Prevalence of Tooth Agenesis in Adolescent Chinese Populations with or without Orthodontics

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Objective: *To determine the prevalence of hypodontia in the general population and orthodontic population in adolescent Chinese Hans.*
Methods: *Two groups named the general population (6015 subjects) and the orthodontic population (2781 subjects) were investigated, respectively. The former came from the students of three general universities in North China and the latter came from patients coming to the Department of Orthodontics, Peking University School and Hospital of Stomatology for orthodontic consulting during the summer and winter holidays in 2008. The prevalence and average missing number of hypodontic teeth was investigated in the two groups. The distribution of missing teeth was analysed between jaw positions and between genders.*
Results: *The prevalence of tooth agenesis was found to be 5.89% for the general population group and 7.48% for orthodontic subjects. Tooth agenesis was more frequently found in females than in males in both of the two groups and showed a statistically significant difference ($P < 0.01$). Tooth agenesis was found more frequently in the mandible than in the maxilla in the general population but had no difference in the orthodontic population. The prevalence and the number of missing teeth were higher in the orthodontic population than in the general population. Tooth agenesis showed different characteristics in the two populations. The congenital absence of the second mandibular premolars and the maxillary lateral incisors increased in the orthodontic population. Gender difference in hypodontia expressed an opposite effect in the two groups. Although tooth agenesis was more frequently found in females than in males, males missed more teeth than females in the orthodontic population.*
Conclusion: *Tooth agenesis showed different characteristics between the general and orthodontic adolescent Chinese populations.*

Key words: *hypodontia, prevalence, orthodontics*

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Tooth agenesis or hypodontia, which is characterised by the absence of one or more teeth, is one of the most common developmental anomalies of human dentition. The term hypodontia is used when one to five teeth, excluding the third molars, are absent. When six or more teeth are missing, the condition is called oligodontia whereas anodontia represents the agenesis of all teeth[1,2]. Hypodontia can also be classified as syndromic or non-syndromic, whereby the tooth agenesis occurs as an isolated anomaly in the case of the latter and as a part of multiple congenital anomalies in the former case.

Numerous epidemiological studies of hypodontia have been carried out, and population studies have revealed that the prevalence of hypodontia (excluding the third molars) varies from 0.3% to 10.1%[3-7] in dif-

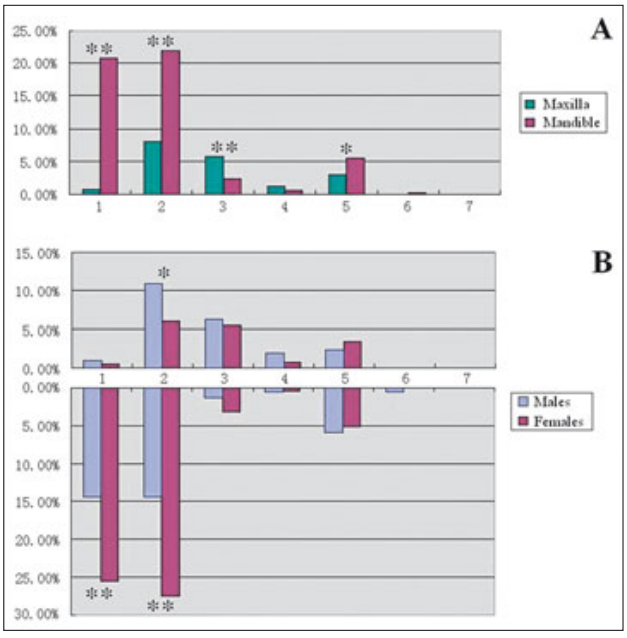

Fig 1 Comparison of the percentage of missing teeth in the general group.
A: comparison between jaws; B: comparison between sexes
Note: x-axis = tooth position; y-axis = percentage missing in each position; the number of missing teeth on both left and right quadrants of the mouth are combined. Maxillary teeth are aligned above the x-axis and mandibular teeth are aligned below the x-axis in part B. 1: central incisor; 2: lateral incisor; 3: canine; 4: first premolar; 5: second premolar; 6: first molar; 7: second molar. Statistically significant differences are indicated by asterisks: * $0.01 < P < 0.05$, ** $P < 0.01$.

ferent ethnic groups. The most common missing teeth also seem to vary amongst ethnic groups. In the Asian population, the mandibular lateral incisors and the mandibular second premolars are most frequently absent, while the mandibular second premolars and the maxillary lateral incisors are most likely to be missing in the Caucasian population. Some studies have reported the prevalence of hypodontia in the orthodontic groups[8-13]. The prevalence of hypodontia in males and females varies from 2.7% to 11.3% in various populations. Considering the type of missing teeth, maxillary lateral incisors have been found to be the most frequent congenitally absent teeth in the Turkish and Brazilian orthodontic patient populations[14,15]. However, most studies thus far have focused on either normal individuals or orthodontic patients, respectively. The aim of this study was to contrast the distribution of hypodontia in Chinese adolescents who had undergone orthodontic counselling against a comparable sample of general college students.

Materials and methods

Subjects

A total of 6,015 students with permanent dentition (3,184 males and 2,831 females) who were enrolled in three universities in the Hebei province in 2008 were examined in this study. This group was named the general population group. The study also included 3,481 subjects (1,392 males and 2,089 females) with mixed to permanent dentition who visited the Department of Orthodontics, Peking University School and Hospital of Stomatology, for an orthodontic check-up and counselling during the summer and winter holidays in 2008. This group was called the orthodontic population group. All subjects in this study were of Han ethnic origin and varied in age between 10 and 26 years old. This study was conducted with the approval of the Ethics Committee of the Peking University Health Science Center.

Diagnosis of hypodontia

The diagnosis of hypodontia was based on intraoral exams and radiographs. The number and the location of missing teeth were recorded during the check-up and confirmed by panoramic radiographs or periapical film. For the periapical film, it was required that the film showed at least two adjacent teeth with the apical region as the projection center to avoid missed diagnosis as far as possible. A tooth was considered congenitally missing when it could not be found in the dental arch and the crown mineralisation was absent in the panoramic radiographs[8]. Permanent teeth lost as a result of extraction, trauma and prior orthodontic treatment were excluded in the diagnosis of hypodontia.

Statistical evaluation

The SPSS statistical software package (SPSS, Illinois, USA) was used to perform the statistical analysis. The number of missing teeth at each position in the left and right quadrants of the mouth for all patients was compiled and evaluated using a Chi-square test. The differences in the number and location of the missing teeth between sexes and between the mandibular and maxillary jaws, in both the general and orthodontic populations were compared. The pattern of hypodontia in the two populations was also analysed.

Table 1 The prevalence of missing teeth in the general and orthodontic groups.

	General group			Orthodontal group			Total
Number of individuals (male/female)	6015			2781			8796
	(3184/2831)			(1112/1669)			(4296/4500)
			Symmetrical missing			Symmetrical missing	
Female	197	**	68/78	145	**	64/72	342
Male	157		41/53	63		37/45	220
Total	354		109/131	208		101/117	562
Prevalence (%) (male/female)	5.89		83	7.48		86	6.39
	(4.93/6.96)			(5.67/8.69)			(5.12/7.60)

The prevalence of missing teeth was compared between sexes in the general and orthodontic groups. Statistically significant differences are indicated by asterisks: ** $P < 0.01$, * $0.01 < P < 0.05$. In the column titled 'symmetrical missing', the numerators indicate the number of subjects with symmetrical tooth agenesis and the denominators indicate the number of subjects with more than one tooth absent.

Table 2 The number of missing teeth in each position.

Subjects		Jaw position	Tooth position													
			7	6	5	4	3	2	1	1	2	3	4	5	6	7
General	F	Max.	0	0	3	3	8	12	3	0	21	11	3	4	0	0
		Man.	0	2	7	2	3	23	18	26	2	1	0	11	0	0
	M	Max.	0	0	8	1	10	13	0	2	11	12	2	6	0	0
		Man.	0	0	8	2	7	79	30	36	71	6	0	13	0	0
Orthodontic	F	Max.	1	0	12	7	6	12	0	0	11	8	6	11	0	1
		Man.	1	0	17	3	2	9	19	13	9	4	4	17	0	1
	M	Max.	3	1	12	6	11	20	1	1	20	9	5	14	1	6
		Man.	3	1	23	2	4	30	24	23	25	4	4	32	0	2

Note: Man, mandible; Max, maxilla.

Results

Prevalence and location of missing teeth

The results of this investigation of missing teeth are summarised in Table 1. The prevalence of hypodontia was 5.89% in the general group and 7.48% in the orthodontic group. In both groups, symmetric hypodontia, which indicates tooth agenesis situated in both the left and right side, was more predominant than asymmetric hypodontia in subjects with more than one tooth absent. The numbers of missing teeth, with regard to the tooth position, in the general and orthodontic population are summarised in Table 2.

Data on missing teeth in the general group

The percentage of missing teeth (which is the ratio of absent teeth in the entire dentition) in the general group was 5.03% in total, 2.68% in the maxilla and 7.38% in the mandible, respectively. A statistically significant difference was found between the upper and lower dentition ($P < 0.01$). The mandibular incisors were absent most frequently, followed by the maxillary canines and the mandibular second premolars and the difference was statistically significant ($P < 0.01$) (Fig 1A). A statistically significant difference also existed in the total number of missing teeth; 63% of individuals lost one tooth, while 31% individuals had two missing teeth ($P < 0.01$).

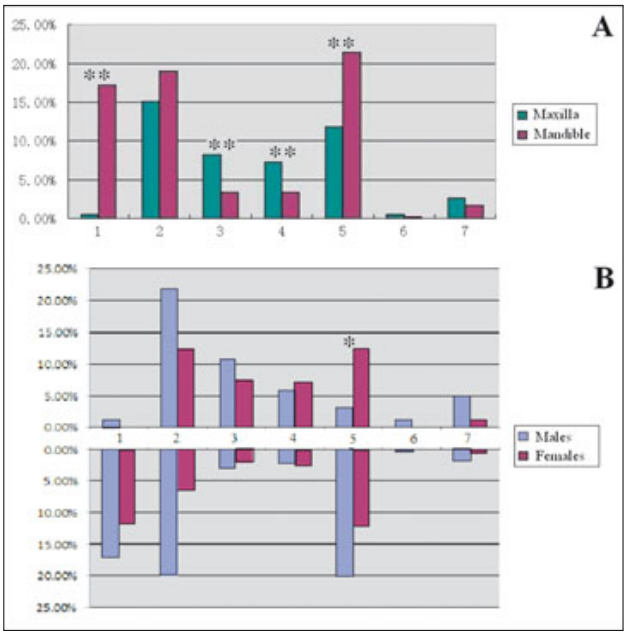

Fig 2 Comparison of the percentage of missing teeth in the orthodontic group.
A: comparison between jaws; B: comparison between sexes
Note: x-axis = tooth position; y-axis = percentage missing in each position; the number of missing teeth on both left and right quadrants of the mouth are combined. Maxillary teeth are aligned above the x-axis and mandibular teeth are aligned below the x-axis in part B. 1: central incisor; 2: lateral incisor; 3: canine; 4: first premolar; 5: second premolar; 6; first molar; 7: second molar. Statistically significant differences are indicated by asterisks: * $0.01 < P < 0.05$, ** $P < 0.01$.

The average number of missing teeth in male subjects was 1.16, whereas in females this number was 1.61, whereas overall 1.41 teeth were absent per capita. The percentage of absent teeth at each position was also calculated and analysed (Fig 1B). Statistically significant differences between sexes were found with regard to the upper lateral incisors and lower incisors. The percentage of missing upper lateral incisors was greater in males than in females ($0.01 < P < 0.05$). In contrast, females had more absent lower incisors than male subjects.

Data on missing teeth in the orthodontic group

The percentage of missing teeth in the orthodontic group was 7.74% in total, 6.11% in the maxilla and 9.38% in the mandible, respectively. A statistically significant difference was found between the upper and lower teeth ($P < 0.01$). The mandibular second premolars were most frequently absent, followed by the mandibular incisors and the maxillary lateral incisors. A statistically significant difference was found between the absence of the mandibular second premolars and the maxillary lateral incisors ($0.01 < P < 0.05$) (Fig 2A). Forty-four percent of individuals lost one tooth, whereas 37% of individuals had two teeth absent; however, this difference was not statistically significant.

The average number of missing teeth was 2.77 in males and 1.93 in females however overall 2.17 teeth were absent per capita. The percentage of teeth missing at each position was also calculated and analysed (Fig 2B). Statistically significant differences were found between sexes with regard to the upper second premolars; males demonstrated more absent teeth ($0.01 < P < 0.05$).

Comparison of tooth agenesis between the general and orthodontic groups

The prevalence of tooth agenesis in the orthodontic group (7.48%) was higher than that in the general group (5.89%) and showed a statistically significant difference ($P < 0.01$). The data for the left and right sides was combined and the percentage of absent teeth in the two groups were compared. A statistically significant difference was found in the case of the upper lateral incisors and the upper and lower premolars ($P < 0.01$) (Fig 3A). When we classified the subjects according to the number of missing teeth (one, two, three or more than four teeth missing), the comparison showed that the absence of one tooth was the most frequently observed in both groups. However, more subjects with only one tooth absent were identified in the general group and those with more than four teeth missing were more common in the orthodontic group (Fig 3B).

Discussion

Prevalence of non-syndromic hypodontia in the general population

This investigation of tooth agenesis was based on a survey of the general population. The age of the subjects is a crucial factor as it directly affects the results[16]. If the target population is too young, false positive incidences of hypodontia could occur because of hypocalcification of the permanent tooth bud. If the target population is too old, the medical history of the individuals may be complicated and hard to trace. Decay and injuries can also lead to the absence of teeth, therefore increasing the

indeterminacy of diagnosis. Taking tooth development into account, the age of the subjects (10 to 26 years old) in this study is suitable. The third molars were excluded to match with the previous research.

Our results suggest that in the general population, when orthodontic patients are excluded, the prevalence of congenital tooth agenesis is 5.89%, with a prevalence of 6.96% in females and 4.93% in males. This variation between sexes was statistically significant ($P < 0.01$). The prevalence of congenital tooth agenesis (excluding the third molars) has been shown to range from 0.3% in the Israeli population[3] to 10.1% in the Norwegian population[4]. This wide range of prevalence may be due to differences in the age, sex and racial origin of the subjects, as well as variations in the methods of sampling and examination. Although a few exceptions exist[16-18], the results of most studies suggest that the incidence of tooth agenesis in women is relatively higher. The locations of the missing teeth also differ according to racial origin. Excluding the third molars, the mandibular second premolars have been found to be the most frequent congenitally missing teeth in the Caucasian population, followed by the maxillary lateral incisors and second premolars. In the British population, the mandibular second premolars have been shown to be the most common congenitally absent teeth. The mandibular incisors have been found to be the most frequently missing teeth in Chinese and Japanese people. The research by Wu suggests that mandibular tooth agenesis is more severe than that of the maxilla in the Chinese population, with the mandibular incisors being the most frequently absent teeth, followed by the mandibular second premolars and molars. Backman's investigation showed that individuals lost mandibular teeth more often than maxillary ones[19]. The subjects of the third part of this study (the military college) were all males and the prevalence of missing teeth was observed to be 10.41%, which is significantly higher than in the other two groups. This deviation may be due to the small sample size. If the results of the three groups are combined, the prevalence, the differences between sexes and the positions of the missing teeth are consistent with the findings of previous research. Among individuals who had more than one tooth missing, symmetric hypodontia was more predominant than asymmetric hypodontia, which is in agreement with previous reports[20].

In our study, the mandibular incisors were the most frequent position to be congenitally absent, followed by the maxillary canines and the mandibular second premolars. The prevalence of congenitally missing teeth showed a significant difference between the maxilla and mandible, with a higher prevalence in the mandibular jaws. It showed a statistically significant higher prevalence in the mandible with regard to the central incisors and the premolars, but the congenital absence of maxillary canines was higher than the mandibular canines. However, other studies have shown different results. Muller[21], for example, suggested that the number of congenitally missing teeth in the maxilla were more than that in the mandible. Schalk-van der Weide et al suggested that there was no statistical differences in the number of congenitally missing teeth between the maxillary and mandibular jaws[22]. The discrepancy between these results and the findings of our paper are most likely due to variations in the racial origin of the subjects included in the studies.

The incidence of congenitally missing teeth also clearly varied between sexes, with a higher prevalence of dental agenesis in females than in males. These findings were consistent with most of the earlier reports

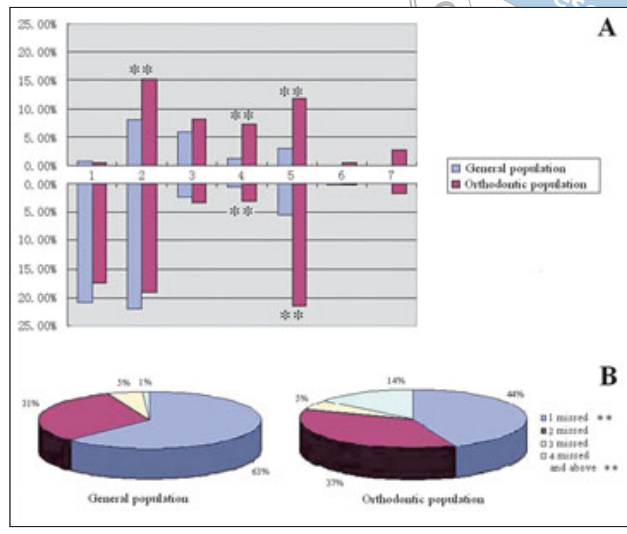

Fig 3 Comparison of the percentage of missing teeth at each position and the total number of teeth absent between the general and orthodontic populations.
A: comparison of the percentage of missing teeth; B: comparison of the total number of absent teeth.
Note: A: x-axis = tooth position; y-axis = percentage missing in each position; the number of missing teeth on both left and right quadrants of the mouth are combined. Maxillary teeth are aligned above the x-axis and mandibular teeth are aligned below the x-axis: 1: central incisor; 2: lateral incisor; 3: canine; 4: first premolar; 5: second premolar; 6: first molar; 7: second molar. Statistically significant differences are indicated by asterisks: * $0.01 < P < 0.05$, ** $P < 0.01$.

except for the research of Rolling and Albashaireh[23], which showed that there was no significant differences between sexes. The results of our study also indicate the prevalence of missing mandibular incisors was higher in women and the prevalence of absent maxillary lateral incisors was higher in men.

With regard to the number of missing teeth, in the general population, congenitally absent teeth were mostly limited to three. More than half of the subjects were missing only one tooth and 1% of cases had more than four missing teeth.

Prevalence of non-syndromic hypodontia in the orthodontic population

Sparse dentition has been one of the main complaints of orthodontic patients. Our results indicate that the prevalence of congenitally missing teeth in orthodontic patients is 5.91%. The incidence was higher in females (6.89%) than in males (4.45%), and statistically significant differences ($P < 0.01$) were found. A survey of the prevalence of hypodontia in orthodontic patients in Japan showed that the prevalence was 8.5%. The incidence was 7.5% in males and 9.3% in females and showed no statistically significant difference[11]. Regarding the position of the congenitally missing teeth, the most frequently affected were the mandibular second premolars, the mandibular and maxillary lateral incisors and the maxillary second premolars. A survey of Brazilian orthodontic patients indicated that the prevalence of tooth agenesis was 6.3% and no statistically significant difference was found between sexes[15]. A study of orthodontic patients in Turkey showed that the prevalence of tooth agenesis was 4.6%[14]. A higher incidence was reported in females than in male subjects but no statistically significant difference was observed. The positions most frequently affected were the maxillary lateral incisors, the mandibular second premolars and the mandibular central incisors. However, the prevalence of tooth agenesis in Chinese orthodontic subjects had not been investigated previously. In our study, symmetrical hypodontia was predominantly compared with asymmetric hypodontia in individuals who had more than one tooth missing, which was consistent with the results of another report[11].

According to the results of our study, the mandibular second premolars were found to be the most frequent missing teeth, followed by the mandibular incisors and the maxillary lateral incisors. A study carried out by Toshiya et al in Japanese orthodontic subjects showed similar findings[14]. Our study also indicated that there were no obvious differences between the sum of the missing teeth in the maxillary and mandibular jaws of orthodontic subjects. However, more incisors and second premolars were absent in the mandible and more canines and first premolars were absent in the maxilla; these differences were statistically significant. There was no obvious difference between the sexes in the orthodontic group. But a higher number of male subjects had missing maxillary first premolars than females.

Comparison of the prevalence of non-syndromic hypodontia in the general and orthodontic groups

A comparison between tooth agenesis in the general and orthodontic groups indicated that the latter presented a more severe incidence. Firstly, the prevalence of congenitally missing upper lateral incisors and upper and lower premolars was significantly higher in subjects belonging to the orthodontic group. The incidence of missing teeth at other positions did not show obvious differences between the groups. Secondly, the average number of missing teeth (excluding the third molars) was significantly higher in the orthodontic group than in the general group. Thirdly, more than half the subjects in the general group had only one tooth absent; thus, a higher number of subjects were missing one tooth than those who had two or more teeth absent. However, in the orthodontic group, the number of subjects missing two teeth was greater and had no statistically significant difference with those missing just one tooth. The number of individuals with four or more teeth absent was higher than in the general group; this difference was statistically significant.

Furthermore, the positions of the missing teeth differed between the general and orthodontic groups. The most frequently absent teeth were the mandibular incisors, the maxillary canines and the mandibular second premolars in the general group. In contrast, in the orthodontic subjects, the mandibular second premolars, the mandibular incisors and the maxillary lateral incisors were most frequently absent in that order. Secondly, a statistically significant difference was found between the maxilla and mandible in general subjects. Tooth agenesis was more severe in the mandibular jaw and the absence of central incisors and premolars showed statistically significant differences between the jaws. In the orthodontic subjects, however, there was no difference in the total number of missing teeth between the maxilla and mandible. If tooth positions were considered separately; in the mandible, incisors and second premolars were more frequently absent; whereas in the maxilla, canines and first premolars were more com-

monly missing. Finally, although differences between the sexes were found in both the general and orthodontic groups, the situations were reversed. Tooth agenesis was more severe in females in the general group and the disparity was 0.14 teeth per capita. The mandibular incisors were observed to be more frequently missing in females and the absence of maxillary lateral incisors was more severe in males. In the orthodontic group, tooth agenesis was found to be more severe in males with a disparity of 0.5 teeth per capita. The maxillary second premolars were found to be more frequently absent in males.

Sparse dentition resulting from hypodontia is one of the major complaints for which individuals seek orthodontic counselling. Therefore, it is certainly no surprise that a higher prevalence of congenitally missing teeth was observed in orthodontic subjects. The absence of one tooth, especially the mandibular incisor, can often alleviate pre-existing dental crowding in the arch. Therefore, such patients would avoid seeking orthodontic counselling. Hypodontia of the posterior teeth can often lead to deciduous tooth retention. The mesiodistal width variance of deciduous and permanent teeth can cause dental crowding or malocclusion. Thus, in the orthodontic group a higher prevalence of tooth agenesis was observed, and the second premolars were found to be the most frequently missing teeth. Furthermore, females tend to be more concerned about appearance than males. Females are more likely to attend an orthodontic counselling session because of a mild malocclusion while males will undergo such counselling for a relatively severe condition. Therefore, more severe tooth agenesis was observed in males in the orthodontic population.

Our study is an epidemiological investigation of hypodontia in adolescents from the Chinese Hans community. Tooth agenesis in orthodontic patients was analysed for the first time. This study provides a good basis for research of hypodontia. The analysis on the prevalence of different tooth position and gender will contribute to an aetiology study. Tooth agenesis will interfere with either the completeness of the dentition or occlusion. Knowledge of the disease characteristics can also get more attention in clinical practice and early treatment.

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