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The prevalence of dental agenesis, supernumerary teeth and odontoma in a Chinese paediatric population: an epidemiological study

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Abstract

Background Dental agenesis, supernumerary teeth and odontoma collectively exert a significant impact on the aesthetics and function of patients. Studies have shown that early detection and intervention may alleviate complications.

Methods Panoramic radiographs and medical records of 5,015 patients aged 5.5–13.9 years who underwent paediatric dentistry at the Affiliated Stomatological Hospital of Fujian Medical University between 2013 and 2022 were retrospectively reviewed for dental agenesis, supernumerary teeth and odontoma. All data were analysed using SPSS 26.0.

Results The total prevalence of dental agenesis, supernumerary teeth and odontoma was 11.31%. The most common congenitally missing teeth were mandibular lateral incisors. The absence of one to five teeth was observed in 341 cases (6.80%). The congenitally missing teeth identified in this study were more commonly observed in the mandible, and in the anterior teeth. The prevalence of supernumerary teeth was 4.03%, and they were most frequently observed in the maxilla. The prevalence of odontoma was 0.26%, and it was more frequently observed in the maxilla than in the mandible.

Conclusion Paediatric cases in China have a relatively high prevalence of dental agenesis, supernumerary teeth and odontoma, which entails a detailed examination and a further significance in the development of a sound treatment plan for children at an early age.

Keywords Dental agenesis, Supernumerary teeth, Odontoma, Panoramic radiography

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Background

Dental agenesis is a condition where the tooth fails to erupt in the oral cavity and the germ of the missing tooth in the alveolar bone is not visible on radiographs [1, 2]. There's no unified classification, but two common ways exist: by the number of missing teeth (hypodontia, oligodontia, anodontia, with hypodontia being most common, especially 1–2 missing teeth) [1, 3–5] and by whether there are systemic diseases (non - syndromic and syndromic), with the former more common [6].

According to studies on the prevalence and distribution of congenitally missing teeth, significant differences exist in congenitally missing teeth, depending on the sample size, sex, race and ethnicity [7–13]. A meta-analysis conducted by Rakhshan et al. [11] showed that the prevalence of congenital absence of permanent teeth ranged from 0.15 to 16.18%, with a mean prevalence of 6.53 ± 3.33%, which is similar to the results of some domestic studies in China [14]. Zhu found in their survey that the number of people with congenital missing teeth accounted for 2.0% of the total surveyed population [15].Wu Hua reported that its incidence rate ranged from 2.6–11.3% [16].

The impacts of dental agenesis include ectopic eruption of teeth, periodontal damage and premature loss of alveolar bone, which significantly impair patients' lives [17–19]. It has negative impacts like ectopic eruption, periodontal damage, and alveolar bone loss, and may affect diagnosis due to possible delayed development of mandibular second premolars [20–23]. Therefore, the benefits of early diagnosis and treatment outweigh the disadvantages.

Hyperdontia, or supernumerary teeth, is the presence of teeth that have either erupted in the oral cavity or are buried in the bone in addition to the normal 20 primary teeth and regular 28–32 permanent teeth [24, 25].Its imaging characteristics show that supernumerary teeth can be located anywhere in the dental arch. They have diverse shapes, but usually present some developmental abnormalities.They are less common, with a prevalence of 0.04 – 2.29% [26].Chen Piaoyang found in their research that the incidence of supernumerary teeth was 3.10% [27]. However, supernumerary teeth often cause problems like eruption issues, root deformities, etc [26, 28–30]. Odontoma, which is not a true odontogenic neoplasm, has a prevalence of 0.24 – 1.21% and causes similar problems [26, 30–31]. Its imaging findings show a mass of inhomogeneous calcified matter or multiple tooth - like structures with a relatively clear border, and a thin layer of low - density radiopaque shadow is often visible around it.

Supernumerary teeth and odontoma cause a series of complications, making follow-up treatment difficult. Therefore, early detection and treatment by a paediatric dentist are important. This makes the focus on the paediatric population particularly relevant as this age group is the target of early detection and treatment.

The aim of the study is to examine the prevalence and distribution of dental agenesis, supernumerary teeth and odontoma in a Chinese paediatric population aged 5.5–13 years in the mixed dentition period.

Methods

This study was a retrospective, observational and epidemiological study, and it was approved by the Ethics Committee of the Affiliated Stomatological Hospital of Fujian Medical University (protocol number: 202050). Legal guardians and patients signed a detailed informed consent form.

The initial sample consisted of Chinese children aged 5.5–13.9 years who attended the paediatric dental centre at the Affiliated Stomatological Hospital of Fujian Medical University between August 2013 and June 2022 and had radiological examination taken with the Sirona ORTH (Sirona Dental Systems GmbH Bensheim, Germany) equipment.

The inclusion criteria were as follows:

- Chinese children aged between 5.5 and 13.9 years with mixed dentition.
- Complete medical records of the visit(Patient Basic Information、Chief Complaint、History of Present Illness、Family History、Oral Examination、Imaging Examinations、Diagnosis、Treatment Plan、Treatment Record、Follow - up Record).
- Good quality panoramic radiograph.
- no developmental anomalies (e.g. ectodermal dysplasia, cleft lip or palate, Down syndrome).
- no history of missing teeth (due to trauma, periodontitis, orthodontic treatment, etc.)
- no congenitally missing third molar.

All panoramic radiographs were analysed by an experienced pre-trained paediatric dentist using a spacious computer screen and properly lit environment. To reduce errors, the analysis was repeated by the same investigator after 14 days and the arithmetic average of the two studies was taken. The age and sex of the patient, the location and number of supernumerary teeth, odontoma and missing teeth were finally recorded by panoramic radiography and filed into medical records.

Statistical analysis

All data were analysed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp, Ar-monk, NY, USA). Before data collection, 100 panoramic radiographs were randomly selected and analysed by a researcher. The

Table 1 Distribution of each type of tooth number abnormality

Abnormal	Number of individuals			Prevalence(%)		
	Male	Female	Total	Male	Female	Total
Congenitally missing teeth	205	156	361	7.01	7.46	7.2
Supernumerary teeth	160	42	202	5.47	2.01	4.03
Odontoma	6	7	13	0.21	0.33	0.3

*prevalence (%) refers to the prevalence of various types of tooth number abnormalities in relation to that of the total cases

results of the statistician's analysis were compared with the diagnostic report issued by the radiologist, and their final kappa value was 0.95, with a high degree of credibility for the researcher. The data found in this study were described using descriptive statistical analysis, and the differences between congenitally missing teeth, supernumerary teeth and odontoma in different sexes and positions were calculated by chi-square and Fisher exact tests. Normality and Mann-Whitney U tests were used to evaluate whether the minimum age included in this study had any effect on the statistics of congenitally missing teeth.

The number of congenitally missing teeth was recorded for each patient. Based on the Shapiro-Wilk test, irrespective of sex, the Mann-Whitney U test was used to compare the distribution of the number of congenitally missing teeth per patient between sexes if it was not normally distributed. According to the Mann-Whitney U test, the difference in the number of congenitally missing teeth between sexes was not statistically significant (Z=-0.18, $P=0.86$). Therefore, for same sex, data in the groups were pooled for subsequent analyses.

The statistical age group of 5.5–13.9 had eight cut-off ages. Each cut-off age could be divided into the younger group (< cut-off age) or older group (≥ cut-off). As the following results will demonstrate, the Shapiro-Wilk test showed that the data of these 16 groups were not normally distributed; therefore, the Mann-Whitney U test was used to compare the distribution of the number of congenitally missing teeth between the younger (< cut-off age) and older group (≥ cut-off). This statistical comparison was repeated for the eight different cut-off ages. For all tests, a two-tailed P-value < 0.05 was considered statistically significant.

Results

After analysing all panoramic radiographs and medical records, per exclusion criteria, the researchers excluded 20 cases with abnormal tooth number due to poor quality of X-ray images and 8 cases with missing teeth due to dental caries, orthodontic treatment and developmental anomalies. The final sample size of this study was 5,015, with an average age of 8.60 ± 2.06 years. It comprised 2,925 males and 2,090 females, with a male to female ratio of 1.4:1. The abnormal tooth number was 564, with a prevalence of 11.31% (9.52% for females and 12.58% for males). The prevalence rate for males was higher than that for females, and the difference was statistically significant ($\chi2=11.4$, $P<0.05$). (Table 1, *prevalence (%) refers to the prevalence of various types of tooth number abnormalities in relation to that of the total cases).

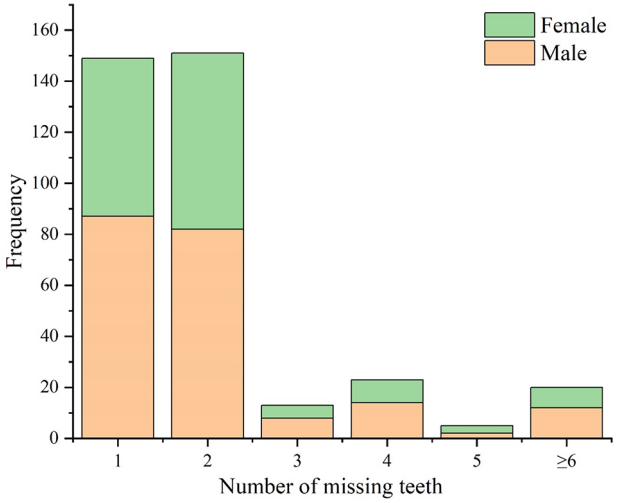

Fig. 1 Frequencies of agenesis in males, in females and in total sample

This study included 205 male and 156 female cases with at least one congenitally missing tooth, totalling 361 cases. The total prevalence of congenitally missing teeth in this sample was 7.20%. The prevalence of dental agenesis was higher in females than in males(7.46% and 7.01%, respectively); however, the difference was not statistically significant ($\chi2=0.91$, $P>0.05$).

Among the 361 cases, an absence of one to five teeth was observed in 341 patients (6.8%), while 20 patients had more than six teeth missing (0.4%). Congenitally missing two teeth was the most common (82 males and 69 females), followed by missing one tooth (87 males and 62 females) and missing four teeth (14 males and 9 females). The difference between males and females in each age group was not statistically different (Fig. 1).

In cases with one missing tooth, the most common missing tooth was the mandibular right lateral incisor in both sexes, with the second most common location being the mandibular left second premolar in females, and the mandibular left lateral incisor in males. In cases with two missing teeth, 147 were bilaterally missing (97.4%), and 4 were asymmetrically missing (2.6%). The most common missing position among both sexes was the bilateral

mandibular lateral incisor, followed by the bilateral mandibular second premolar (Figs. 2 and 3).

In this study, 844 congenitally missing teeth were observed, with an average of 2.34 missing teeth per patient, of which 482 were missing in males with 2.35 missing teeth per patient, and 362 were missing in females with 2.32 missing teeth per patient.

Among the 844 congenitally missing teeth counted, 313 maxillary teeth and 531 mandibular teeth were missing. A significant difference was observed in the prevalence of dental agenesis between the mandibular and maxillary ($\chi2 = 56.6$, $P < 0.05$). Among the 844 congenitally missing teeth counted, 425 were missing on the left side and 419 on the right side. No significant difference was observed between the left and right sides ($\chi2 = 0.04$, $P > 0.05$). Among the 844 congenitally missing teeth counted, 483 were anterior teeth and 361 were posterior teeth, with a higher prevalence in the anterior region than in the posterior region and displaying a statistically significant difference ($\chi2 = 17.7$, $P < 0.05$).

According to the FDI tooth position, the most common position of missing teeth in males was the mandibular lateral incisor, followed by the mandibular second premolar, maxillary lateral incisor and maxillary second premolar. However, the most common position of missing teeth in females was the mandibular lateral incisor, followed by the mandibular second premolar, maxillary second premolar and maxillary lateral incisor. No significant difference was observed in the prevalence of congenitally missing teeth between males and females in the same tooth position (Table 2).

significant difference in the median numbers of congenital missing teeth per patient between the younger group (< cut-off age) and older group (≥ cut-off) according to the different cut-off points between 5.5 and 13 years of age (Table 3).

In this study, 202 patients with supernumerary teeth were identified, including 160 males with a prevalence of 5.47% and 42 females with a prevalence of 2.01%. The total prevalence of supernumerary teeth in this sample was 4.03%. The prevalence of supernumerary teeth was higher in males than in females, and the difference was statistically significant ($\chi2 = 37.76$, $P < 0.05$).

Among the 202 patients with supernumerary teeth (195 patients, maxilla; 5 patients, mandible; and 2 patients, maxillary and mandible), a total of 249 supernumerary teeth were found, with an average of 1.23 teeth per patient, including 223 teeth in the maxilla (94.89%) and 12 teeth in the mandible (5.11%). The prevalence of supernumerary teeth was much higher in the maxilla than in the mandible, and the difference was statistically significant ($\chi2 = 175.6$, $P < 0.05$). Supernumerary teeth are most common among the maxillary central incisors, followed by the maxillary anterior teeth.

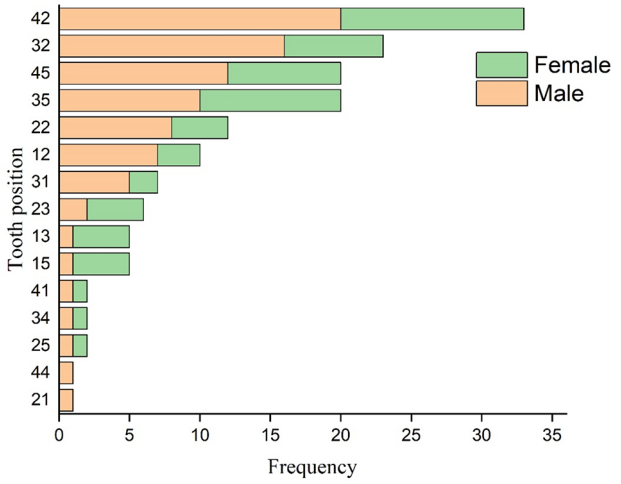

Fig. 2 Distribution of individual tooth missing by tooth positon and by gender (the FDI system was used for tooth notation)

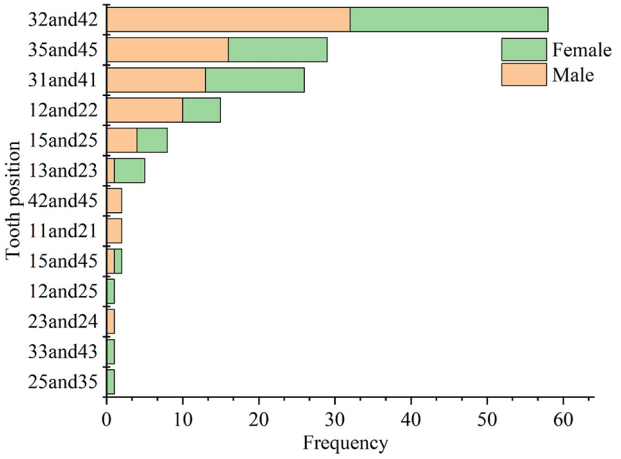

Fig. 3 Distribution of two teeth missing by tooth positon and by gender (the FDI system was used for tooth notation)

In this study, 13 cases with odontoma were identified, and the total prevalence of odontoma in this sample was 0.30%, including six males with a prevalence of 0.21% and seven females with a prevalence of 0.33%, with a higher prevalence in females than in males, yet the difference was not statistically significant ($\chi2 = 0.8$, $P > 0.05$). Of these 13 cases, 11 were located in the maxilla and 2 in the mandible, with a higher prevalence in the maxilla than in the mandible, and the difference was statistically significant ($\chi2 = 6.2$, $P < 0.05$).

In summary, through a retrospective review and statistical analysis, we found a higher significant difference in the prevalence of dental agenesis in the mandible and anterior region. Furthermore, we found a higher significant difference in the prevalence of supernumerary teeth in males and in the maxilla. The study also confirmed a higher significant difference in the prevalence of maxilla odontoma.

Table 2 Distribution of missing teeth according to tooth position and sex using the FDI system

Tooth position	Male (*n*)	Male (%)	Female (*n*)	Female (%)	*P*-value
11	6	0.7	1	0.1	0.251
12	29	3.4	20	2.4	0.902
13	12	1.4	15	1.8	0.142
14	9	1.1	5	0.6	0.651
15	26	3.1	25	3.0	0.285
16	0	0	0	0	<0.999
17	3	0.4	2	0.2	<0.999
21	7	0.8	1	0.1	0.151
22	31	3.7	22	2.6	0.980
23	15	1.8	15	1.8	0.354
24	13	1.5	5	0.6	0.231
25	28	3.3	20	2.4	<0.999
26	0	0	0	0	<0.999
27	2	0.2	1	0.1	<0.999
31	27	3.2	17	2.0	0.681
32	58	6.9	43	5.1	0.853
33	3	0.4	4	0.5	0.460
34	7	0.8	9	1.1	0.236
35	52	6.2	41	4.9	0.634
36	0	0	1	0.1	0.417
37	1	0.1	2	0.2	0.575
41	23	2.7	16	1.9	0.934
42	65	7.7	45	5.3	0.869
43	3	0.4	5	0.6	0.290
44	6	0.7	7	0.8	0.373
45	54	6.4	37	4.4	0.843
46	0	0	1	0.1	0.417
47	2	0.2	2	0.2	>0.999

Discussion

In this study, we investigated the prevalence of dental agenesis, supernumerary teeth and odontoma, through a retrospective review of Chinese children aged 5.5–13.9 years with mixed dentition in the Affiliated Stomatological Hospital of Fujian Medical University, and found significant results in the following areas.

Regarding the calculation of age, in order to record children's ages more accurately, the calculation method in this study is based on full years of age, combined with conversion of months. The number of months less than one year is converted into decimal form, and all ages are recorded in years. Since there are 12 months in a year, dividing the number of months by 12 gives the corresponding decimal part.

For studies on tooth number abnormalities, most of the data are obtained through panoramic radiographs or cone - beam computed tomography (CBCT). This study mainly focuses on observing the panoramic radiographs of patients. Panoramic radiographs can clearly show the erupted and unerupted teeth in the maxilla and mandible, as well as the tooth germs within the jawbones. Moreover, for children, it has relatively low radiation exposure, a lower cost, and a shorter shooting time, making it easier for children to cooperate.

In this study, the prevalence of abnormal teeth number was 11.31%, with a higher prevalence in males than in females. This result is similar to that of a Chinese study of 1,093 children aged 12 years who attended an oral health survey, which found that the prevalence of hypodontia and hyperdontia were 6.9% and 2.9%, respectively [32]. However, this is lower than the results of an American study of 1,101 patients aged 6–88 years who visited the University of Nevada dental clinic, which found that the prevalence of hypodontia and hyperdontia were 2.09% and 16.89%, respectively [33]. We posit that the differences may be related to the age structure of the sample, the sample size, differences in ethnicity, etc.Some scholars believes that during the prolonged process of tooth development, the complex interactions between genetic, epigenetic and environmental factors lead to dental abnormalities. This process is multifactorial, multilayered and multidimensional, and progresses over time [34]. The characteristics of tooth development in different racial groups may also lead to differences in the occurrence of dental abnormalities, such as variations in the eruption time, size and shape of teeth due to racial differences. Some ethnic groups may be more prone to issues such as retained primary teeth or delayed eruption of permanent teeth, which can lead to dental tooth number anomalies. Environmental factors, such as diet, lifestyle and oral hygiene habits, also have a significant impact on tooth development. In ethnic groups from different

Table 3 Comparison of means, SDs, medians and IQRs of missing teeth per patient by cut-off ages

Cut-off age (y)	≥Cut-off age					< Cut-off age					*P*-value
	n	Mean	SD	Median	IQR	*n*	Mean	SD	Median	IQR	
6	343	2.3	2.8	2.0	1.0	18	2.5	2.7	2.0	0.25	0.29
7	305	2.4	3.0	2.0	1.0	56	2.2	1.7	2.0	1.0	0.12
8	343	2.5	3.2	2.0	1.0	102	2.0	1.4	2.0	1.0	0.81
9	199	2.6	2.9	2.0	1.0	162	2.1	2.7	2.0	1.0	0.13
10	136	2.5	2.7	2.0	1.0	225	2.2	2.9	2.0	1.0	0.28
11	93	2.7	2.8	2.0	2.0	268	2.2	2.8	2.0	1.0	0.07
12	44	2.9	3.0	2.0	2.0	317	2.3	2.8	2.0	1.0	0.06
13	13	2.1	1.1	2.0	1.5	348	2.4	2.9	2.0	1.0	0.46

regions, differences in living environments may affect tooth development and the occurrence of abnormalities. For example, different dietary habits can influence tooth development, with diets rich in certain nutrients (such as calcium and phosphorus) potentially affecting tooth development and, consequently, the occurrence of dental tooth number abnormalities [35]. Cultural differences and social factors may also play a role in tooth development in certain cases. For instance, in some cultural backgrounds, a special emphasis may be made on tooth development or specific oral care practices during childhood, which can result in a relatively lower rate of developmental abnormalities. Different cultural and social practices may also influence whether individuals receive early dental check-ups and treatments. The statistical data on the prevalence of dental tooth number abnormalities across different ethnic groups may have certain biases. Owing to variations in health survey methods and medical conditions across different regions and countries, dental abnormalities in some ethnic groups may be more easily diagnosed and reported, leading to discrepancies in the data. The differences in the occurrence of dental tooth number abnormalities between different ethnic groups are the result of multiple factors acting together. Genetic factors, ethnicity-specific tooth development patterns, environmental factors and cultural habits all play important roles. Understanding these differences can help improve prevention, diagnosis and treatment of dental abnormalities.

Congenitally missing teeth are a common developmental abnormality in the number of teeth. The meta-analysis conducted by Rakhshan et al. found that the prevalence of dental agenesis in permanent teeth ranged from 0.15 to 16.18%, with lower prevalence in West Asia, Africa and North America, and even less than 1% in African and Australian indigenous populations; however, the prevalence was higher in East Asia [11]. In this study, the prevalence of dental agenesis in permanent teeth was 7.2%, which correlates with the result of Rakhshan et al. where congenitally missing teeth present a higher prevalence in East Asia. Therefore, our study supports the conjecture that the prevalence of congenitally missing teeth may vary with country, ethnicity, race, among other factors.

According to Polder's meta-analysis of 28 articles on the prevalence of congenitally missing teeth by sex, the prevalence was 1.4 times higher in females than in males [36]. In our study, the prevalence of congenitally missing teeth was 7.01% in males and 7.46% in females, with no statistically significant difference in the prevalence of dental agenesis between sexes. Female cases showed a higher prevalence of dental agenesis, which is similar to the results of an Italian study of 4,006 orthodontic patients aged 9–16 years with an 8.7% prevalence of congenitally missing teeth in males, and 9.1% in females [3]. Our study also supports a Japanese study of 3,358 orthodontic patients aged 5–15 years, which found that the prevalence of congenitally missing teeth was 7.5% in males and 9.3% in females [8]. This may be due to women paying more attention to aesthetics, resulting in a higher consultation rate for women than for men. However, a Turkish study of 9,874 patients aged 12–22 years who visited a tertiary health care facility in Turkey found that the prevalence of congenitally missing teeth was higher in males than in females (9% for males and 6% for females) [19]. This may be due to the difference in sample base and ethnicity.

As for the number of missing teeth, our study found that the prevalence of hypodontia ($1 \leq$ congenitally missing teeth > 6) was 8.6% and the prevalence of oligodontia (congenitally missing teeth ≥ 6) was 0.4%, with 1–2 congenitally missing teeth accounting for 84.4%, similar to the results of the aforementioned studies [3, 4]. Therefore, based on our results, concluding that most patients with congenitally missing teeth are only affected by a mild form of hypodontia is reasonable.

In this study, we found that the most common congenitally missing teeth were the mandibular lateral incisors, followed by the mandibular second premolars, maxillary lateral incisors and maxillary premolars, which was consistent with a Chinese study of 4,347 children aged 5–15 years with mixed dentition who visited a local paediatric dental clinic [14]. However, according to a meta-analysis by Polder et al. in Europe, the most common congenitally missing teeth were the mandibular second premolars, followed by the maxillary lateral incisors and maxillary second premolars, while in Malaysia and the United States, the most common was the maxillary lateral incisor [9]. This may be due to the differences in the expression of these genes among different races. This racial difference can be attributed to the atypical genetic control in congenitally missing teeth, and the lack of signal during tooth development is one of its manifestations. The variation of MSX1 and PAX9 genes is closely related to the occurrence of congenitally missing teeth, in which MSX1 is related to the loss of premolars, whereas PAX9 is related to the loss of molars [37]. This suggests differences in the expression of these genes across different races. In 2011, Vanessa et al. [38] conducted a study analysing exon 3 and the intronic sequences on both the 5' and 3' sides of the PAX9 gene in 172 individuals from different countries and regions, including South America, Europe, Africa and Japan. The study found that the polymorphism in exon 3 of the PAX9 gene may be related to human adaptation to the environment and natural selection, serving as a good example of molecular-level changes during human evolution. Jing et al., after conducting PAX9, MSX1 and Axin2 gene testing and analysis of a Chinese family with congenital hypodontia, concluded that the A240P polymorphism of the PAX9 gene

may be a risk factor for isolated congenital hypodontia in the Chinese population [39–40].

As for the location of congenitally missing teeth in the jaw, in this study, the prevalence of congenitally missing teeth was higher in the mandible than in the maxilla, and the difference was statistically significant. This is similar to a study of 4,256 patients conducted by Dzemidzic et al., which found that the prevalence of dental agenesis in the mandible (1.57%) was higher than that in the maxilla (1.42%) [24]. Gokkaya et al. also found that the prevalence of congenitally missing teeth was higher in the mandible (53.8%) than in the maxilla (46.2%) [41]. However, Gracco et al. found that the prevalence of at least one missing tooth in the maxilla was 5.4%, while in the mandible it was 4.7% [3].This is similar to a study by Peker et al., which found that the maxilla accounted for 64.5%, while the mandible accounted for 35.5% [42].

Our study also found that the prevalence of congenitally missing teeth in the anterior region was higher than that in the posterior region, and the difference was statistically significant. These findings are similar to that of Turkish scholars who studied 2,761 orthodontic patients [43], but different from those of Japanese scholars who studied 3,358 orthodontic patients aged 5–15 years who visited local clinics, which showed that congenitally missing teeth were more common in the posterior region [8].

This discrepancy may be because the origins of the maxillary and mandibular mesenchymal cells are different, resulting in different responses to ectodermal signalling for certain genetic pathways [44, 45]. In the process of congenital teeth development, the gene variations between the maxillary and mandibles, and the anterior and posterior teeth become apparent in presentation. According to previous studies [14, 32] and this study, in Chinese children, permanent tooth gene variations may be more common in the mandibular anterior region. However, this requires further investigation.

In this study, we also attempted to include minimum age on congenitally missing teeth statistics. No statistically significant differences were observed between the comparison groups at each cut-off age in the eight cut-off ages from 5½ to 13.9 years. This is comparable with studies conducted by Eliacik et al. on 9,874 patients aged 12–22 years who visited a tertiary health care facility in Turkey [19], and Arai on 228 orthodontic patients aged 8–14 years with non-syndromic oligodontia [23]. Our results are similar to that of both studies. This may be due to the fact that congenitally missing mandibular second premolar teeth are more common and have a higher possibility of delayed development [23]. However, owing to individual differences, the mineralization time of congenitally missing teeth also vary [46–48].

In this study, the prevalence of supernumerary teeth was 4.03%, which is higher than that in the aforementioned studies [26]. This may be related to the age range of the sample surveyed, as the subjects were primarily children in the mixed dentition period. Previous studies have shown that the prevalence of supernumerary teeth is highest among children in the mixed dentition period across all age groups [49]. However, the results of this study show a much lower prevalence of supernumerary teeth than that of Eshgian et al. in patients aged 6–88 years between 2010 and 2018 [33]. This suggests that the prevalence of supernumerary teeth may be related to sample size, sample source, survey method and ethnicity.

Similar to previous studies [14, 33, 50], in this study, the prevalence of supernumerary teeth in males (5.47%) was higher than that in females (2.01%), and the difference was statistically significant. Thus, our study proposes that males may be more susceptible to supernumerary teeth. Scholars have suggested that the occurrence of supernumerary teeth may be related to autosomal or sex chromosome inheritance. Genetic studies on families with supernumerary teeth or large-scale epidemiological surveys could aid in understanding the aetiology [51–52]. Mendelian genetic diseases can be classified into two main categories: autosomal and sex-linked inheritance. Both categories can be further divided into dominant and recessive inheritance. Since sex chromosomes include both X and Y chromosomes, sex-linked inheritance can involve X- and Y-linked inheritance.

The EDA gene encodes a product called ectodysplasin, or EDA protein, which is a type II transmembrane protein [53]. Studies on transgenic mice have demonstrated the important role of the EDA protein in development. Overexpression of EDA in mice affects the development of multiple organs, causing supernumerary teeth, enamel hypoplasia or changes in tooth morphology [52]. Currently, the EDA gene is located on the X chromosome, and a mutation in this gene was first reported in 2008 [54–55], further confirming the pathogenicity of this mutation. The mutation detection rate of the EDA gene is higher in male patients, reaching over 80%.

As regards the location of supernumerary teeth in the jaw, this study found that the maxilla accounted for 96.53%, whereas the mandible accounted for 2.47%, with a much higher prevalence in the maxilla than in the mandible, and the difference was statistically significant. This is consistent with the review of the prevalence of supernumerary teeth in different jaws by Pippi, which showed that the majority of studies assert that supernumerary teeth are more often in the maxillary than in the mandible [26].

In this study, the prevalence of odontoma was 0.30%: 0.33% for females and 0.21% for males. No significant difference was observed between sexes. However, the prevalence was 84.62% in the maxilla and 15.38% in the mandible. The difference between both jaws was statistically significant, which was again similar to the review by Pippi, which showed that the prevalence of odontoma was 0.24–1.21%

and more frequently in the maxillary than in the mandible [26]. However, the sample size of odontoma was small, making it prone to statistical errors, thus warranting subsequent studies with a larger sample size.

This study has some limitations. The sample selected for this study was drawn from a population of children in China within a local dental hospital. We will collaborate with other hospitals to share data resources and conduct a multicentre study, expanding the geographical coverage and data diversity of the research, thus making the study more universal. Future studies with larger sample sizes and further longitudinal studies are necessary to confirm the results of this study. As clinicians, before building a consensus, we should pay attention to the possibility of delayed development of permanent teeth in clinical work. Further research is needed to shed light on potential differences between the general population or different ethnic groups.

Conclusion

The purpose of this study was to observe the occurrence of congenitally missing teeth, supernumerary teeth and odontoma in a Chinese paediatric group by panoramic radiography. In the study, we drew the following conclusions:

1. Dental agenesis may be a relatively common developmental anomaly in Chinese children and should be taken seriously in later clinical work.
2. Congenitally missing teeth were more prevalent in the mandible than in the maxilla, and in the anterior region than in the posterior region.
3. According to the number of congenitally missing teeth, hypodontia was the most common type, among which one or two congenitally missing permanent teeth were the most common.
4. In this study, the most common congenitally missing teeth were mandibular lateral incisors, followed by mandibular second premolars, maxillary lateral incisors and maxillary second premolars.
5. A higher prevalence was observed in males than in females, and in the maxilla than in the mandible. The most common position of supernumerary teeth was between the maxillary central incisors, followed by the maxillary anterior teeth.
6. The prevalence of odontoma was similar between sexes but was more common in the maxilla than in the mandible.

Abbreviations

SPSS	Statistical Package for the Social Sciences
CBCT	Cone-Beam Computed Tomography
FDI	Fédération Dentaire Internationale
χ^2	Chi-square
P-value	Probability Value
SD	Standard Deviation
IQR	Interquartile Range
EDA	Ectodysplasin A
BMP	Bone Morphogenetic Protein
MMP	Matrix Metalloproteinase
DNA	Deoxyribonucleic Acid
RNA	Ribonucleic Acid
PAX9	Paired Box 9
MSX1	Msh Homeobox 1
Axin2	Axis Inhibition Protein 2

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions

J.Y is responsible for conceptualization and methodology. Y.J.Z is responsible for collecting case studies. J.L.Z is responsible for conducting statistical analysis and data analysis. Z.X.S and J.Y.W are responsible for writing original drafts. Validation and writing review and editing. All the authors reviewed the manuscript.

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Data availability

All data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The study was approved by the Experimental Animal Welfare and Ethics Committee of Fujian Medical University (Approval No. 202050). Clinical trial number: 202050. Legal guardians and patients signed a detailed informed consent form. This study adhered to the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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