

Reasons and patterns for tooth extraction among patients presenting at a hospital of stomatology in Guangzhou, China: A cross-sectional study

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Abstract

Background

Few related surveys about reasons for tooth extraction was shown in mainland China. Our aim was to investigate the primary reasons and main pattern for extractions among patients presenting at a hospital of stomatology in Guangzhou, China.

Methods

This descriptive cross-sectional study was conducted over a period of 3 months, 2000 patients who underwent tooth extraction were recorded and analyzed by age, gender, the tooth type and the extraction reasons. Chi-square test was used to examine the differences in the extraction reasons between different genders, age groups and tooth types.

Results

A total of 3106 teeth were removed from 2000 patients, with an age ranging from 6 to 91. This study revealed details of extraction reasons and suggested that dental caries (25.42%) was the main reasons for tooth extraction and pointed out preventive extraction of third molar (19.89%) had displaced periodontal diseases (12.89%) as the dominant reason for extractions. Overall, third molar was the most frequently extracted tooth (1567). Significant statistical differences were found among different age groups, genders and tooth types for tooth extraction reasons ($p < 0.05$). For example, caries was the main reason for tooth extraction in 30–59 years old patients, while 20–29 years old patients asked for preventive extraction of third molar teeth mostly. Posterior teeth were mostly removed because of caries and periodontal disease was the leading cause for anterior teeth extraction.

Conclusions

We found the primary reasons and the new patterns for tooth extraction among patients in Guangzhou. It was proposed for the first time that the dominant reason for extractions was preventive extraction of third molar. Our finding could help to put forward some predictors and adjust the preventive strategies in oral disorders.

Background

In 2017, oral disorders became one of the commonest causes of prevalent cases that affecting people of all-age groups, approximately 3.6 billion around the world. In addition, tooth loss is a prevalent condition worldwide and continues to be a public health problem [1, 2]. Tooth extraction is mostly the final choice and consequence of oral disorders and affect our life quality physically, psychologically and socially. One of the goals and targets which WHO set in Global Goals for Oral health 2020 was to keep our teeth as much as possible and keep them functional [3].

Investigations on the reasons for tooth extraction have been widely conducted [4–25]. There are various of potential reasons for tooth extraction, including dental caries, periodontal disease, orthodontic reason, supernumerary tooth, impacted tooth and so on [17, 19, 21, 22, 26]. The methods and diagnostic criteria of those investigations were analogous, but the primary causes of extractions varied from different countries and regions. Some studies found that caries was the principle reason for tooth extraction [22–24, 27, 28], some reported that periodontal disease was more dominant [11, 29], while others showed that dental caries and periodontal disease were equally important [8, 9]. Generally speaking, both dental caries and periodontal disease have consistently been shown as the two prevalent reasons for extractions.

Reasons for tooth extraction were reported quite inconsistent in different ages. Most of the studies suggested caries was responsible for the majority of tooth extraction among 20–50 years old patients [21, 28, 30], while periodontal disease was more related in those older patients [25, 27]. However, several studies indicated that dental caries was the main reason for tooth extraction in all age group [13, 22, 27]. Furthermore, although caries and periodontal disease could lead to tooth loss in both genders, females extracted more teeth due to caries while males extracted for periodontal disease [23, 25]. Regarding tooth type, the third molar was considered as the commonest type of teeth extracted [8, 9, 11, 23]. Several findings concluded that posterior teeth were more frequently to be removed because of dental caries, to the contrary, periodontal disease caused more anterior teeth to be extracted [4, 6, 21, 27, 28].

In order to improve oral health status, and to evaluate the adequacy of oral health care and preventive program, it is necessary to assess the extraction reasons. Despite majority of studies for extraction reasons had been performed worldwide [8, 9, 15, 19–24, 31, 32], there was no study in mainland China on reasons for extraction in the past 3 decades [7, 13]. Therefore, it is crucial to learn the reasons and patterns for tooth extraction. In China, reasons and patterns for extractions have already changed with the rising living standards, the improvement of oral health care awareness and the advanced technology of detection and treatment. Therefore, our aim was to revealed the changes of the extraction patterns and draw a preliminary conclusion of extraction reason in Guangzhou, China, as well as to find out the relevance among age, gender and patterns of extraction.

Methods

Participants

This survey was performed at the Department of Oral and Maxillofacial Surgery, Hospital of Stomatology, Sun Yat-Sen University. This hospital is the largest hospital of stomatology in South China and regional medical center of Guangdong Province, indicating that the results we shown can represent the characteristics of tooth loss in this region.

Data Source

Patients undergoing extractions were selected for this survey between May 2019 and July 2019. The comprehensive information included patient's age, sex and area was recorded by a trained dental assistant. The definitions and criteria for possible causes for tooth extraction were discussed with specialist dentists so that their records would be as unequivocal as possible (Table 1). And then the dentist registered the reason for extractions and the tooth type according to the oral examination. All subjects were recorded by the same dental assistant and the reason for tooth extraction and tooth type were determined by the same dentist.

Table 1
Criteria for tooth extraction categories

Extraction Reason	Criteria
Caries	Primary and recurrent caries. Failed root treatment which the tooth was first treated because of caries. All sequelae of caries including roots extraction which lost their crown through caries or due to weakening by caries.
Preventive extraction	Patients ask for an extraction of third molar without any symptom to prevent any discomfort.
Periodontal Disease	Tooth with pain, loss of function, loosening that caused by periodontal disease and could not be retained by periodontal treatment.
Pericoronitis	Recurrent inflammation, swelling and pain in the pericoronal tissue of third molar.
Pre-prosthetic	Tooth extracted in order to facilitates a better prosthetic restoration.
Surgical	Tooth need to be extracted because of oral mucosal lesions, temporomandibular joint disease, food impaction, adjacent tooth caries.
Orthodontic	Tooth removed to correct malocclusion or maintain the effect of orthodontic treatment.
Tooth Fracture	Tooth fracture caused by trauma, biting hard food, cracked tooth. Tooth fracture with crown weakening by caries was excluded.
Others	The reason for tooth extraction was not mentioned above, including tooth removed as a result of retained primary teeth, supernumerary tooth, ectopic tooth and radiotherapy.

Case Selection And Exclusion Criteria

A total of 3106 teeth were removed from 2000 patients aging from 6 to 91. Subjects who met the following criteria were excluded from the study: Patients who did not require an extraction or refused a treatment, having contraindications of tooth extraction.

Statistical analysis

The statistical analysis was conducted with SPSS software (v.20.0, SPSS Inc., U.S.A). A two-sided significance test was carried out at an alpha level of 0.05. Descriptive statistics and frequency distributions were used to demonstrate the sample characteristics and studied variables. Chi-square test was used to examine the differences in the extraction reasons between different genders and age groups. According to our definition of extraction reasons, third molar was the unique tooth type extracted for prevention. And supernumerary tooth and primary tooth was almost extracted for Other reasons (Table 1). After careful consideration, we eventually decided to exclude subjects of these three reasons as well as subjects involving supernumerary tooth and primary tooth. And then we used Chi-square test to examine the differences in the reasons among different tooth types, $n = 1871$. $p < 0.05$ were considered significant.

Results

Proportion of patients and teeth by gender and age

A total of 2000 patients were included in this survey, with an average of 1.55 ± 0.97 teeth per person. The distribution of patients and teeth by gender and age is shown in Table 2. Most of the patients were female (59.35%) and male accounted for 40.65%. The number of female patients was larger than male patients in each age group. The age of the patients was ranged from 6–91, with a mean age of 39.57 ± 17.95 . Females having their teeth extracted in an average age of 38.06 ± 16.60 while males were 41.77 ± 17.95 . Patients below 20 years showed the smallest proportion (5.20%) and age of 20–29 had the largest proportion (32.85%).

Females extracted 1832 teeth, comprising 58.98% of the total extracted teeth. Male removed 1.54 teeth on average, while female was 1.57. Both genders removed teeth most frequently in the age group of 20–29. It was more in females compare to males, 39.08% and 26.84% respectively. The average number of teeth extracted increased with age among patients of age 30 and older totally. Nevertheless, some difference between genders were that, females aged over 30 years and males aged over 40 years removed more teeth per patient. Patients over 70 years extracted the most teeth on average, 2.10(SD = 1.54) extractions for male and 1.78 extractions (SD = 1.25) for female respectively.

Table 2
Distribution of patients and teeth by gender range and age*

Age groups (Years)	Males Patients	Teeth	Mean No. of teeth extracted	Females Patients	Teeth	Mean No. of teeth extracted	Total Patients	Teeth	Mean No. of teeth extracted
≤20	43(5.29)	73(5.73)	1.70 ± 0.89	61(5.14)	103(5.62)	1.69 ± 1.01	104(5.20)	176(5.67)	1.69 ± 0.96
20–29	221(27.18)	342(26.84)	1.55 ± 0.77	436(36.73)	716(39.08)	1.64 ± 0.91	657(32.85)	1058(34.01)	1.61 ± 0.86
30–39	158(19.43)	213(16.72)	1.35 ± 0.73	243(20.47)	331(18.07)	1.36 ± 0.66	401(20.05)	544(17.55)	1.36 ± 0.69
40–49	125(15.38)	168(13.19)	1.34 ± 0.76	159(13.40)	227(12.39)	1.43 ± 0.81	284(14.20)	395(12.72)	1.39 ± 0.79
50–59	103(12.67)	170(13.34)	1.65 ± 1.20	112(9.44)	152(8.30)	1.36 ± 1.16	215(10.75)	322(10.37)	1.50 ± 1.19
60–69	95(11.69)	165(12.95)	1.74 ± 1.20	109(9.18)	184(10.04)	1.69 ± 1.24	204(10.20)	349(11.24)	1.71 ± 1.22
≥ 70	68(8.36)	143(11.22)	2.10 ± 1.54	67(5.64)	119(6.50)	1.78 ± 1.25	135(6.75)	262(8.44)	1.94 ± 1.41
total	813(40.65)	1274(41.02)	1.57 ± 0.99	1187(59.35)	1832(58.98)	1.54 ± 0.95	2000	3106	1.55 ± 0.97

*Figures in parentheses indicate percentages (%). Mean \pm standard deviation (S.D.) for mean number of teeth extracted per patients.

Reasons For Tooth Extraction Were Different Between Genders

Overall, Dental caries accounted for the majority of tooth extractions (25.42%), while preventive extraction (19.89%) and periodontal reasons (12.89%) were less. Other reasons included: pericoronitis (9.70%), pre-prosthetic extraction (9.54%), surgical reason (8.41%), orthodontic reason (7.96%), tooth fracture (2.90%), and other reasons (3.58%). Figure 1 shows the distribution of the extraction reasons.

Our results suggested that the difference in the reasons between genders was statistically significant ($\chi^2 = 189.36$, $df = 8$, $p < 0.05$, Table 3). For both genders, dental caries was the main reason, accounted for 23.37% in male and 26.42% in female respectively. By contrast, more teeth extracted due to periodontal disease in male (20.02%), while female had more teeth removed because of preventive extraction of third molar (24.78%).

Table 3
Reasons for tooth extraction by gender*

Gender	Caries	Preventive Extraction	Periodontal Disease	Pericoronitis	Pre-prosthetic	Surgical	Orthodontic	Tooth Fracture	Others	Total
Male	299(23.47)	163(12.79)	255(20.02)	104(8.16)	159(12.48)	129(10.13)	74(5.81)	43(3.38)	48(3.77)	1274
female	484(26.42)	454(24.78)	145(7.91)	197(10.75)	137(7.48)	132(7.21)	173(9.44)	47(2.57)	63(3.44)	1832
Total	783(25.24)	617(19.89)	400(12.89)	301(9.70)	296(9.54)	261(8.41)	247(7.96)	90(2.90)	111(3.58)	3106

*Figures in parentheses indicate percentages (%). Difference in the reasons for extraction between genders was detected using the chi-square test. ($\chi^2 = 189.36$, $n = 3106$, $df = 8$, $p = 0.000$.)

Reasons For Tooth Extraction Were Different Among Age Groups

Figure 2 shows the percentage distribution of extraction reasons in different age groups and Table 4 lists it in details. Reasons were different among age groups ($\chi^2 = 2358.23$, $df = 48$, $p < 0.05$). Caries was the most common reason in three age groups (30–39: 30.88%, 40–49: 34.68%, 50–59: 35.71%). Patients aged from 20–29 preferred to remove their teeth for preventive extraction (38.09%). On the other hand, periodontal disease was the leading reason in 60–69 (35.82%). What was more, the percentage of extracting for periodontal disease was increasing with age, especially in patients older than 40 years old. Not surprisingly, orthodontic reason was important in those younger than 29, and it was the dominant reason in patients below 20 years (36.36%). However, among patients over 70 years, tooth removed for a better prosthodontics became more important (41.22%).

Table 4
Reasons for tooth extraction by age range*

Age range years	Caries	Preventive Extraction	Periodontal Disease	Peri-coronitis	Pre-prosthetic	Surgical	Orthodontic	Tooth Fracture	Others	Total
≤20	8(4.55)	32(18.18)	2(1.14)	13(7.39)	3(1.70)	8(4.55)	64(36.36)	0(0)	46(26.14)	176
20–29	192(18.15)	403(38.09)	8(0.76)	178(16.82)	21(1.98)	68(6.63)	168(15.88)	5(0.47)	15(1.42)	1058
30–39	168(30.88)	139(25.55)	26(4.78)	71(13.05)	10(1.84)	77(14.15)	15(2.76)	16(2.94)	22(4.04)	544
40–49	137(34.68)	26(6.58)	67(16.96)	29(7.34)	26(6.58)	67(16.96)	0(0)	28(7.09)	15(3.80)	395
50–59	115(35.71)	8(2.48)	110(34.16)	7(2.17)	37(11.49)	25(7.76)	0(0)	12(3.73)	8(2.48)	322
60–69	87(24.93)	9(2.58)	125(35.82)	1(0.29)	91(26.07)	10(2.87)	0(0)	21(6.02)	5(1.43)	349
≥ 70	76(29.01)	0(0)	62(23.66)	2(0.76)	108(41.22)	6(2.29)	0(0)	8(3.05)	0(0)	262
Total	783(25.24)	617(19.89)	400(12.89)	301(9.70)	296(9.54)	261(8.41)	247(7.96)	90(2.90)	111(3.58)	3106

*Figures in parentheses indicate percentages (%). Difference in the extraction reasons among different age groups was detected using the chi-square test. ($\chi^2 = 2358.23$, $n=3106$, $df = 48$, $p=0.000$.)

Tooth Type Were Distinct For Tooth Extraction

Table 5 shows the distribution of different extraction tooth types. Posterior teeth were most commonly extracted, 2764 in total (88.99%), in contrast to 286 anterior teeth (9.21%). Apart from permanent teeth, only 1.8% of teeth extracted were primary teeth and supernumerary teeth. Regarding the permanent teeth, third molar was extracted most frequently (674 in maxillary and 1023 in mandibular), comprising 54.64% of all extractions, followed by first molar (11.11%), and canine extraction was the least (2.67%). According to our definition of extraction reasons, third molar was the unique tooth type which removed for preventive extraction, pericoronitis, and surgical reason.

Table 5
Distribution of the extraction reasons according to tooth type*

Tooth type	Caries	Preventive Extraction	Periodontal Disease	Pericoronitis	Pre-prosthetic	Surgical	Orthodontic	Tooth Fracture	Others	Total
I1	16(14.16)	0(0)	53(46.90)	0(0)	28(24.78)	0(0)	1(0.88)	6(5.31)	9(7.96)	113
I2	11(12.22)	0(0)	41(45.56)	0(0)	30(33.33)	0(0)	1(1.11)	0(0)	7(7.78)	90
C	11(13.25)	0(0)	32(38.55)	0(0)	29(34.94)	0(0)	3(3.61)	1(1.20)	7(8.43)	83
P1	43(17.62)	0(0)	38(15.57)	0(0)	50(20.49)	0(0)	99(30.57)	13(5.33)	1(0.41)	244
P2	54(27.41)	0(0)	32(16.24)	0(0)	47(23.86)	0(0)	40(20.30)	9(4.57)	15(7.61)	197
M1	156(45.22)	0(0)	88(25.51)	0(0)	57(16.52)	0(0)	5(1.45)	33(9.57)	6(1.74)	345
M2	126(44.84)	0(0)	85(30.25)	0(0)	39(13.88)	0(0)	1(0.36)	26(9.25)	4(1.42)	281
M3	366(21.57)	617(36.36)	31(1.83)	301(17.74)	16(0.94)	261(15.38)	94(5.54)	2(0.12)	9(0.53)	1697
ST	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	19(100)	19
PT	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	3(8.11)	0	34(91.89)	37

*Figures in parentheses indicated percentages (%). Third molar was the unique tooth type which removed for the reason of preventive extraction, pericoronitis, and surgical reason and supernumerary tooth and primary tooth was almost extracted for other reasons. When excluded these subjects, difference in the reasons for extraction among different tooth types was detected using the chi-square test. ($\chi^2 = 822.21$, $n = 1871$, $df = 35$, $p < 0.000$.) **Abbreviations:** I1: Central Incisor; I2: Lateral Incisor; C: Canine; P1: First Premolar; P2: Second Premolar; M1: First Molar; M2: Second Molar; M3: Third Molar; ST: Supernumerary Tooth; PT: Primary Tooth.

Moreover, supernumerary tooth and primary tooth was almost extracted for other reasons (Table 1). Thus, when we excluded these three reasons and two types of teeth, there was a statistically significant difference in the reasons for tooth extraction among different tooth types ($\chi^2 = 822.21$, $n = 1871$, $df = 35$, $p < 0.05$). It was worth of note that posterior teeth were mostly removed because of caries and periodontal disease was the leading cause for anterior teeth extraction (Fig. 3). Furthermore, orthodontic reason was the dominant reason for first premolar extraction.

Discussion

The present results showed the primary reasons and pattern for tooth extraction in Guangzhou and revealed that extraction reasons were different in ages, genders and tooth types. It was proposed for the first time that preventive extraction of third molar was the main reason for extraction. Our results suggest that dental health institutions should pay more attention on early intervening in disease progression, reminding people of the harmfulness and consequences of the oral disease, and eventually, raising people's awareness of dental health and promoting their change of oral health habits consciously.

Related studies have been conducted in Hong Kong and Taiwan [13, 23] and studies in mainland China focused on the frequency of a certain cause and the important role of this cause [7, 33, 34]. Previous investigations did not conduct a detailed classification and criteria of all the possible causes of tooth extraction as our study.

More than half patients extracted teeth in the age of 20 to 39 (52.9%), while patients below 20 had the smallest proportion (5.20%). These may be due to the fact that caries was thought to be easily found at a young people [21] and most patients who received orthodontic treatment and extracted third molars were concentrated in the age of 20–39 years [24, 26]. We also found patients below 20 years extracted teeth mainly because of retained primary tooth and orthodontic treatment. Children could extract primary teeth in the department of pediatric dentistry in such a specialized hospital. Thus, fewer children visited our department led to fewer patients below 20 years were recorded in our study. The average number of teeth extracted increased with age among patients over 30. This was because that, there were more teeth loss because of periodontal disease in older patients, and on the other, teeth were extracted for a better prosthetic restoration in old age.

It was observed that reasons for tooth loss was varied from age groups. Caries was the leading reason in the 30–59 age groups. Some studies presented a declining prevalence as age increased [6, 8, 9, 15, 18, 25]. In contrast, our results presented an increasing trend in patients under 60 years. The proportion of periodontal disease markedly increased in patients over 40 years and peaked in the age of 60–69. This finding was in accord with studies which concluded that the main reason for tooth loss in older patients was periodontal disease [9, 15, 21–24, 29]. It could be explained that caries was a disease of the young and many patients extracted because of caries before they suffered from periodontal disease [21]. Furthermore, with the development of crown preservation and root canal therapy, patients preferred to restoration rather than extraction, and then patients postpone their extractions to an older age of which teeth were easier to suffer periodontal disease [24].

Our results indicated that dental caries was a main reason for tooth extraction among patients presenting at a hospital of stomatology in Guangzhou, accounted for 25.4%. This finding was consistent with the majority of similar investigations in other countries [13, 17, 21–24, 27, 28, 35]. Dental caries and periodontal disease have been believed to be the more preponderant reasons. Studies in Singapore and Italy showed that both

of them was equally important [8, 9], surveys in Canada and Germany stated that periodontal disease was more dominant [11, 29]. However, our data suggested that the proportion of teeth extracted as a result of preventive extraction of third molar was only second to dental caries. This preliminary result was quite inconsistent with the previous studies and it may be attributing to a higher level of dental awareness among young patients.

It was worthy of note that preventive extraction of third molar became a dominant reason for tooth loss. In contrast with patients extracted teeth for caries in all age and periodontal disease in age over 40, majority of patients undertook preventive extraction in the age of under-40. What lead people presenting at a specialized hospital to remove their third molar for preventive reason at a young age was because that, first of all, there are more than 40 colleges and universities in Guangzhou with a large number of young students. With the strengthening of the publicity of oral health care, young people have a certain understanding of the potential danger of asymptomatic wisdom teeth. Second, the age of 20–39 is the age at which woman should prepare for pregnancy. Moreover, skills and experience were required for extraction, people were more willing to go to a specialized hospital for a treatment.

The largest number of extractions in patients under 20 was attributing to orthodontic reason (36.36%), which was consistent with previous studies in Italy, England, and Germany [8, 11, 36]. Young people extracted more than 90% of teeth for the orthodontic reason before 30 years old. They removed teeth in such young age were to correct malocclusion and maintain the effect of orthodontic treatment. The most important reason in those over 70 was pre-prosthetics extraction. Pre-prosthetics extraction, dental caries and periodontal disease were accounted for 93.89% of tooth extractions in patients over 70 years, consistent with results from previous studies [17, 23]. The present results may reflect a worse oral condition and more tooth loss in older people. However, in some backward countries like Afghanistan [21], Libya [25] and Iran [24], a small number of teeth were extracted because of orthodontic and prosthetics reasons. This is because financially and technically demanding were in need in these treatments and in a country like Afghanistan, people were eager to eat and live in peace rather than seeking for an improvement of appearance or restoration [21].

Gender difference was also suggested in this study. Males were reported more extractions (20.02%) because of periodontal disease than females (7.91%). Our finding confirmed most previous investigations which have indicated that more teeth were removed for periodontal disease in males than in females [20, 23, 29]. We observed that tooth was more likely extracted by caries and orthodontic reason in females, which was in accordance with previous investigations [15, 22, 24]. It can be explained that females are more willing to spend time and money than males to treat periodontal disease in order to avoid the loss of masticatory function and the effect of aesthetics caused by tooth loss. Moreover, male has been considered as a risk predictor for periodontal disease severity [15]. However, studies in Afghanistan and Iran have come to an opposite conclusion [21, 24]. These differences were possibly the result of different methodologies and population composition. Females were easier to suffer oral disease, which because of changes in habits and hormones when they were pregnant. As a result, the proportion of preventive extraction of third molar in female (24.78%) is much larger than that in male (12.79%).

Concerning tooth types, current results confirmed several previous findings that more posterior teeth were extracted than anterior teeth [21, 25, 27], and third molars were most extracted [8, 9, 11, 19, 23]. Third molar were comprising 54.64% of extractions, followed by first molar (11.11%), and canine extraction was the least common (2.67%). On the basis of our definition (Table 1), third molar was the unique tooth type extracted for prevention, pericoronitis and surgical reasons. And supernumerary tooth and primary tooth was almost extracted for other reasons. After careful consideration, we eventually decided to exclude subjects of these three reasons as well as subjects involving supernumerary tooth and primary tooth. We then found a statistically significant difference in the reasons for tooth extraction among tooth types ($\chi^2 = 822.21$, $n = 1871$, $df = 35$, $p < 0.05$).

There were more than one third of third molars extracted because of preventive extraction. Caries was the principal reason in first molars and second molars. A few numbers of incisors and canines were loss for caries. These findings have been reported previously as well [12, 13, 21, 24, 27]. Furthermore, the number of third molar extracted for caries was more than double the number of either first molar or second molar, which was alike to that reported in Taiwan [23]. One possible explanation that has been discussed before was that posterior teeth were more important and involved in mastication and beyond that, posterior teeth particularly third molars were more difficult than anterior teeth to be brushed clean, thus they were easier to be exposed to a greater risk of caries. In contrast, anterior teeth were frequently extracted because of periodontal disease and pre-prosthetic reasons, which was in agreement with findings in Hong Kong [13]. Anterior teeth are less susceptible to caries than posterior teeth, they could remained longer and might be more exposed to the risk of periodontal disease [15, 24]. Moreover, anterior teeth are easier to undergo endodontic and complicated restoration treatment and thus extraction of these teeth could be deferred to an older age for aesthetic [21]. Furthermore, orthodontic reason was important for premolar extraction [8, 21, 28, 36]. What was different from the previous results was that only first premolars mainly extracted for orthodontic reasons in present study. This might be due to the fact that few subjects of second premolars extractions was collected in our study.

However, there were some limitation of this study. For one, because of the vast area and huge population of China, we only chose a southern city as a sample to perform this survey. The hospital is the regional medical center of Guangdong Province, indicating that the results we shown can represent the characteristics in this region. However, such a single-center study can't stand for the whole country. We will conduct a multi-centers investigation in China and make a 5 years' comparison with the current data in the future. For another, we discussed few factors associated with missing teeth. Some studies have shown several factors such as education, fluoride-related preventive effort, cultural background and dental

attendance [23–25, 37]. Future studies should focus on establishing several predictors of tooth loss and this information could help to improve the oral health status.

Conclusions

Our study sets a clear definition for the extraction reasons and indicates that dental caries and preventive extraction of third molar are the main reason for tooth extraction in patients presenting at a hospital of stomatology in Guangzhou. It was proposed for the first time that preventive extraction of third molar was the main reason for extractions. Our finding may be roughly representative of the characteristics of reason for extractions in developed areas of South China. **In addition, the present study also shows that reasons for extractions are related to age, gender and tooth type.** These results indicate that people's awareness of oral health care is gradually increasing and suggested that dental health institutions should pay more attention on oral diseases prevention-centered strategies rather than therapy-centered strategies.

Abbreviations

Not applicable

Declarations

Ethics approval and consent to participate

This cross-sectional study was performed in accordance with the Declaration of Helsinki and approved by the institutional review board of the Hospital of Stomatology, Sun Yat-Sen University (ERC- [2014] -5). Informed consent was obtained from patients and, if subjects are under 18, from a parent and/or legal guardian.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

HT and DY contributed to conception, design, data acquisition, and critically revised the manuscript. HL contributed to analysis, and interpretation, drafted and wrote the main manuscript text; ZL contributed to data acquisition and analysis, and prepared the figures and tables. All authors read and approved the final manuscript.

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Figures

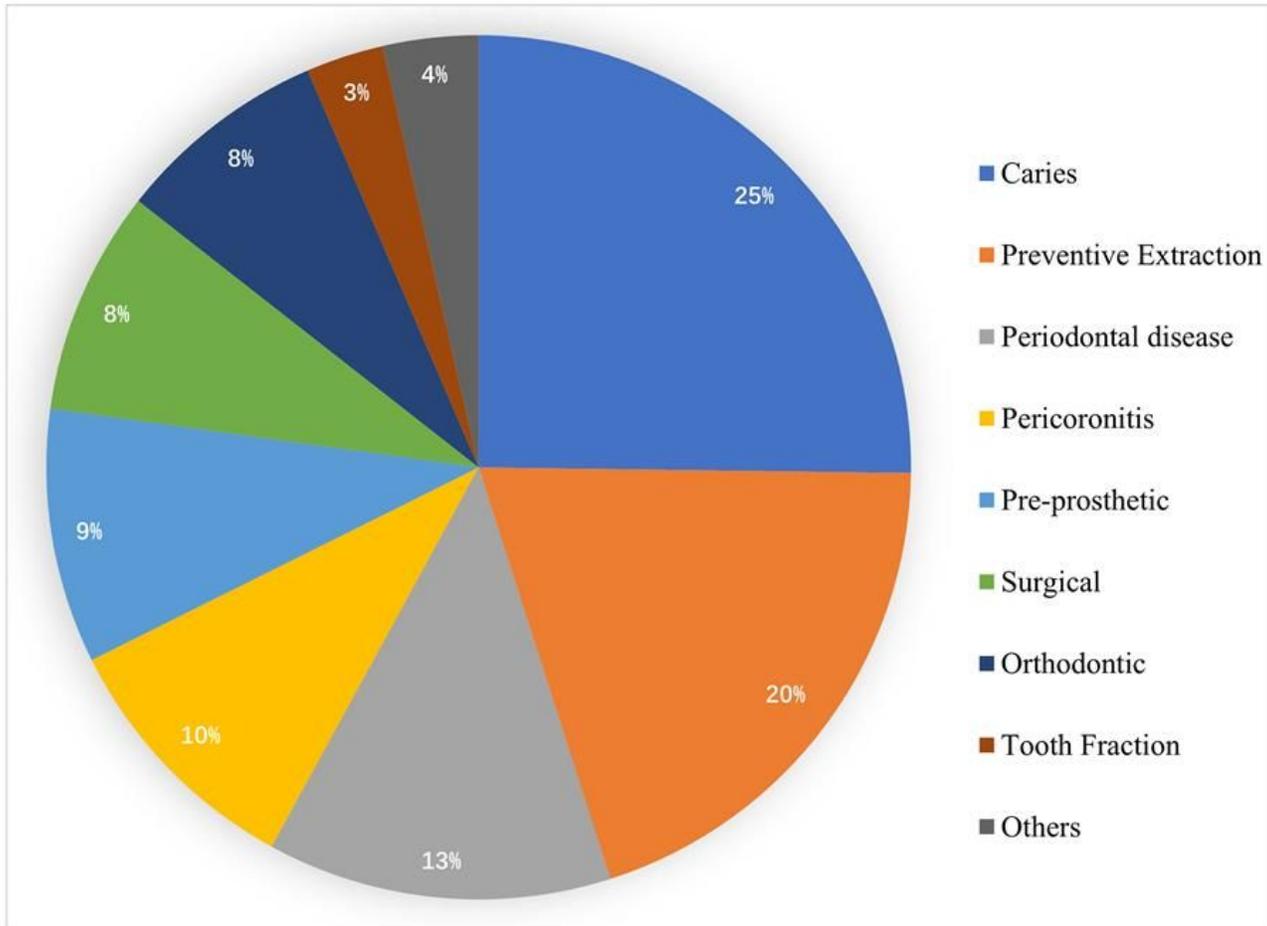


Figure 1

Pie charts of the proportion of the reasons for tooth loss. The leading reason was dental caries, followed by preventive extraction of third molars and periodontal disease. Tooth fraction accounted for the least.

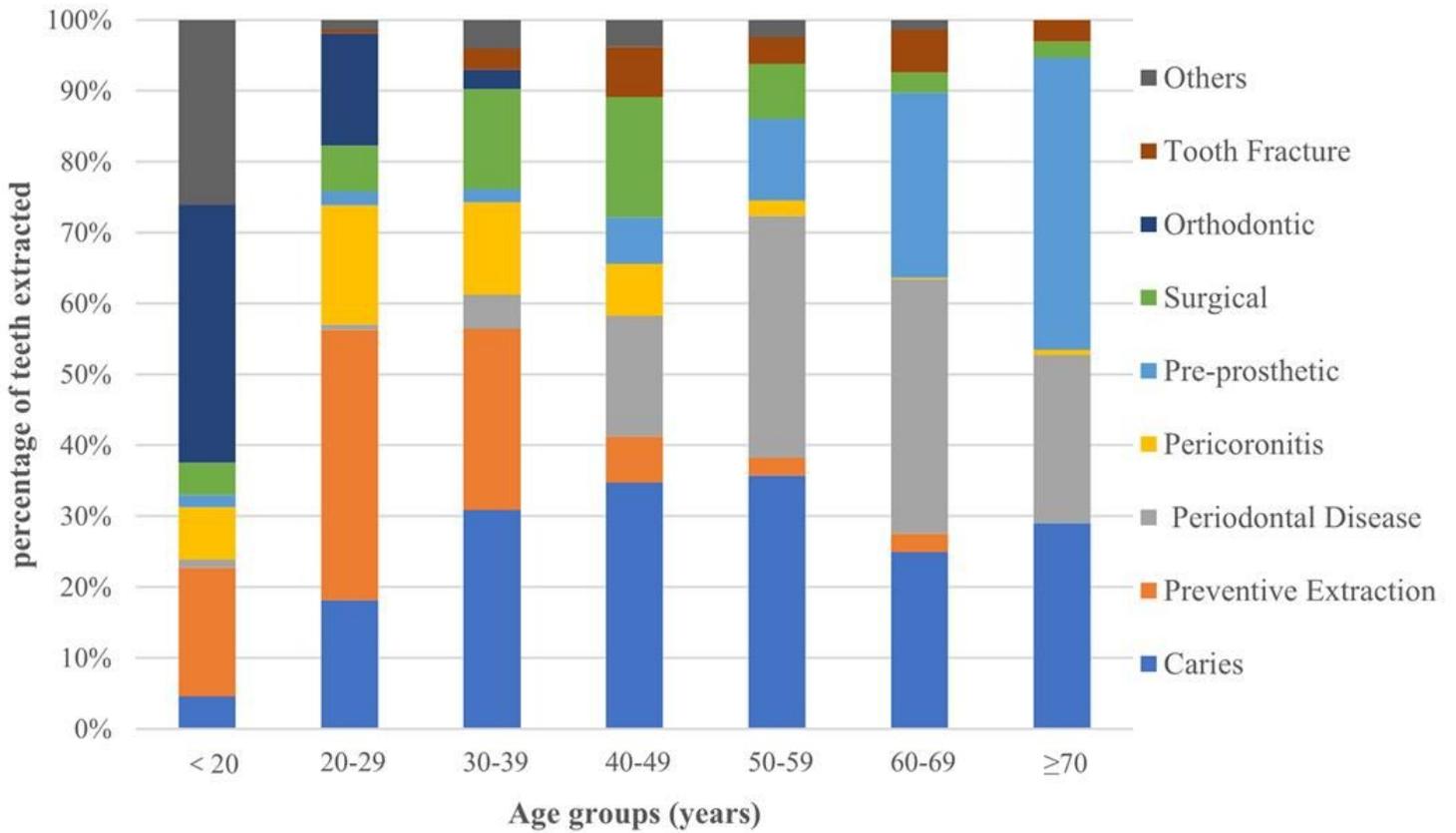


Figure 2
 Percentage distribution of extraction reasons in different age groups. Orthodontic reason was important in patients below 20. Preventive extraction was the major reason in age group of 20-29. Caries was most commonly in age groups of 30-39, 40-49, 50-59. Periodontal disease was the leading reason in age of 60-69 and pre-prosthetic was the main reason in those older than 70 years.

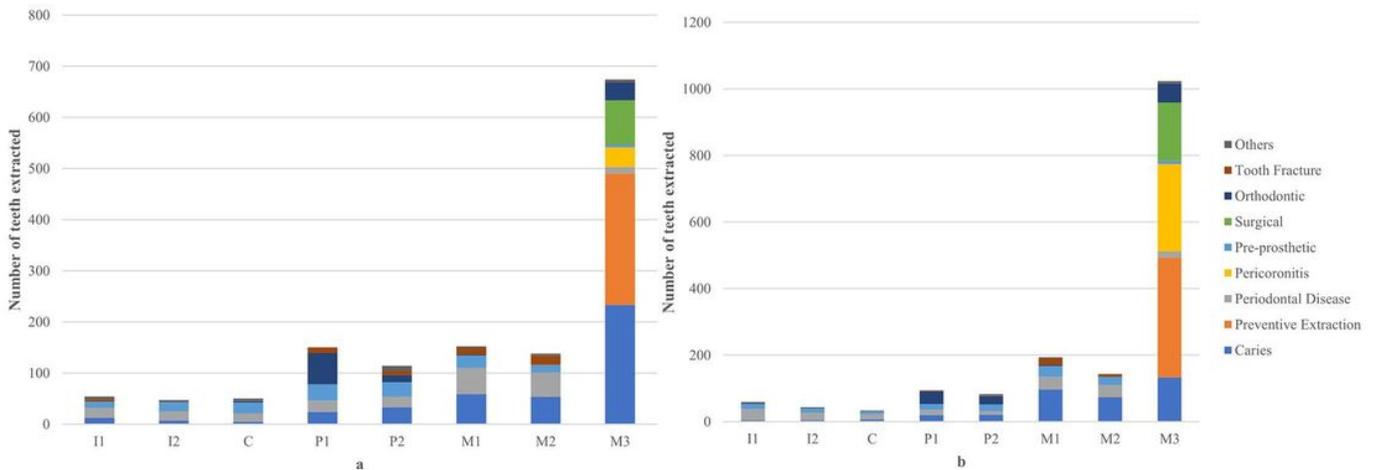


Figure 3
 Distribution of the reasons for maxillary tooth and mandibular tooth extraction according to tooth type. M3 were extracted most frequently (674 in maxillary (a) and 1023 in mandibular(b)), comprising 54.64% of extractions, and then M1 (11.11%). Canine extraction was least (2.67%).
 Abbreviations: I1: Central Incisor; I2: Lateral Incisor; C: Canine; P1: First Premolar; P2: Second Premolar; M1: First Molar; M2: Second Molar; M3: Third Molar.