

Reasons for Extraction of Permanent Teeth in a University Dental Clinic Setting

This article was published in the following Dove Press journal:
Clinical, Cosmetic and Investigational Dentistry

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Purpose: This study aimed to explore the reasons for tooth extraction and investigated the potential correlations between tooth loss and several variables including age, gender, education level, and other risk factors, such as diabetes and smoking habit.

Patients and Methods: The study retrospectively analyzed 1811 dental records of patients who underwent extraction procedure of at least one tooth. Patients' variables included: age, gender, level of education, diabetes, and smoking habit. Reasons for extraction were recorded as follows: caries, periodontal disease, endodontic treatment complications, orthodontic treatment, impactions, trauma, pre-prosthetic, and others (esthetic reasons, tooth malposition, or unspecified reasons).

Statistical analysis: The significance of variables was analyzed by Chi square test, $P < 0.05$. The variances in the mean number of extracted teeth per patient were investigated using ANOVA. Pearson correlation test was used to test the strength of the association among the tested variables, $P < 0.01$.

Results: Out of 1811 reviewed patients' records, 2654 extracted teeth were identified. Males had a higher number of extracted teeth, 1447 (54.5%), than females, 1207 (45.5%). Males had more extractions due to periodontal disease, while females had more extractions for orthodontic and pre-prosthetic reasons. The highest mean of extracted teeth was identified among the 51-year-old and above age groups (3.73 ± 0.53 teeth) where periodontal disease was shown to have a significant association ($P < 0.05$). Diabetic patients showed a significant association with periodontal diseases, while smokers showed a significant association with caries. Both diabetics and smokers had moderate correlation (0.055 and 0.04, respectively).

Conclusion: Caries, periodontal disease, and endodontic complications were the most common causes of tooth extraction. In addition, this study indicated that age, diabetes, and smoking habits were found to be suitable forecasters for permanent tooth loss as these variables displayed significant statistical association.

Keywords: tooth extraction, dental caries, periodontal disease

Introduction

Tooth loss remains the foremost universal problematic dental issue.¹ Previous studies of the reasons for tooth extractions have been conducted in multiple regions and concluded that caries, periodontal diseases, trauma, orthodontic and prosthodontic treatments, endodontic treatment complications, root fracture, and malpositioned teeth are the main reasons for tooth loss.²⁻⁷ In order to implement good measures for oral disease prevention and oral health awareness policies, it is important to understand the reasons for tooth loss.

Multiple studies revealed that dental carious lesions and periodontal disease were the most common reasons for tooth extraction.⁷⁻¹¹ In general, most of the

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studies showed that dental caries was the primary reason for tooth loss among 20 to 60 years old patients. Besides, periodontal disease was the principal reason for tooth loss among patients in their late 40s and older as there was an association between age and periodontal disease. On the other hand, endodontic treatment complications and orthodontic treatment was observed as the main reason for tooth extraction among adolescent patients.^{12–14}

Some studies concluded that there was an association between tooth loss and gender, where females had more tooth loss due to dental caries while males lose their teeth mostly due to periodontal disease.^{12–14} Other reasons such as root fracture, pre-prosthetic, esthetic reasons, and tooth malposition were found to have less influence on tooth loss.^{2–6}

Few studies explored the association between socio-demographic and medical factors with tooth loss.^{8,10,17} Therefore, the aims of this study were to explore the reasons for tooth extraction and investigate the potential correlations between tooth loss and several variables including age, gender, education level, and other risk factors, such as diabetes and smoking habit.

Patients and Methods

This study retrospectively analyzed 1811 dental records of patients who underwent extraction procedure of at least one tooth at the department of Oral and Maxillofacial Surgery at Kuwait University Faculty of Dentistry. The extraction procedures were performed under either local anesthesia alone or combined with nitrous oxide inhalation sedation from the period of January 2015 until December 2019. This study was conducted in full accordance with the World Medical Association Declaration of Helsinki and was approved by the Ethics Committee of the Health Sciences Center at Kuwait University. All previously enrolled patients at Kuwait University dental clinic have signed consent forms that stated the possibility of using patient's information for scientific projects with assurance of anonymity and privacy. Therefore, the research approval did not require a waiver of informed consent or documentation of informed consent. Patients' dental records were retrieved using Titanium dental software (Titanium Software, Inc. USA).

One examiner assessed all patients' dental records where patients' variables included: age (categorized into six age groups starting with age group <20 years and ending with >60 years of age), gender, level of education, diabetes, and smoking habit. Tooth extraction variables

consisted of the reason for extraction which was recorded as follows: caries (including fractured teeth and remaining roots primarily due to caries), periodontal disease (including breakdown of the periodontal apparatus and weakening of the periodontal attachments), endodontic treatment complications (including persistent symptoms, resistant periapical healing as well as fractures), orthodontic treatment, impactions, trauma, pre-prosthetic, and other reasons (esthetic reasons, tooth malposition, or unspecified reasons). In addition, tooth type, number of extracted teeth per patient were recorded. Patients who underwent extraction of supernumerary and deciduous teeth plus dental records with incomplete data entry were excluded from the study.

The data were entered and analyzed using Statistical package for Social Sciences software (SPSS), version 26.0. The significance of the patients' variables, such as age, gender, education level, diabetes, and smoking habit with reasons of tooth extraction were analyzed by Chi square test, where a *p*-value <0.05 was considered significant. The variances in the mean number of extracted teeth per patient were investigated using ANOVA test. Pearson correlation test was used to test the strength of the association among the tested variables. Correlation was considered significant at *p* < 0.01 level (two-tailed; <http://dx.doi.org/10.17504/protocols.io.bp7nmrme>).

Results

The total number of patients involved in this study was 1811 with a total of 2654 extracted teeth. The mean age of patients was 43.4 ± 11.4 , ranging from 16 to 86 years. The mean number of extracted teeth per patient was 1.46 ± 0.67 . The distribution of extracted teeth by gender, age groups, level of education, diabetes, and smoking habits is illustrated in Table 1. Male patients count was higher, 990 (54.7%), than female patients, 821 (45.3%). Male patients had a higher number of extracted teeth, 1447 (54.5%), than females, 1207 (45.5%). However, there was no significant differences among the two genders. The age group of 31–40 years included 455 patients (25.1%), and the age group of 41–50 years counted for 429 patients (23.7%). These groups were the highest in count as well as in number of extracted teeth, which was 665 (25.1%) and 632 (23.8%) respectively. The highest mean for the number of extracted teeth per patient was identified among 51 years old and above age groups (3.73 ± 0.53 teeth), with a *p*-value of 0.03. On the other hand, the lowest mean for the number of extracted teeth per patient was identified

Table 1 Distribution of Extracted Teeth by Patient Variables

Patient's Variables	Male		Female		Total			
	Patient	Teeth	Patient	Teeth	Patient	%	Teeth	%
Age group								
≤ 20	31	37	36	47	67	3.7	84	3.2
21–30	153	208	157	227	310	17.1	435	16.4
31–40	209	307	246	358	455	25.1	665	25.1
41–50	249	358	180	274	429	23.7	632	23.8
51–60	180	283	123	183	303	16.7	466	17.6
≥ 60	168	254	79	118	247	13.6	372	14.0
Level of education								
Elementary school	88	118	53	70	141	7.8	188	7.1
Middle school	282	396	145	207	427	23.6	603	22.7
High school	492	745	387	589	879	48.5	1334	50.3
College level and higher	128	188	236	341	364	20.1	529	19.9
Medical condition								
Diabetes	122	185	43	63	165	9.1	248	9.3
Smoking habit								
Smoking	223	331	21	31	244	13.5	362	13.6
Total	990	1447	821	1207	1811	100	2654	100
%	54.7%	54.5%	45.3%	45.5%				

among ≤20 years of age (1.43 ± 0.46 teeth), with a p-value of 0.006.

With regards to education level, patients who held a high school diploma were the highest in count, 879 (48.5%), followed by middle school, 427 (23.6%). College & higher education level included 364 patients (20.1%). Subsequently, the total number of extracted teeth, which is shown in Table 1, followed the same arrangement, where 1334 extracted teeth (50.3%) for high school diploma holders vs 603 (22.7%) for middle school education level vs 529 (19.9%) college and higher education level. A total of 165 patients (9.1%) had diabetes and 244 patients (13.5%) had smoking habits. Forty-one patients (2.3%) had both diabetes and smoking habits.

Table 2 illustrates the results from stratifying the entire patients' population by gender, age groups, level of education, diabetes, and smoking habits with multiple reasons for tooth extractions. The results suggested that dental caries was the major reason for tooth extraction as 1796 (67.7%) teeth were extracted due to caries, followed by periodontal disease, 543 (20.5%), and endodontic treatment complications, 225 (8.5%). Other reasons for tooth extractions such as dental trauma, pre-prosthetic treatment, and esthetics plus malpositioned teeth and unspecified reasons were considered minor.

Dental caries was the chief cause for extraction in both genders, with a slightly higher number among male patients 971 (67.1%) as shown in Table 2. Males reported to have more extractions due to periodontal diseases 315 (21.8%) and endodontic treatment complications 128 (8.8%) than females. On the contrary, females showed more extracted teeth due to orthodontic treatment 35 (2.9%) and pre-prosthetic treatment 4 (0.3%).

Additionally, Caries as a reason for extraction, scored high in age groups of 50 years and younger. Conversely, periodontal diseases scored higher percentages of extractions among age groups 51–60 and 60 years and higher, 25.3% and 29.3%, respectively. In addition, the number of extracted teeth was significantly higher among middle and high school diploma holders when stratified against caries, periodontal reasons, and endodontic treatment complications. With respect to diabetes and smoking habits, diabetic patients and smokers had high percentages of their teeth extracted due to caries (58.1% and 27.4%) and periodontal reasons (71.0% and 21.0%) respectively, as shown in Table 2.

Correlation and strength of association among variables were tested and revealed that age groups, in general, showed a significant association with caries, periodontal reasons, and endodontic treatment complications;

Table 2 Reasons for Tooth Extraction by Patient Variables

	Caries		Periodontal Disease		Endo Tx Complications		Orthodontic Tx		Trauma		Pre-Prosthetic Tx		Other Reasons		Total
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Gender															
Male	971	67.1%	315	21.8% ^b	128	8.8%	8	0.6%	5	0.3%	2	0.1%	18	1.2%	1447
Female	825	68.4%	228	18.9%	97	8.0%	35	2.9%	2	0.2%	4	0.3%	16	1.3%	1207
Age Group															
≤ 20	69	82.1% ^a	5	6.0%	5	6.0%	4	4.8%	1	1.2%	0	0.0%	0	0.0%	84
21–30	297	68.3% ^a	99	22.8%	15	3.4%	18	4.1%	2	0.5%	1	0.2%	3	0.7%	435
31–40	490	73.7% ^a	100	15.0%	45	6.8%	18	2.7%	0	0.0%	3	0.5%	9	1.4%	665
41–50	445	70.4% ^a	112	17.7% ^b	66	10.4%	2	0.3%	2	0.3%	1	0.2%	4	0.6%	632
51–60	284	60.9%	118	25.3% ^{a,b}	55	11.8%	1	0.2%	0	0.0%	1	0.2%	7	1.5%	466
≥ 60	211	56.7%	109	29.3% ^{a,b}	39	10.5%	0	0.0%	2	0.5%	0	0.0%	11	3.0%	372
Level of education															
Elementary school	136	72.3%	24	12.8%	20	10.6%	0	0.0%	0	0.0%	0	0.0%	8	4.3%	188
Middle school	408	67.7%	130	21.6%	52	8.6%	0	0.0%	2	0.3%	1	0.2%	10	1.7%	603
High school	921	69.0%	279	20.9%	106	7.9%	15	1.1%	3	0.2%	2	0.1%	8	0.6%	1334
College level and higher	331	62.6%	110	20.8%	47	8.9%	28	5.3%	2	0.4%	3	0.6%	8	1.5%	529
Medical condition															
Diabetic	144	58.1%	68	27.4% ^c	29	11.7%	0	0.0%	1	0.4%	0	0.0%	6	2.4%	248
Non diabetic	1652	68.7%	475	19.7%	196	8.1%	43	1.8%	6	0.2%	6	0.2%	28	1.2%	2406
Smoking habit															
Smoker	257	71.0% ^c	76	21.0%	22	6.1%	0	0.0%	2	0.6%	0	0.0%	5	1.4%	362
Non smoker	1539	67.1%	467	20.4%	203	8.9%	43	1.9%	5	0.2%	6	0.3%	29	1.3%	2292
Total	1796	67.7%	543	20.5%	225	8.5%	43	1.6%	7	0.3%	6	0.2%	34	1.3%	2654

Notes: Other reasons: esthetic reasons, tooth malposition, or unspecified reasons. ^aThe most common reason for extraction within the age group (χ^2 test; $p < 0.05$). ^bStrong correlation association, Pearson correlation test, $p < 0.01$ level (two-tailed). ^cModerate correlation association, Pearson correlation test, $p < 0.01$ level (two-tailed).

however, only caries and periodontal reasons presented strong correlation associations with age (0.001 and 0.03, respectively). Interestingly, age groups of 41 years and higher have particularly showed a significant association and strong correlation with periodontal reasons (0.042) as a cause of tooth extraction. When gender was tested for association, only males have shown a significant association and moderate correlation with periodontal disease (0.05) as a reason for extraction. With regards to level of education in general, there was a significant association with caries and orthodontic treatment as causes for extraction among high school and college education levels. However, the correlation was weak (-0.016). Concerning diabetic patients, there was a significant association with periodontal diseases as a reason for extraction. On the other hand, smoking habits showed a significant association with caries. Both groups had moderate correlation

association (0.055 and 0.04, respectively), shown in Table 2.

Table 3 presents the frequency of extraction of different teeth types with respect to various reasons for tooth extraction. The most commonly extracted teeth were mandibular and maxillary second and third molars, 743 (28%) and 678 (25.4%) sequentially. Dental caries, periodontal diseases, and endodontic treatment complications were among the most frequent reasons for extraction in molar teeth. The least common tooth extracted among all sampled population were mandibular canines, 30 (1.1%), which were mostly extracted due to caries. Nonetheless, mandibular central incisors were commonly extracted due to periodontal diseases while maxillary central incisors were commonly extracted due to caries. Premolars were noticed to be extracted due to orthodontic treatment and endodontic complications

Table 3 Distribution of Tooth Type by Reasons for Extraction

	Caries		Periodontal Disease		Orthodontic Tx		Trauma		Endo Tx Complications		Pre-Prosthetic Tx		Other Reasons		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Upper Jaw																
Incisors	51	2.8	19	3.5	1	2.3	1	14.3	14	6.2	1	16.7	2	5.9	89	3.4
Canines	31	1.7	12	2.2	1	2.3	0	0.0	7	3.1	0	0.0	2	5.9	53	2.0
Premolars	224	12.5	27	5.0	56	50.0	0	0.0	9	20.9	3	50.0	9	26.5	328	12.4
1st molars	152	8.5	28	5.2	0	0.0	2	28.6	23	10.2	0	0.0	2	5.9	207	7.8
2nd and 3rd molars	541	30.1	165	30.4	17	39.5	0	0.0	19	8.4	1	16.7	0	0.0	743	28.0
Lower Jaw																
Incisors	27	1.5	40	7.4	0	0.0	3	42.9	0	0.0	0	0.0	0	0.0	70	2.6
Canines	20	1.1	6	1.1	0	0.0	0	0.0	2	0.9	0	0.0	2	5.9	30	1.1
Premolars	122	6.8	35	6.4	13	30.2	0	0.0	34	15.1	1	16.7	8	23.5	202	7.6
1st molars	164	9.1	38	7.0	0	0.0	0	0.0	52	23.1	0	0.0	5	14.7	259	9.8
2nd and 3rd molars	464	25.8	173	31.9	2	4.7	1	14.3	18	8.0	0	0.0	4	11.8	673	25.4
Total	1796	100	543	100	43	100	7	100	225	100	6	100	34	100	2654	100

Note: Other reasons: esthetic reasons, tooth malposition, or unspecified reasons.

besides caries and periodontal reasons. Figure 1 demonstrates the frequency of extracted teeth by tooth type.

Discussion

The results of the current study concluded that caries (67.7%) and periodontal disease (20.5%) are the foremost reasons for tooth extractions at Kuwait University Dental Clinic. This finding is in agreement with the majority of previous studies conducted within the same region, such as Saudi Arabia, Yemen, and Kuwait, as well as internationally, in Italy, Greece, and Iran, where caries was the primary reason for tooth extraction followed by periodontal disease.^{7-10,18,19} However, in other studies, periodontal

disease ranked higher than caries as a reason for tooth loss.¹²⁻¹⁴ These studies were conducted in private practice settings where most of the patients that were periodontally involved aged 40 years and above. Third common reason for tooth extraction was endodontic treatment complications, 225 (8.5%). Previous studies by Pretzl et al and Suzuki et al have explained that root canal treatment had a significant effect on tooth loss. They explained that root canal therapy might cause deterioration of furcation lesions in molars, root fracture, and recurrent carious lesions.^{20,21}

In the current study, there was no significant difference between genders although male patients had more extractions than female patients. It is noteworthy to mention that

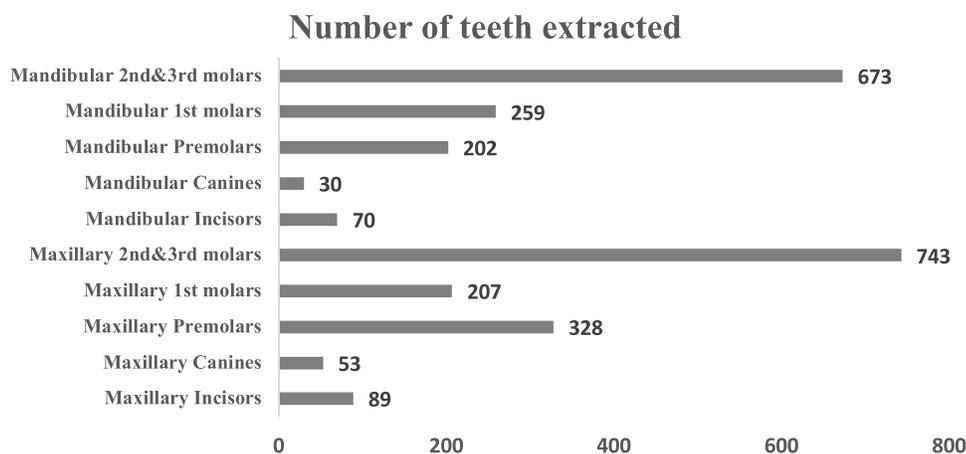


Figure 1 Frequency of extracted teeth by tooth type.

male patients displayed a significant association with periodontal disease, however, the correlation association was moderate. This finding was also reported in previous studies.^{15–17} These studies rationalized the higher number of tooth extraction among males due to less interest in adhering to dental maintenance and recall programs plus common smoking habits among males.

The mean number of tooth loss in the present study was higher among older population of age groups of 51 years and higher, 3.73 ± 0.53 , compared to the other groups, which is similar to other studies.^{2,7,10} Remarkably, in this age group, tooth loss due to periodontal disease was more common than in younger population. In addition, the correlation association test indicated a strong correlation among age and dental caries and periodontal disease. This finding has been attributed to multiple factors including the presence of systemic conditions in older population, medications, manual dexterity and oral hygiene maintenance, and genetic proneness to periodontal diseases. Dental caries, however, was the main cause of tooth extraction in patients aged 50 years and younger, a similar finding was reported by several studies and attributed it to irregular dental visits, fail to comply with oral hygiene instructions, and high sugar intake.^{8,10,17}

With respect to education level, the highest tooth extraction frequency was among patients who held high school (50.2%) and middle school (23.0%) degrees. This finding is in agreement with other studies where tooth loss was associated with primary level of education.^{9,22,23} Further, there was a significant association between education level and dental caries and orthodontic treatment. This finding can be rationalized to the fact that orthodontic treatment is conducted mostly on younger/adolescent population which include extraction of premolars and non-restorable teeth.

Diabetic patients reported a significant association with tooth extraction due to periodontal disease while smokers reported a significant association with tooth extraction due to caries, both with moderate correlation. Passarelli et al have reported that diabetes and smoking habits have a direct association with tooth loss.⁸ On the other hand, Kawahara et al have reported that there was no clear correlation between systemic diseases, such as diabetes, and tooth loss.¹⁵

With regards to tooth types, the most commonly extracted tooth type was molars due to dental caries primarily followed by periodontal diseases. This finding is in

agreement with Passarelli et al and Jafarian et al where they reasoned it to the anatomical development of molar tooth type that results in the formation of grooves and fissures making them more susceptible to dental caries. Additionally, first and second molars erupt in the oral cavity at a relatively young age making them more prone to dental caries and periodontal attacks.^{8,9}

Lower incisors were extracted mostly due to periodontal reasons. This observation has been reported previously, and a possible explanation was attributed to the fact that lower incisors are less prone to caries as they are protected by the tongue, but are more likely to be retained in older population where they are more prone to periodontal disease.^{7–9} Premolars were extracted mainly due to orthodontic reasons and endodontic treatment complications, at a lesser extent. This can be attributed to the fact that premolars are extracted either for relieve of crowding or for facial profile change. The least common extracted teeth were the canines; a possible justification is that canines have prominent smooth clinical crowns and large bulbous roots with an extensive periodontal attachment making them resistible to caries and periodontal diseases.

According to the results of the present study, dental caries and periodontal disease continue to be the foremost causes of permanent tooth extraction. This emphasizes the role of the oral healthcare provider in raising oral health awareness among the general population on one side and provide preventative measures for patients with a high risk for caries or periodontal disease.

This study had some limitations that might be beneficial to explore in future projects. For instance, oral hygiene status needs to be explored in association with the number of extracted teeth. In addition, caries risk assessment tests and periodontal screening tests including *Streptococcus mutans*, *Lactobacilli*, and *Porphyromonas gingivalis* species count, in addition to saliva buffering capacity and production tests can be explored in order to test the degree of association with the reasons of tooth extraction.

Conclusion

We found that dental caries, periodontal disease, and endodontic treatment complications were the most common causes of extraction. However, this study has provided that age, diabetes, and smoking habits were found to be suitable forecasters for permanent tooth loss as they displayed strong statistical association. Further studies are needed to provide an overview of the role of the oral

healthcare provider in raising awareness of oral health and provide efficient screening strategies for caries and periodontal disease in order to shift the paradigm of dental health from oral disease treatment to disease prevention.

Acknowledgments

The author would like to thank Mrs Daiven Manuel for assisting in data collection and data entry.

Disclosure

The author reports no conflicts of interest in this work.

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