

ORIGINAL RESEARCH

Dental trauma patterns in the primary dentition in Beijing, China: a retrospective study

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Abstract

Background: Traumatic dental injuries (TDIs) in the primary dentition are frequently seen in the oral emergency department and may affect children's mastication, pronunciation, and aesthetic function, leading to tooth defects or loss. Also, severe TDIs may have a long-term impact on children's mental health, emotional control, and social ability. Thus, actions taken at the place of injury are important, considering that they may affect the prevention and treatment of TDIs. **Methods:** This retrospective study assessed children with TDIs who were initially diagnosed in a department of oral emergency in Beijing. Descriptive analyses were performed to obtain the distribution of gender, age, visiting date and time, number and tooth position of the injured teeth, and types of tooth injury. **Results:** A total of 9039 children, 5643 boys (62.4%) and 3396 girls (37.6%), with an average age of 3.5 years, were assessed. The incidence of primary dental trauma was highest from May to June and from September to October. The average number of daily visits on holidays was 4.65 ± 2.81 per day, and that on working days was 3.88 ± 2.42 per day ($p < 0.05$). The positions of traumatic teeth on both sides were approximately symmetrical, and maxillary central incisors were the most affected. Most patients (50.8% of cases) had only one traumatic tooth vs. 49.2% with two or more teeth injuries. In the injuries to the periodontal tissues, the incidence rates of subluxation and concussion were higher in the kindergarten child group (3–5 yr) and schoolchild group (≥ 6 yr) than in the baby group (0–2 yr) ($p < 0.05$). The incidence rates of avulsion and luxation in the schoolchild group were the highest, while the incidence rates of intrusive luxation in the baby group were higher than in other groups ($p < 0.05$). For injuries to dental hard tissue, incidence rates of complex crown-root fracture and complex crown fracture in the baby group were the highest. **Conclusions:** TDIs in primary dentition were most likely to occur on holidays and in warm seasons. Boys and children in the kindergarten group resulted as high-risk populations. Maxillary central incisors were the most affected. Different TDI patterns with high incidence varied in different age groups. Families, schools and kindergartens should strengthen the protection against dental trauma. Also, clinicians should be updated on treatment guidelines for TDIs in primary dentition.

Keywords

Traumatic dental injuries; Oral emergency; Primary dentition; Epidemiology

1. Introduction

Traumatic dental injuries (TDIs) are among the most common injuries treated in the oral emergency department. They frequently affect children and young adults and have been associated with the immature neuromotor system [1, 2]. In children aged 0–6 years, oral injuries account for 18% of all physical injuries, and the mouth is the second most common area affected [3]. According to a meta-analysis from 2018, the worldwide prevalence of TDIs in primary dentition was 22.7% [4]; however, the actual prevalence might be underestimated [5]. Repeated TDIs are also frequently seen in children [2,

6]. In patients who have suffered from TDIs in primary dentition, TDIs may affect mastication, pronunciation, and aesthetic function, leading to tooth defects or loss. Severe TDIs may have a long-term impact on children's mental health, emotional control, and social ability [7]. Thus, the prevention and treatment of dental trauma in children are very important.

In this study, we aimed to assess trauma patterns in the primary dentition in children with TDIs and the characteristics of TDIs in the primary dentition in one of the two 24-hour public emergency oral centers in Beijing, China, between 01 January 2017 and 31 December 2022. These data can help create preventive measures, reduce the number of trauma

cases, guide families, kindergartens, and schools to effectively prevent primary teeth trauma, and enable doctors to carry out more targeted propaganda and education to promote the healthy growth of children.

2. Materials and methods

2.1 Patients

This retrospective study assessed children with TDIs who were initially diagnosed in the Department of Oral Emergency, Peking University School and Hospital of Stomatology, between 01 January 2017 and 31 December 2022.

The inclusion criteria were as follows:

1. Patients' age range was 0–12 years old;
2. Patients with TDIs in primary teeth; TDIs were diagnosed based on the classification of Andreasen and Andreasen [8, 9]; the injuries to the periodontal tissues included concussion, subluxation, extrusive luxation, lateral luxation, intrusive luxation, avulsion; the injuries to the dental hard tissues and pulp included enamel infraction, enamel fracture, enamel-dentin fracture, complicated crown fracture, uncomplicated crown-root fracture, complicated crown-root fracture, and root fracture.

3. Patients with complete electronic medical records, including information on gender, age, visit time, chief complaint, examination, diagnosis and treatment.

The exclusion criteria were as follows:

1. Patients with incomplete electronic medical records;
2. Patients who had received treatment in other hospitals;
3. Patients who were returning after their initial visit.

A patient with TDI who came for treatment was counted as one, regardless of how many injured teeth he had simultaneously. However, the number of injured teeth was calculated based on the number of injured teeth.

Generally, children under 6 years old are categorized as preschool children [10]; however, in Beijing, children over 3 years old start attending kindergarten, so they were divided into three groups: baby group (0–2 yr), kindergarten child group (3–5 yr), and schoolchild group (≥ 6 yr).

2.2 Statistical analysis

Statistical analysis was performed using SPSS for Windows 21.0 (IBM Corp. Released 2012. Armonk, NY, USA). Descriptive analyses were performed to obtain the distribution of gender, age, visiting date and time, number and tooth position of the injured teeth, types of tooth injury, association with soft tissue injuries or maxillofacial bone fractures, and the numbers of associated bone fractures or associated soft tissue injuries. The number, percentage, mean, and standard deviation values were estimated for descriptive statistics. The Pearson Chi-square test, Paired-Samples *t*-test, nonparametric Kruskal-Wallis test, and nonparametric Mann-Whitney test were used ($p \leq 0.05$). Further pairwise comparisons were performed using the Bonferroni correction method. The level of significance was set at p -value < 0.05 .

3. Results

A total of 9039 patients (811 in 2017, 1344 in 2018, 1697 in 2019, 1654 in 2020, 1861 in 2021 and 1672 in 2022) with TDIs in primary teeth were included in this study. There were 5643 (62.4%) boys and 3396 (37.6%) girls with a mean age of 3.5 ± 1.9 years and 3.5 ± 1.8 years, respectively. The distribution of gender across different ages is presented in Fig. 1.

Most tooth injuries occurred in children aged 3–4 years old. There were more boys than girls in all age groups (Paired-Samples *t*-test, $p < 0.05$).

The distribution of dental trauma patients per month is shown in Fig. 2. The tooth injuries occurred most commonly between May and June and between September and October; the incidence rates significantly differed across months (Kruskal-Wallis Test, $\chi^2 = 77$, $p < 0.001$).

Chinese statutory holidays and weekends were recorded as holidays, while the rest were working days. The average number of daily visits on holidays was 4.65 ± 2.81 per day (3227 patients, 694 days), and on working days, it was 3.88 ± 2.42 per day (5812 patients, 1497 days); the difference was statistically significant (Table 1, Mann-Whitney U test, $Z = -5.804$, $p < 0.001$).

TABLE 1. Average number of daily visits on holidays and work days.

Year	NW	NH	DW	DH	ADW	ADH
2017	542	269	249	116	2.18	2.32
2018	886	458	250	115	3.54	3.98
2019	1103	594	250	115	4.41	5.17
2020	1069	585	249	117	4.29	5.00
2021	1205	656	250	115	4.82	5.70
2022	1007	665	249	116	4.04	5.73
Total	5812	3227	1497	694	3.88	4.65

NH: number of daily visits on holidays; *NW*: number of daily visits on work days; *DH*: number of holidays; *DW*: number of work days; *ADH*: Average number of daily visits on holidays; *ADW*: Average number of daily visits on workdays.

The distribution of dental trauma patients per hour is shown in Fig. 3. The peak time the doctors dealt with TDIs in the primary dentition was 8:00–11:00 and 19:00–21:00 every day (Kruskal-Wallis Test, $\chi^2 = 275$, $p < 0.001$).

The injured teeth of primary dentition were basically symmetrical. The upper central incisor was the most commonly affected tooth, followed by the upper lateral incisor, the lower central incisor, and the lower lateral incisor (Table 2, Kruskal-Wallis Test, $\chi^2 = 54$, $p < 0.001$). Most patients (50.8% of cases) only had one traumatic tooth; 49.2% of patients had two or more teeth injuries, while in one case, 12 teeth were affected (Table 3, Kruskal-Wallis Test, $\chi^2 = 54$, $p < 0.001$).

Among the primary tooth trauma, subluxation was the most common, followed by tooth concussion and lateral displacement (Supplementary Table 1, Kruskal-Wallis Test, $\chi^2 = 90$, $p < 0.001$).

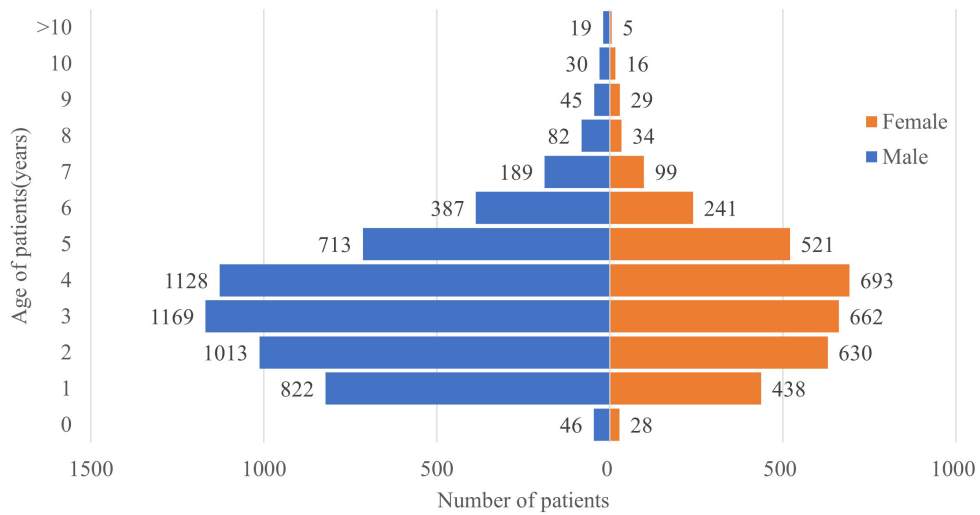


FIGURE 1. Distribution of gender across different ages.

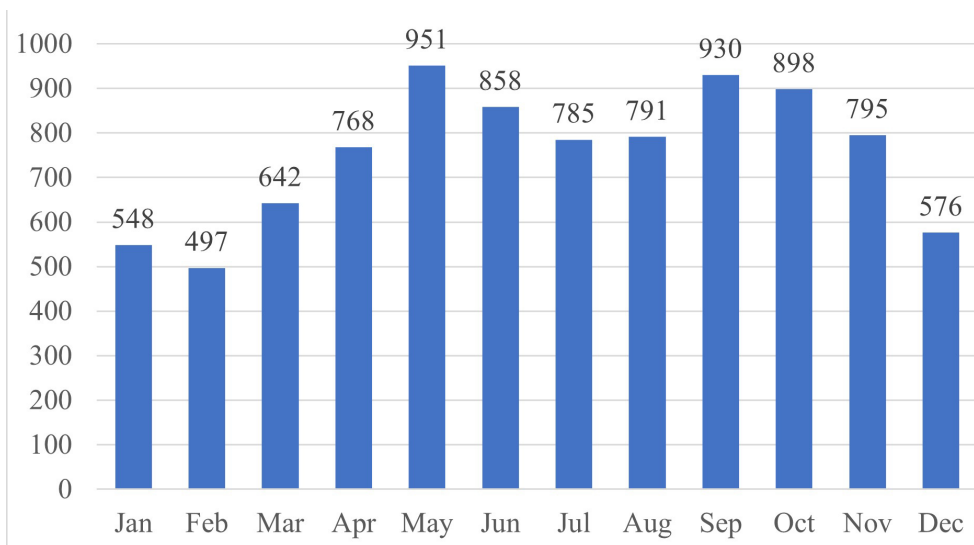


FIGURE 2. Distribution of dental trauma patients per month.

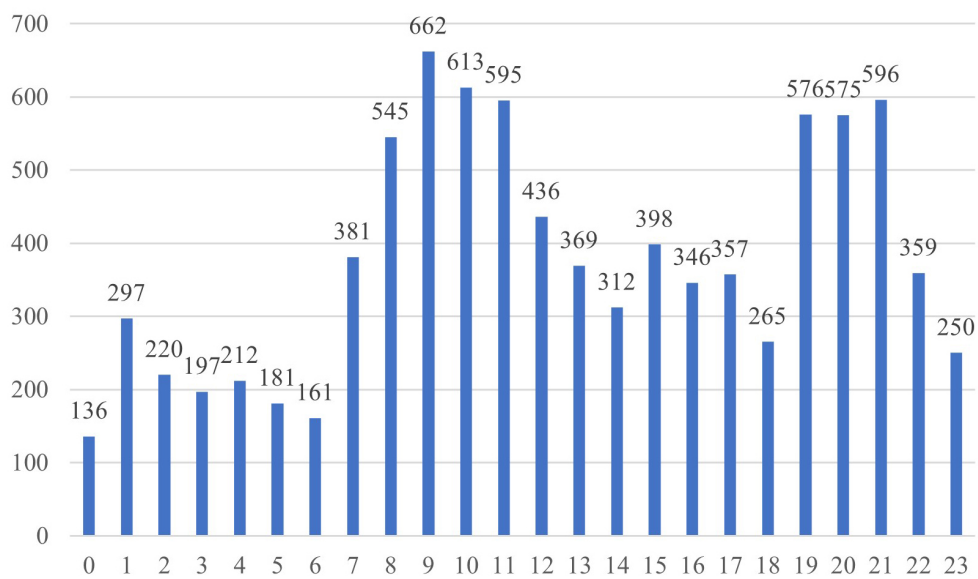


FIGURE 3. Distribution of dental trauma patients per hour.

TABLE 2. Position of traumatic primary teeth.

Position	Right upper central incisor	Left upper central incisor	Left upper lateral incisor	Right upper lateral incisor	Left lower central incisor	Right lower central incisor	Left lower lateral incisor	Right lower lateral incisor	Canine	Molar	Total
Number	5735	5612	1066	1014	420	409	193	170	396	139	15,154
Percentage	37.8	37.0	7.0	6.7	2.8	2.7	1.3	1.1	2.6	0.9	100.0

TABLE 3. Number of traumatic teeth for one patient.

Number of teeth	1	2	3	4	5	6	7	8	11	12	Total
Number	4596	3362	639	361	41	26	7	5	1	1	9039
Percentage	50.8	37.2	7.1	4.0	0.5	0.3	0.1	0.1	0.0	0.0	100.0

TABLE 4. Dental trauma and associated injury.

Diagnosis	D	S + D	S + F + D	F + D	Total
Number	7024	1891	91	33	9039
Percentage	77.7	20.9	1.0	0.4	100.0

D: Dental trauma; S: Soft tissue injury; F: Jaw Fracture.

Bivariate analysis comparing gender and dental trauma types showed no significant correlations except the incidence rate of enamel-dentin fracture, which was higher in girls (**Supplementary Table 1**, $p < 0.05$).

Bivariate analysis comparing age and dental trauma types showed significant correlations with some independent variables. For the injuries to the periodontal tissues, the incidence rates of subluxation and concussion were higher in the kindergarten and school-age children than in the baby group. The incidence rates of avulsion and luxation in the schoolchild group were the highest, while the incidence rates of intrusive luxation in the baby group were higher than in other groups. For the injuries to the dental hard tissues, babies had the highest incidence rates of complex crown-root and complex crown fractures (**Supplementary Table 1**, $p < 0.05$). In addition, 22.3% of the children with TDIs in primary teeth suffered from maxillofacial soft or hard tissue injury (Table 4).

4. Discussion

As there is a close spatial relationship between the apex of the primary tooth root and the underlying permanent tooth germ, TDIs in the primary dentition should be given more attention. Tooth malformation, impacted teeth, and eruption disturbances in the developing permanent dentition are only some of the issues that can occur following injuries to primary teeth and the alveolar bone [9, 11]. Intrusion and avulsion injuries are the most commonly associated with the development of anomalies in permanent dentition [9]. A previous study used the bibliometric method to analyze worldwide tendencies and perspectives in TDIs over two decades, finding that 66% of publications on TDIs concerned permanent teeth, while only 11.5% of articles focused exclusively on primary teeth [12]. Existing research has shown that the characteristics of TDIs in primary dentition may vary between countries and that local environmental, behavioral, and cultural diversities of countries

could influence TDIs [13–15]. For example, a study that included children with TDIs in primary teeth conducted at the University Dental Clinic of Vienna (Austria) between 2014 and 2016 revealed that upper central and lateral incisors were the most frequently affected teeth, and boys were significantly more affected than girls [14, 16]. Similar results were reported by an Italian study that included 265 children (89%) with dental trauma (DT) [17]. Interestingly, Tewari *et al.* [18] performed a meta-analysis to estimate the prevalence of TDIs in India, finding a slightly higher prevalence of TDIs in girls than boys younger than ≤ 6 ; the most common causes of TDIs were falls, and the most frequent location was home. Still, few reports have focused on TDIs in primary dentition in China.

TDIs in primary dentition are highly prevalent and can negatively impact the oral health-related quality of life in preschool children [19–21]. Besides caries, a traumatic dental injury is the most common reason for visiting a pediatric dentist. Moreover, the apparent decrease in the occurrence of caries, as evidenced by epidemiologic studies in developed countries, suggests that tooth injuries may become the leading cause of consultation in pediatric dental practice [6]. In this study, the number of TDIs cases has increased on a yearly basis.

Children are particularly vulnerable to traumatic injuries to the primary teeth in their first years of life, which is when they begin to walk and socialize. In this study, the peak age range for primary TDIs was 3–4 years old, which is consistent with other studies [22, 23]. Concerning age, different authors have identified the period of 1–4 years as the most vulnerable period, with the peak incidence between 10 and 24 months [24–28]. During this period, children begin their first independent movements, learn how to walk and develop their motor skills [24, 29, 30]. According to some studies, dental trauma commonly occurs in children aged 4–5 years old. At this age, children are more active and independent and, therefore, more susceptible to dental trauma [22, 31, 32]. In

this study, we assessed children with dental trauma treated in the emergency department of a specialized hospital in Beijing. In Beijing, children usually enter kindergarten at the age of 3 and primary school at the age of 6. Following the development of the economy and the improvement of the economic level, society and parents have come to pay more attention to the care of young children. Before entering kindergarten, children are usually cared for by at least one adult, which may explain the low incidence of dental trauma in young children. On the other hand, school-age children with TDIs have access to the school clinic and may eventually be recommended to seek medical attention at a specialized hospital.

Concerning the type of lesion, the alveolar process in preschool children is relatively flexible and characterized by large bone marrow spaces. Furthermore, the periodontal ligament, which acts as a “physiological hammock”, is very elastic, so the teeth are held in place less firmly. As a result, in the event of a slight traumatic injury, the teeth are displaced rather than fractured [26, 33]. This could explain the considerable difference in prevalence we observed for the injuries to the periodontal tissues in the primary teeth and those affecting the dental hard tissue and/or pulp. Other studies [26, 34, 35] revealed that periodontal ligament damage is the most common type of lesion in primary dentition. In line with this, subluxation was the most frequently observed dental trauma affecting the primary dentition in our series, followed by concussion, then lateral luxation. Similarly, other authors consider luxation of any degree of severity as the most frequent injury to the primary teeth [16, 24, 34, 36]. The incidence of avulsion and luxation was significantly higher in the schoolchild group than in the other two groups, which may be because the upper and lower anterior teeth of children in the primary school age group are in the replacement stage, the root of the teeth is already absorbed, and the teeth are loose.

The proportion of complicated crown-root and complicated crown fractures in the baby group (10.7%, 11.4%) was higher than in the other two groups (3.2%, 2.6% in the kindergarten child group, and 1.2%, 0.7% in the schoolchild group). At the time of eruption of the teeth, the enamel calcification is incomplete, and an additional 2 years are required for the calcification process to be completed in the oral cavity [37], which increases the hardness of the teeth. Therefore, the deciduous front teeth in the baby group have not yet been sufficiently calcified, making them more prone to breakage during trauma, while the permanent front teeth of school-age children are about to erupt, and the roots of the deciduous teeth begin to absorb, making them more prone to tooth loosening during trauma. However, infants and children are young and have poor coordination, so there are often different treatment plans for these types of injuries, depending on the child’s maturity and ability to tolerate procedures. These treatments should always be discussed with the parents. According to the International Association of Dental Traumatology (IADT) guidelines [9], an experienced and skilled child-oriented team should perform the treatment. No treatment may be the most appropriate option in emergencies, but only when there is the potential for rapid referral (within several days) to the child-oriented team.

Our results showed that the boys were affected more by

dental trauma than girls in all age groups, which corroborates work carried out by other researchers [13, 16, 24, 38]. This may be related to social roles and genetic environment differences, as male children are encouraged more to participate in activities that require physical activity, have higher dopamine and epinephrine levels, and have higher tendencies towards violence [39, 40]. Also, this could be related to the fact that girls are generally more mature in their behaviors than boys [10, 39]. However, other studies reported no obvious gender differences. Also, gender differences in sports accident-related trauma have decreased since more females have started to show interest in different sports activities. There are also reports suggesting that gender was related to the type of trauma, and male children are more prone to injuries to dental hard tissue and pulp [39, 41]. In our study, girls had a higher incidence rate of enamel-dentin fracture, while gender and the other dental trauma types had no significant difference. In their study, Traebert *et al.* [42] found no significant difference between girls and boys in risk factors for TDIs, which is a characteristic of modern Western society. Based on the conclusions of the above research, U. Glendor *et al.* [6] argued that human activity and environment may have a more significant impact on TDIs compared to gender. Different studies have come to different conclusions on the impact of gender on the types of TDIs, which may be because the research subjects were from different social and economic environments, and their guardians may have different educational and social expectations for young children. Therefore, the impact of gender on TDIs may need to be considered comprehensively based on the above factors.

The present study found that the children were the most susceptible to TDIs during early summer (from May to June in Beijing) and autumn (from September to October in Beijing). Some studies reported that primary TDIs increased in children along with outdoor activities facilitated by high temperatures [13, 38]. Just like the maxillofacial soft tissue injuries [43, 44], the incidence of TDIs in warm seasons was higher than in cold seasons. The month with the highest incidence of trauma was May, followed by September and October; the lowest incidence of primary TDIs was detected in February and January. In northern China, May, September and October are the most comfortable months, while January and February are the coldest. People are inclined to stay indoors during very hot or cold periods [44]. In China, preschool children rarely participate in intense snow and ice sports, and guardians pay more attention to protection in winter, which might explain the lower incidence rate of primary TDIs during this time of year. Numerous reports have indicated that soft and hard tissue injuries in the maxillofacial region are higher in warm seasons than in cold seasons unless in some countries where the temperature changes are not significant throughout the year, and the distribution is similar throughout the four seasons [45, 46].

The average number of daily visits to primary dental trauma patients was significantly higher on holidays than working days, which is similar to the results of our previous study on maxillofacial soft tissue injuries and could be because parents who do not need to work have more time to take their children to participate in sports and outdoor activities during holidays.

The peak period when patients sought medical treatment for dental trauma was in the morning and evening, which is mainly due to work-related issues of the parents and failure to identify trauma immediately. Delays in seeking care after dental trauma are common in all countries [31, 46, 47]. The time elapsed between the child's dental trauma and seeking professional medical care was very high and was related to the education level of the guardian, the level of awareness of the child's oral health care, and the frequency of parents seeking dental care within 24 hours after trauma [48, 49]. Considering that when a child is injured, their emotional state needs to be managed, which also puts their parents in an anxious state, these factors have an impact on the time between the occurrence of the dental trauma and seeking professional medical care. For very young patients, this time is crucial as it may affect the prognosis of the injured tooth [33].

Similar to previous research results, the injured teeth in this study were basically symmetrical, and the maxillary central incisors were the most vulnerable [25, 50], followed by the lateral incisors, possibly because the upper incisors are located in the prominent part of the face. Most authors have reported a strong correlation between protrusion, incompetent lip seals, and dental trauma in both the primary and the permanent dentition [51, 52].

5. Conclusions

The peak age range for primary TDIs was 3–4 years old. The incidence rate of primary TDIs was higher in boys than in girls. The condition occurred frequently in early summer and autumn. The incidence of primary TDIs was higher on holidays than on weekdays. The maxillary central incisors were the most vulnerable, and the incidence of subluxation was the highest.

AVAILABILITY OF DATA AND MATERIALS

Some data generated or analyzed during this study are included in this published article. The other data analyzed during the current study are not publicly available due to medical record information security but are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS

JB and MWH—contributed to the conception, design, and interpretation of data. XY, XTW and HQG—collected and analyzed the data. XY, XTW, JB and HQG—were involved in drafting the manuscript and revising it critically for important intellectual content. JB and MWH—agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. XY and XTW—contributed equally to the study and are co-first authors. All authors read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted with approval from the Ethics Committee of Peking University School and Hospital of Stomatology (PKUSSIRB-202054051). Informed consent was waived by the Ethics Committee.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at <https://oss.jocpd.com/files/article/1875059884700909568/attachment/Supplementary%20material.xlsx>.

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