ORIGINAL ARTICLE

International Dental Journal 2011; 61: 19–24

doi: 10.1111/j.1875-595X.2011.00004.x

Reasons for extraction of permanent teeth in Greece: a five-year follow-up study

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Aim: To investigate the reasons for tooth extraction and their correlations with age and gender in Greece. **Materials and methods:** The study population consisted of 1,018 patients, 560 males and 458 females, aged 18–74 years from a private practice in Greece. Each patient's age, gender, number of extracted teeth and the reasons for the extraction were recorded for a period of 5 years. **Results:** Two thousand four hundred and eighteen permanent teeth were extracted for various reasons during the study period. The results showed that the main reasons for extraction were caries (45.6%), periodontal disease (32.1%), failed root canal treatment (7.3%) and root fracture (4.4%). Caries was the main reason for extraction in patients up to 44 years old (64.7%), while periodontal disease was the main reason for extraction in patients over years of age (77.6%). Maxillary and mandibular 1st and 2nd molars, were the most frequently extracted teeth due to dental caries. Premolars of the mandible and maxillary and mandibular anterior teeth were the most frequently extracted teeth due to periodontal disease. **Conclusions:** Although the targets of the WHO regarding the reduction of dental caries were accomplished, dental caries and periodontal disease are still the main reasons for tooth extraction regardless of the age of the patients.

Key words: *Tooth extraction, caries, periodontal disease*

Tooth extraction, regardless of the progress of modern dentistry causes serious problems and dysfunction of the masticatory system and is considered as a multi-complex problem for both the clinical dentist and the patient. In addition, the number of extracted teeth can serve as an indicator of socio-economic and oral hygiene level. Decrease in the number of teeth results in poor dietary habits and deterioration of quality of life[1]. Therefore it is important to investigate the reasons for permanent tooth extraction. Based on this information, public dental health can put into practice adequate dental policies. Extraction of permanent teeth is performed for several reasons including dental caries, periodontal disease, accidents-injuries, orthodontic reasons, impacted teeth (e.g. canines, lateral incisors), failed dental treatments (root canal treatments, etc.), prosthetic indications and other reasons such as patients' request[2–5].

However, dental caries and periodontal disease have consistently been shown as the two main causes of tooth extraction[3,6–19]. Dental caries appears to be the principal cause of tooth extraction in a large number of countries and the numbers of extracted teeth show an increasing percentage with age. Only few studies reported that periodontal disease was the main reason[5,20–24] while other studies found that dental caries and periodontal disease were equally responsible[9,25,26].

The aim of this study was to investigate the reasons for tooth extraction of permanent teeth in an adult population sample and its correlations to several aspects such as age, gender and type of the teeth extracted.

MATERIALS AND METHODS

Subjects

The study population consisted of 1,018 patients, 560 males and 458 females, 18–74 years of age (mean age 42.6 ± 5.8) from a private practice in Patra, one of the biggest cities in Greece.

The reasons for extractions of teeth in the sample for a period of 5 years (June 2004–May 2009) were obtained including aspects such as age, gender and the type of teeth extracted due to reasons such as dental caries, periodontal disease, failed root treatment, root fracture, orthodontic reasons, patient's request and

other reasons (impacted teeth, prosthetic indications, etc.). A comprehensive history was taken and all examinations, clinical measurements and extractions were performed by one investigator.

The sample was divided into six groups according to age: group I: 18–24 years, 91 patients; group II: 25–34 years, 200 patients; group III: 35–44 years, 305 patients; group IV: 45–54 years, 198 patients; group V: 55–64 years, 130 patients; group VI: 65+ years, 94 patients. The participants were in good general health as determined by a health questionnaire.

All participants were informed about the evaluation to which they would be submitted and gave their informed consent to participate in the study.

Clinical examination

The clinical examinations of the participants were performed by one investigator as mentioned above. Criteria for tooth extraction due to dental caries included initial or recurrent caries, its sequelae, root remnants in case that the crown was lost due to dental caries and fractures due to weakening by dental caries[20]. Tooth mobility, severity of attachment loss and furcation involvement were the main criteria which indicated the need for the extraction of periodontally affected teeth[27,28]. Failed root canal treatment and fracture of teeth weakened diagnosed by radiographic and clinical examination were also included. The criterion for tooth extraction due to orthodontic reason was lack of space.

Root fracture as an accident-trauma sequel diagnosed by radiographic examination and any other reason such as impacted teeth and prosthetic indications which is not included in the categories above. The teeth and gingivae were dried with compressed air while a dental unit light was used as the light source for the inspections.

The selection criteria comprised age above 18 years and a mean number of 20 natural teeth, since large numbers of missing teeth might interfere with the results of the present study. Third molars excluded from the study.

Statistical analysis

The main outcome variable was reason for tooth extraction. Means and frequency distributions were calculated for all the background and outcome study variables. Relations of the categorical background variables, such as age range and gender, with reasons for tooth extraction were analysed by chi-squared test, while differences in the mean number of extracted teeth per patient by reason for extraction were analysed by one way analysis of variance (ANOVA) method.

The data analysis was performed using the statistical package of SPSS version16.0 program package (SPSS Inc., Chicago, IL, USA). A *P*-value <5% (<0.05) was considered to be statistically significant.

RESULTS

A total of 2,462 permanent teeth were extracted from 1,018 patients surveyed. The distribution of patients and extracted teeth by age range and gender is shown in *Table 1*. The average number of extracted teeth overall was 2.42 (2.15 in males and 2.74 in females) difference statistically significant ($P < 0.001$). Males comprised 55.0% of the sample and presented a lower percentage of teeth extracted (48.9%) than females (51.1%).

In general, older patients lost more teeth than younger ones, as calculated by the mean number of teeth extracted per patient in each age group (*Figure 1*). The highest tooth extraction rate per patient was seen in the 55–64 year age group (4.1 ± 0.85 teeth) and over 65 year age group (2.95 ± 0.44 teeth). The differences among the mean numbers of teeth extracted per patient by age groups was statistically significant ($P < 0.001$, ANOVA method).

The percentages of teeth extracted due to dental caries and periodontal disease were overall 45.6% and 32.1%, respectively. Other reasons included failed root canal treatment (7.3%), root fracture (4.4%), patient's request (3.6%), orthodontic reasons (2.5%) and non-categorised reasons (4.5%) such as impacted teeth, prosthetic indications. The reasons for extraction in

Table 1 Distribution of patients and extracted teeth by age range and gender

Age range (years)	Males		Females		Total	
	Patients (%)	Teeth (%)	Patients (%)	Teeth (%)	Patients (%)	Teeth (%)
18–24	45 (8.0)	74 (6.1)	46 (10.0)	106 (8.4)	91 (8.9)	180 (7.3)
25–34	102 (18.2)	178 (14.7)	98 (21.4)	268 (21.3)	200 (19.6)	446 (18.1)
35–44	167 (29.8)	304 (25.2)	138 (30.1)	272 (21.6)	305 (30.0)	576 (23.4)
45–54	106 (18.9)	244 (20.2)	92 (20.0)	210 (16.7)	198 (19.4)	454 (18.4)
55–64	78 (13.9)	261 (21.6)	52 (11.3)	268 (21.3)	130 (12.8)	529 (21.5)
65+	62 (11.2)	145 (12.2)	32 (7.2)	132 (10.7)	94 (9.3)	277 (11.3)
Total	560 (100)	1,206 (100)	458 (100)	1,256 (100)	1,018 (100)	2,462 (100)

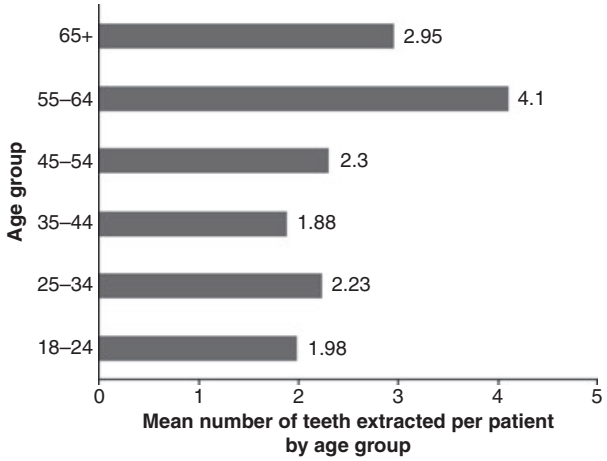

Figure 1. Mean number of teeth extracted per patient by age group.

different age ranges are shown in *Table 2*. Dental caries was the main cause of tooth extraction in various age groups (18–24: 54.4%; 25–34: 65.9%; 35–44: 58.2% and 45–54: 41.4%), while periodontal disease was the most frequent reason for extraction in the oldest age groups (55–64: 50.1% and 65+: 65.0%). The difference between the above mentioned age groups (18–54 years of age groups and 55–65+ years of age groups) regarding the prevalence of dental caries and periodontal disease was statistically significant ($P < 0.001$).

Table 3 shows the reasons for tooth extraction by gender. Males lost more teeth due to periodontal disease and other reasons (mentioned above) while females showed more teeth extracted due to dental caries and failed root canal treatment (RCT). *Figure 2* shows the mean number of teeth extracted per patient by reason for tooth extraction. The mean number of extracted teeth due to periodontal disease (3.62) was the greatest compared to other causes (difference statistically significant, $P < 0.001$ ANOVA method). The distribution of extracted teeth by tooth type is shown in *Figure 3*.

According to the above figures, the most frequently extracted teeth were the maxillary and mandibular 1st molars (17.1% and 21.6%, respectively) followed by the 2nd molars of both jaws (13.9% and 17.0%, respectively). Molars of both jaws and premolars of the maxilla were the most frequently extracted teeth due to dental caries, while anterior teeth of both jaws (incisors and canines) and premolars of mandible were the most frequently extracted teeth due to periodontal disease ($P < 0.001$) (*Figure 4*).

Table 3 Reasons for tooth extraction by gender

Reasons for extraction	Males	Females	*P*-value (χ^2)
Dental caries (%)	530 (43.9)	594 (47.3)	<0.001
Periodontal disease (%)	435 (36.1)	355 (28.3)	<0.001
Failed RCT (%)	92 (7.6)	87 (6.9)	NS
Other reasons (%)	149 (12.4)	220 (17.5)	<0.001

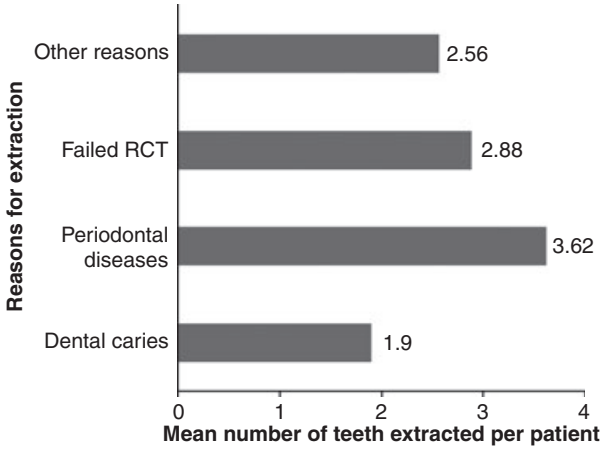

Figure 2. Mean number of teeth extracted per patient by reason for tooth extraction (Other reasons: root fracture, orthodontic reasons, patient's request, unspecified reason).

DISCUSSION

In the present study the average number of missing teeth overall was 2.42, lower compared to similar studies performed in Greece[29–31] during recent decades. This observation shows the improvement of socio-economic level, the interest of the Greek population regarding its oral health, the acceptance of the value and importance of the role of preventive dentistry. Previous studies implicated dental caries and periodontal disease to be the most prevalent causes of tooth extraction in several countries[2,3,6–19,24] and the percentage ranged from 31.8%[19] to 94.4%[2].

Table 2 Reasons for tooth extraction by age range

Age range (years)	Dental caries (%)	Periodontal disease (%)	Failed RCT (%)	Root fracture (%)	Orthodontic reasons (%)	Patient's request (%)	Other Reasons (%)	Total (%)
18–24	54.4*	2.2	2.8	3.3	22.2	1.7	13.4	100
25–34	65.9*	10.0	10.8	5.8	4.0	1.1	2.4	100
35–44	58.2*	22.2	9.0	5.6	0.7	1.6	2.7	100
45–54	41.4	37.0*	8.0	5.3	0.0	3.7	4.6	100
55–64	28.9	50.0*	4.7	2.4	0.0	8.3	5.7	100
65+	20.2	65.0*	4.7	2.9	0.0	3.9	3.3	100

*$P < 0.001$.

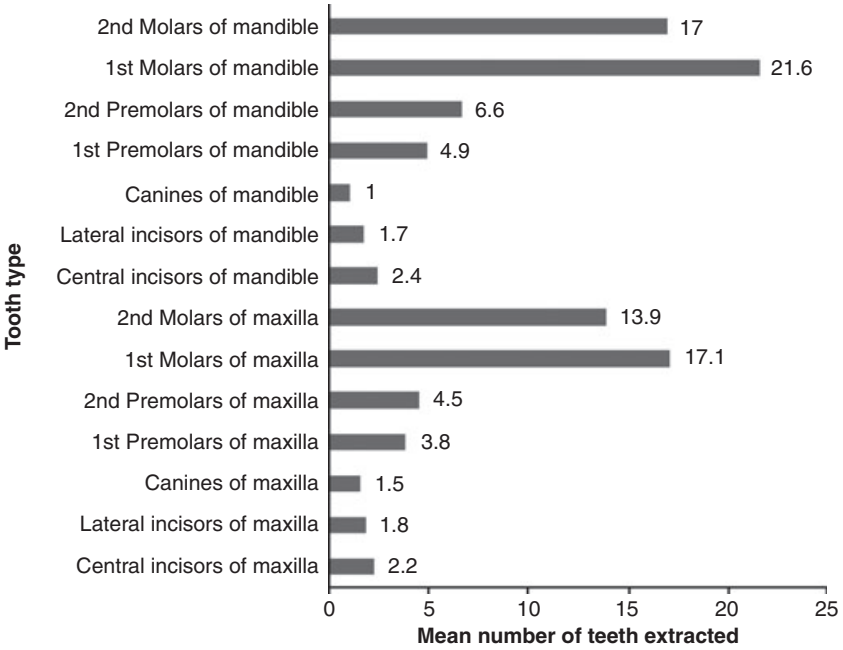

Figure 3. Distribution of extracted teeth by tooth type.

However, dental caries appears to be the main cause of tooth extraction in a large number of countries in which the following percentages were recorded: 70.3%[2], 67.5%[6], 63.3%[10], 59.2%[12], 59%[13], 56.4%[14], 52.6%[11], 51%[3], 50.0%[15], 47.9%[18], 46.9%[16], 43.7%[8], 43.3%[9] and 39.5%[32].

Three studies showed that both caries and periodontal disease were almost equally important reasons for tooth extraction, such as in Japan[9], Italy[25] and Singapore[26].

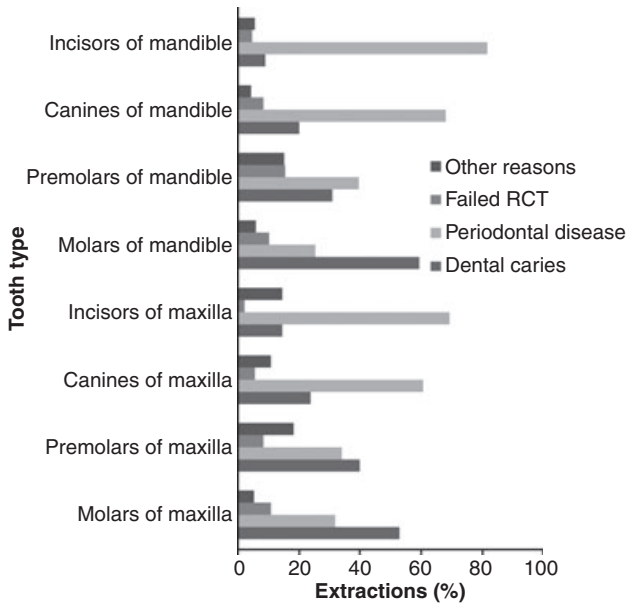

Figure 4. Reasons for extraction by tooth type.

Periodontal disease appears to be the main reason of tooth extraction in a small number of previous studies, including the present study (36.4%) followed by dental caries (24.5%). A study in Germany[23] showed that 27.3% of the extractions were due to periodontal reasons and 20.7% due to dental caries. A study in an Asian population[24] showed that 35.8% of the extractions were due to periodontal disease and 35.4% due to dental caries. The same results were observed in Canada[4] and Jordan[33]. Studies by Murray *et al.*[21] and by Phipps and Stevens[22] showed similar results.

A low percentage of the other causes such as injuries-accidents, orthodontic reasons, impacted teeth, failed dental treatments (e.g., root canal treatments) was recorded.

The above differences could be attributed to the heterogeneous population samples which were examined, the progression of dental caries and periodontal disease during the last decades, the different methods which were used in order to estimate the frequency of permanent teeth missing (e.g. clinical examination, questionnaire) and the different importance that has been adopted by the population samples regarding the value of oral health and the need for a regular dental follow-up. The present study concerned subjects who sought dental treatment in a private practice therefore the sample could not be considered as a random one.

According to the results of the present study the average number of extracted teeth between males and females was statistically significant. Similar results were observed in other studies[8,15,19,34,35]. In the present study the extracted teeth due to periodontal disease

showed a significantly increasing percentage with age. This finding was similar to other studies[9,10,16,23,24,34], however, other studies have shown that periodontal disease was the main cause of extraction in patients up to and over 35 years of age[8,9,12,15–17,21–23,33,35]. That finding could be attributed to the smaller, present sample and possibly to the negative attitude of the elderly people in seeking preventive dental follow-up. Previous studies showed that dental caries was the main cause of tooth extraction even in older age groups[2,36].

Those differences could be attributed to variations in study designs, overrepresentation of certain age ranges or tooth types that may affected the samples studied or to differences in practice patterns and attitudes towards the retention of teeth by both patients and dental professionals[21]. In addition, the above mentioned differences showed the difficulties of comparing tooth loss studies due to the differing methodologies and populations studied, necessitating caution in the interpretation of such comparisons[16].

It is important to consider that the extraction of teeth is only based on disease-related factors. Studies in many European and other countries have shown that the decision to extract a tooth is substantially influenced by factors related to both the patient's and dentist's specific requirement[37,38]. These factors may include the dentist's philosophy of practice, his experience as well as aesthetic, prosthetic and economic considerations. These factors may have played important role in the decision over tooth extraction but in most other studies including this study, they have not been taken into consideration.

Extractions for periodontal disease and other reasons were more frequent in males, while extractions for dental caries and failed root canal treatment were more frequent in females. The first finding is in agreement with previous papers[39,40]. Male gender has been reported as a risk indicator for periodontal disease severity [41]. The present study also showed that more teeth per patient were extracted for periodontal disease than for any other reason. This finding is in agreement with the study by Phipps and Stevens[22].

According to the present study the anterior teeth of maxilla and mandible showed a trend to be more frequently extracted for periodontal disease while 1st and 2nd molars of both jaws were the most frequently extracted teeth due to dental caries. Other studies showed that the more frequently extracted teeth were the mandibular molars[14,21,42], the molars of both jaws[18], maxillary teeth[16], mandibular central incisors[16,24,35,36], canines and incisors of both jaws[8,12], maxillary anteriors[19,35] and the posterior teeth of both jaws[11,12]. These differences could be attributed to the factors mentioned above. Lower anterior teeth are less susceptible to caries than other teeth, they are more likely to remain in the dentition in older patients where periodontal disease becomes the more frequent reason for extraction[43].

According to the results of the present study, periodontal disease and dental caries remain the main causes for permanent tooth extraction in adults. The role of the clinical dentist is important in order to maintain the permanent teeth especially of elderly people who lose their teeth due to periodontal disease. Caries is the dominant reason for tooth extraction in younger patients, while periodontal disease is the main cause of tooth extraction in patients up to and over 55 years of age.

CONCLUSIONS

- Periodontal disease (45.6%) and dental caries (32.1%) were the main causes for tooth extraction both for males and females.
- Dental caries was the main cause of tooth extraction in patients up to 54 years of age, while periodontal disease was the main reason for tooth extraction in the oldest age groups (over 55 years of age)
- Males lost more teeth due to periodontal disease, while females showed more teeth extracted due to dental caries and failed root canal treatments
- The more frequently extracted teeth due to dental caries were the molars of both jaws and maxillary premolars, while those lost due to periodontal disease were the anterior teeth of both jaws and mandibular premolars.

Conflict of interest and sources of funding

The author declares that he has no conflicts of interests. The study was self-funded by the author and his private practice.

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