investigate the association between restorations/prostheses failure and Khat/Shammah use with the controlling factors of age and gender as independent variables.

Results: Khat/Shammah use was statistically significantly associated with restorative failure ($p < 0.05$) relative to amalgam, composite, crowns, fixed partial dentures, removable partial dentures, and complete dentures. In addition, a significant

association of restorative failure was observed with gender, education, and brushing.

Conclusion: Consumption of Khat/Shammah may be attributed as one of the reasons associated with restorative failure among the Saudi population.

Keywords: Khat, Restorative failure, Saudi population, Shammah.

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INTRODUCTION

One of the vital areas of concern in dental practice is a failure of dental restorations. It has been reported in the literature that about 60% of all operative work involves the replacement of failed restorations.^{1,2} Failure of restoration occurs when a restoration degrades to a level where it precludes proper performance either for esthetic or functional reasons or because of inability to prevent disease development or recurrence.²⁻⁴ The following are the three main reasons why restorations are replaced: Clinician factors, material properties, and patient factors.^{2,5} The longevity of dental restorations is influenced by several factors, including the restorative materials used,⁶⁻⁸ the clinician's expertise,⁹ patient's age,⁹ the type of tooth,^{10,11} the tooth's position in the dental arch,¹¹⁻¹³ the restoration's design and size,¹²⁻¹⁴ and the number of restored surfaces.¹⁴⁻¹⁶

Burke et al¹⁷ found that normal occlusal function is associated with increased restoration's age at replacement and that excessive and high occlusal function is associated with reduced restoration's age at failure.^{1,17}

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Khat, or *Catha edulis*, of the plant family Celastraceae, is an evergreen shrub indigenous to Yemen and East Africa. The plant has amphetamine-like effects, and a high proportion of the population habitually chews its fresh leaves and twigs.¹⁸⁻²⁰ Traditionally, 100 to 200 gm of the fresh leaves and twigs are chewed for 4 to 10 hours into a large quid that is parked against the buccal mucosa or the mandibular sulcus. The juice is swallowed, and the quid is usually ejected out at the end of the chewing session.²⁰ Although largely viewed as a social habit, long-term heavy chewing has been recently reported to induce a degree of dependence.²¹

The juice of the Khat leaves is composed of various components including alkaloids, carbohydrates, tannins, flavonoids, and vitamins. Vitamin C, as a constituent in Khat juice, may contribute to dental erosion due to its acidity.²² Various studies have reported oral effects of Khat chewing, which range from dental erosion,²³ periodontal pocketing,²³⁻²⁵ gum bleeding,²³⁻²⁵ and gingival recession,²³⁻²⁶ hence leading to failure of the periodontal attachment apparatus.

Xerostomia has been reported by Khat chewers approximately half an hour after initiation of the chewing session. This is the major contributory factor in the increased caries susceptibility, as well as staining of teeth adjacent to the site of chewing.²⁶⁻²⁸ Khat chewers report a high frequency of chronic recurrent subluxation and dislocation of the temporomandibular joint which may cause parafunctional jaw activities, which in turn may contribute to restorative and prosthetic failure in these individuals.^{29,30}

Low salivary flow rate, lower salivary pH, and increased viscosity of saliva were reported in Khat chewers, which may further predispose these individuals to increase caries risk.³⁰ However, the effect of those habits with the parafunctional jaw activities that accompanies them on the integrity of the natural dentition, dental restorations, and prostheses has not yet been investigated. Therefore, the aim of this study was to identify the patterns of restorative failure in amalgam, composite, crowns, fixed partial dentures (FPD), removable partial dentures (RPD), and complete dentures (CD) among Khat chewers and Shammah users and to increase the population awareness in Jazan region of Saudi Arabia, in particular, and other parts of the world where these habits are common.

MATERIALS AND METHODS

A cross-sectional survey was conducted to identify the patterns of restorative failure among Khat chewers and Shammah users reporting to dental clinics in Jazan City, Kingdom of Saudi Arabia. Data collection was carried out in the period from October 1, 2015, to April 30, 2016. The study subjects included individuals aged 15 to 80

years, patients with restoration or prosthesis that were in function for at least 5 years, patients medically fit or with a disease that did not affect oral health, regularly attend follow-up appointments, and absence of congenital abnormalities were included in this study. All subjects without restorations or prosthesis were excluded from the study. A convenient sample size of 205 participants was included in the study. All subjects were informed about the study in a language of their comprehension and voluntary written informed consent was obtained from them. Ethical clearance for conducting the study was obtained from the Institutional Review Board. The study proforma, i.e., questionnaire and examination chart, was pretested and validated before the study through a pilot study. Cronbach's alpha value of 0.89 showed a good internal consistency of the study tool. The proforma was used to collect the following information: Demographic data including age, gender, education, oral hygiene habits, chewing habit (Khat/Shammah), and restorative failure. Detailed information on the chewing habit was collected. Failure causative cofactors were categorized under amalgam, composite, crown, RPD, FPD, and CD. The patients were then clinically examined by mouth mirror, probe, articulating paper, shim stock, and occlusal indicating wax to gain information about the restorations/prostheses they had and their failures. The oral examination was conducted by two dentists who were trained and calibrated. The training and calibration were done to facilitate accurate detection of failures and their causative factors and achieve concordance among the examiners respectively. The Kappa statistics value for interexaminer reliability in this study was 0.92.

Statistical Analysis

All obtained data were compiled systematically in Microsoft Excel Worksheet and analyzed using Statistical Package for the Social Sciences (version 21, IBM, USA). Bivariate analyses were conducted to investigate if each independent variable is associated with restorative failure. Chi-square test was used for the association between categorical variables. Independent sample t-test was used for the relationship between numerical and binary variables. One-way analysis of variance was conducted to explore the relationship between numerical and categorical variables with more than two levels. Bonferroni correction was applied for the multiple tests of each outcome. The results from the bivariate analyses were presented with Bonferroni correction. General linear model was performed for each of the outcomes. The variable of consuming Khat/Shammah was analyzed with the controlling factors of age and gender as the independent variables. Statistical significance level was set to 0.05 for all tests.

RESULTS

A total of 294 patients were enrolled in the study. Of the enrolled patients, 205 (69.7%) reported with various restorative failures. The majority of the study participants were males (n = 174/205; 84.9%). The data were analyzed to answer the following research questions:

- Are the variables of consuming any Khat/Shammah, gender, age, education level, and brushing teeth associated with the outcomes of amalgam, composite, crowns, FPD, RPD, and CD failures?
- Is consuming any Khat/Shammah associated with the number of teeth lost and number of teeth restored?
- What is the frequency of each failure causative cofactor or pattern under each failure category in users group?

Hence, to answer the aforementioned research questions, the independent variables included in the analysis were Khat/Shammah use, gender, age, education, and brushing. The outcome variables that were assessed included the number of teeth lost; the number of teeth restored; and restorative failure categorized under amalgam, composite, crowns, FPD, RPD, and CD. Further, some variables with multiple levels were collapsed to two or three levels for ease of analyses, as shown in Table 1.

For the first research question, bivariate analyses (Table 2) were conducted to investigate if each independent variable is associated with each of outcomes. For the

Table 1: Some variables that were collapsed for ease of statistical analyses

Variables	Levels in the original data	Levels after collapsing
Khat/Shammah use	Khat/Shammah/ both/none	Khat/Shammah use (Yes or No)
Education	Levels 1–6	3 categories Low: Levels 1, 2, 3, or 4 High: Level 5 None: Level 6

binary dependent variables (restorative failure), logistic regression was not performed due to the nature of the data, either one of their values did not have exactly two distinct nonmissing values or very small sample size was included in the Khat/Shammah use group.

Of the 205 reported restorative failures, the highest were amalgam (29.75%) followed by composite (25.85%), FPD (33 (16.1%), CD (10.24%), RPD (9.27%), and crowns (8.78%). The results of the bivariate analysis show that Khat/Shammah use was significantly associated with the various restorative failures in amalgam (p < 0.001), composite (p < 0.001), crowns (p < 0.001), FPD (p < 0.001), RPD (p < 0.001), and CD (p < 0.001). All outcomes failure rates were higher in the consuming than in the nonconsuming group. Males had a significantly higher failure rate of amalgam (p = 0.001), composite (p < 0.001), crowns

Table 2: Bivariate analysis for association of the dependent and independent variables (n = 205)

Variables	Amalgam n = 61	Composite n = 53	Crown n = 18	FPD n = 33	RPD n = 19	CD n = 21
Independent variable	n (% of failure)					
	p-value*					
Khat/Shammah user						
Yes	61 (29.7)	50 (24.4)	18 (8.78)	32 (15.6)	19 (9.27)	21 (10.2)
No	0 (0.0)	3 (1.5)	0 (0.0)	1 (0.5)	0 (0.0)	0 (0.0)
p	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Gender						
Male	51 (24.9)	46 (22.4)	18 (8.78)	31 (15.1)	13 (6.3)	15 (7.3)
Female	10 (4.9)	7 (3.4)	0 (0.0)	2 (0.9)	6 (2.9)	6 (2.9)
p	0.001*	<0.001*	0.002*	0.004*	0.842	0.608
Education						
High	17 (8.3)	25 (12.2)	8 (3.9)	6 (2.9)	0 (0.0)	1 (0.8)
Low	32 (15.6)	25 (12.2)	10 (4.9)	22 (10.7)	6 (2.9)	6 (2.9)
None	12 (5.85)	3 (1.5)	0 (0.0)	5 (2.4)	13 (6.3)	14 (6.8)
p	0.039	0.077	0.003*	0.005*	0.001*	0.001*
Brushing						
Yes	39 (19)	43 (20.9)	15 (7.3)	25 (12.2)	10 (4.9)	
No	22 (10.7)	10 (4.9)	3 (1.5)	8 (3.9)	9 (4.4)	
p	0.009*	0.0081*	0.580	0.911	0.021	
Age	n, mean age (SD)					
Failure group	61, 41.2 (12.8)	53, 33.5 (9.9)	35, 50.4 (9.8)	33, 47.1 (12.7)	19, 55.2 (10.9)	21, 63.0 (11.4)
Nonfailure group	233, 39.0 (15.4)	241, 40.8 (15.5)	259, 35.8 (14.1)	261, 38.5 (14.9)	275, 38.4 (14.6)	273, 37.7 (13.6)
p	0.301	0.001**	0.0025**	0.002**	0.001**	0.001**

*Chi-square test; **Independent sample t-test

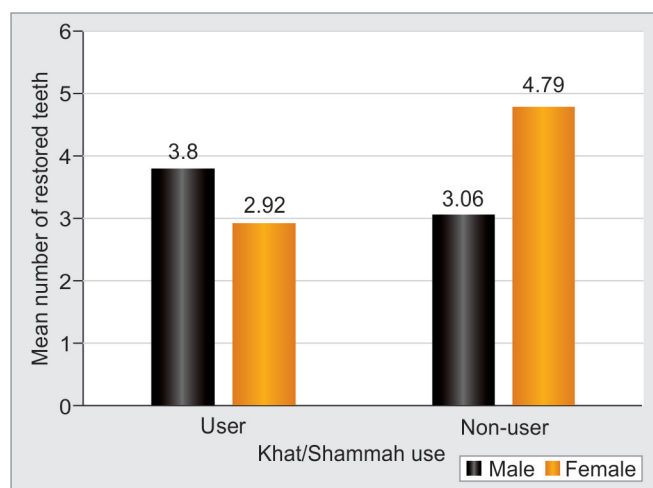
Table 3: General linear model showing the effect of Khat/Shammah use, gender, age, and interaction of Khat/Shammah use and gender on the # of teeth lost and restored

Independent variable		Outcome variable					
		# of teeth lost			# of teeth restored		
		n	Mean (SD)	p-value	n	Mean (SD)	p-value
Khat/Shammah use	Yes	201	5.42 (9.41)	0.812	159	3.66 (3.66)	0.007*
	No	135	2.54 (5.76)		134	3.99 (3.89)	
Gender	Male	195	4.21 (8.13)	0.355	195	3.57 (3.51)	0.582
	Female	99	3.88 (7.95)		98	4.30 (4.22)	
Age				<0.001*			<0.001*
Interaction of Khat/Shammah use and gender				0.569			0.001*

(p = 0.002), and FPD (p = 0.004) than females. Education was found to be significantly associated with failure of crowns, FPD, RPD, and CD (p<0.05). High education group had fewer failures as compared with the low or no education group. Patients who brush their teeth had a significantly lower failure of amalgam (p<0.05) and composite (p<0.05) restorations than the patients who did not brush their teeth. The indirect restorations showed slight reduction in failure among people who brush, however not enough to show statistical significance. Age was found to be associated with failure of all restorations except amalgam (p<0.05). The mean age of composite failure group was significantly less than the nonfailure group (33.5 vs 40.8 years respectively), whereas the mean age in the other failure groups was significantly higher than the nonfailure groups.

For the second research question, a general linear model was performed for each outcome (i.e., number of teeth lost and the number of teeth restored). The variable Khat/Shammah use with the controlling factors of age and gender were considered as the independent variables (Table 3). It was observed that Khat/Shammah use was associated with the number of teeth restored (p = 0.007), but not associated with the number of teeth lost. Khat/Shammah users [mean: 3.66, standard deviation (SD): 3.66] had significantly fewer numbers of teeth restored than nonusers (mean: 3.99, SD: 3.89). Interaction of Khat/Shammah user and gender was observed to be significantly associated with the number of teeth restored (p<0.05). The mean number of teeth restored between the users and nonusers is significantly less for females than for males (Graph 1). Furthermore, age was found to be significantly associated with both the number of teeth lost and restored (p<0.05).

For the last research question, the frequency of the causative cofactors within the failure categories of users group was listed in Tables 4 and 5. The cofactor "Others," refers to accidental trauma and parafunctional habits that are not listed in the main causative cofactor categories.



Graph 1: Gender-wise distribution of the mean number of restored teeth among Khat/Shammah users

Table 4: Frequency of failure causative cofactors in direct restorations noted among Khat/Shammah users group

Failure category	Causative co-factors	Percentage
Amalgam	Recurrent caries	49.2
	Fractured tooth	24.6
	Fractured restoration	57.4
	Heavy occlusal contact	8.2
	Others	38.4
Composite	Recurrent caries	42
	Fractured tooth	10
	Fractured restoration	58
	RCT	12
	Tooth wear	10
	Others	8

DISCUSSION

This study was conducted to identify the patterns of restorative failure among Khat chewers and Shammah users in Jazan City, Kingdom of Saudi Arabia. Moreover, an attempt was made to recognize any association, if any, between independent variables of Khat/Shammah use, gender, age, education level, brushing teeth, and the failure of direct and indirect restorations/prostheses. Furthermore, the

Table 5: Frequency of failure causative cofactors in indirect restorations/prostheses noted among Khat/Shammah users group

Failure category	Causative co-factors	Percentage
Crown	Recurrent caries	27.8
	Excessive occlusal wear	33.3
	Fracture of post/core	16.7
	Fracture tooth	11.1
	Others	16.7
FPD	Recurrent caries	46.9
	Excessive occlusal wear	31.3
	Fracture of post/core	0
	Fracture tooth	15.6
	Loss of retainer	50
RPD	Others	12.5
	Poor RPD framework	31.6
	Heavy occlusal contact	26.3
	Recurrent caries	15.8
	Periodontal disease	57.9
CD	Others	21.1
	Poor CD fabrication/design	28.6
	Poor CD fit	52.4
	CD fracture	23.8
	Excessive occlusal wear	47.6
	Deflective occlusal contact	0
	Others	0

causative cofactors for each failure category were determined. In addition, the association of Khat/Shammah use with the number of teeth lost and restored was also studied. An exhaustive literature search has revealed that this is the first attempt to identify restorative failures associated with Khat/Shammah use in the Saudi population. Over the years, several studies have been published on the longevity of direct and indirect restorations listing various reasons for their failures leading to replacement. However, none of the available studies has reported the effect of oral habits like those in the present study on restorative failure.

Of the 205 reported restorative failures, the highest was in amalgam restorations followed by composite, FPD, CD, RPD, and crowns. As these are results of a cross-sectional survey, no direct extrapolations can be made on the longevity of any of these restorations.

In the present study, it was observed that Khat/Shammah use was significantly associated with the various restorative failure categories. All outcomes failure rates were higher in the user than the nonuser group. A study conducted by Al-Sharabi et al³⁰ reported a detailed description of Khat use in particular in the Yemeni population. They observed that chewers reported a mean of 14.45 years of Khat use with a mean chewing session duration of 4.22 ± 1.39 hours. It has also been reported that increased occlusal stress is associated with increased restorative failures.^{1,16} This explains the high failure rates seen in amalgam, composite, and crowns.

Males had significantly higher failure rates in amalgam ($p = 0.001$), composite ($p < 0.001$), crowns ($p = 0.002$), and FPD ($p = 0.004$) than females. This finding, however, was in contrast with previous studies conducted by Hutton et al³¹ and Mjör et al³² who found no association of gender with restorative failures. This difference could be due to the fact that females were not equally represented in the present study with about 85% of the study participants being male.

Education was found to be significantly associated with failure of crowns, FPD, RPD, and CD ($p < 0.05$). High education group had fewer failures as compared with the low or no education group. Education has been traditionally linked to oral health outcomes. Nikias et al,³³ reported that poor education was related to poor oral hygiene, tooth loss, and periodontal disease due to lack of awareness and motivation toward the maintenance of oral health.

Patients who brush their teeth had significantly lower failure rates in amalgam ($p < 0.05$) and composite ($p < 0.05$) restorations than patients who did not brush their teeth. The failure rates for indirect restorations/prostheses showed slight reduction among people who brush; however, it was not enough to show statistical significance. Maintenance of good oral hygiene is imperative to the success of any dental restoration or prosthesis.³³ Hence, it was not surprising to notice more restorative failures in the participants who did not brush their teeth.

Age was found to be associated with failure of all direct and indirect restorations/prostheses except amalgam ($p < 0.05$). The mean age of composite failure group was significantly less than the nonfailure group (33.5 vs 40.8 years respectively), whereas the mean age in the other failure groups was significantly higher than the nonfailure groups. This could be attributed to the fact that younger people prefer more esthetics restorations (i.e., composite). Higher percentage of restorations/prostheses are seen in older individuals due to the pattern of tooth loss.³⁴

In the present study, the interaction of Khat/Shammah use and gender was observed to be significantly associated with the number of teeth restored. The mean number of teeth restored between the user and nonuser groups is significantly less for females than for males. Khat chewing is predominantly a male habit, but women do practice it as well.^{30,35} Khat is chewed at social gatherings, i.e., Khat sessions, where the plant leaves are chewed on one side of the mouth, the juice being swallowed. The residue is retained as a bolus on the inside of the cheek and is ejected at the end of the session.^{18,30} This is typical for male Khat chewers, for whom the chewing is the main event. At female Khat sessions, however, the social gathering is more important than the chewing itself and much smaller quantities are chewed and for shorter periods.^{30,35}

The second most common reason for restorative failure in amalgam, composite, and crowns in the present study was recurrent caries. However, recurrent caries was found as the primary causative factor of failure in FPD. Other reasons were fracture of tooth, fracture of restoration, and excessive occlusal forces. This finding is consistent with various studies conducted to evaluate restorative failure over the years.^{2,3,5-12} Poor framework/design was reported as the major cause for RPD failure. Technical failures and complications are caused by faults introduced during the manufacturing process, inappropriate design, or simply due to the amount of time the RDP was in function.^{36,37} The major reason for CD failure was reported to be poor construction and poor fit. This observation is also in agreement with literature pertaining to prosthetic failure.^{38,39}

The Khat plant (*C. edulis*) is widely cultivated in certain areas of East Africa and the Arabian Peninsula. The prevalence of Khat/Shammah use is estimated to be more than 20 million globally. In social gatherings, users, typically males, chew and store fresh leaves of Khat for several hours on a daily basis.^{18,40,41} Owing to the amphetamine-like effect of this plant, the main effects of Khat chewing include moderate euphoria and excitation when chewed for 4 to 5 hours per day. This effect is mainly attributed to the alkaloid cathinone, a constituent of the Khat juice, which possesses amphetamine-like properties.¹⁸

The oral use of unburned tobacco, i.e., Shammah, in Jazan City has been reported to begin as young as 10 to 13 years of age. It is also reported to be used in infants to reduce the pain linked with teething.⁴² The real magnitude of this habit may be higher since Shammah is illegal in Kingdom of Saudi Arabia and the study subjects may not be very willing to disclose the use of Khat/Shammah to the researchers.⁴⁰⁻⁴⁶

Khat leaves after chewing are usually parked in the mandibular distobuccal fold of the oral cavity. Chewing Khat has been linked to gingivitis, periodontal pocket formation, gingival recession, dental caries, and tooth mobility.^{22-26,41} Previous studies have also associated Khat chewing with salivary enlargement, inflammation, and xerostomia.^{25,35,41} Although there is a plethora of literature on the negative effects of Khat/Shammah use on oral health, no authors have yet reported the effects that this habit may have on the restorations/prostheses present in the oral cavity.

The main limitation of the study was a lack of standardization of the clinician and material factors associated with the restorations and prostheses, as these factors strongly affect their long-term success and longevity over time. Sample distribution relative to gender was another limitation in this study as female participants were fewer than males.

CONCLUSION

This study is the first of its kind to identify the patterns of restorative failure associated with Khat/Shammah use among Saudi population. Within the limitations of the study, the authors conclude that Khat/Shammah use is associated with failure of various types of restorations/prostheses. Therefore, clinicians have the added responsibility to make their patients aware of the catastrophic effects of Khat/Shammah use on dental restorations and prostheses. The negative effects of smokeless tobacco use are already well documented in the literature. Therefore, public health programs are needed to increase awareness among users with regard to the detrimental effects of Khat/Shammah use on general as well as oral health.

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