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Original Article

Epidemiological characteristics and disease burden of pediatric caries treatment under general anesthesia in China: A 3-year retrospective study

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Abstract

Background: The global demand for pediatric caries treatment under general anesthesia (PCTGA) has been increasing, driven by the rising incidence of dental caries in young children and adolescents and the challenges posed by non-cooperative pediatric patients. This study aimed to examine the epidemiological features and disease burden of PCTGA in China during the COVID-19 pandemic.

Methods: Data were collected from the medical record discharge summaries of patients admitted to three children's hospitals affiliated with the Futang Research Center for Pediatric Development between January 1, 2020, and December 31, 2022. Information gathered included patient sex, age, region, year of hospitalization, and hospitalization costs.

Results: A total of 2707 cases were reviewed, representing 0.43% (2707/634 597) of all hospital admissions during this time. The male-to-female ratio was 1.43:1. Most PCTGA hospitalizations occurred in the 4–6-year age group. The COVID-19 pandemic influenced both case numbers and monthly hospitalizations. Childhood autism was the most common comorbidity in children requiring PCTGA. The median hospitalization cost was 15 201.94 RMB.

Conclusion: This study provides valuable insights into the epidemiological characteristics and disease burden of PCTGA in China from 2020 to 2022, offering a better understanding of its impact during the pandemic.

Keywords: Dental caries, Anesthesia, General, Cost of illness, COVID-19 pandemic

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Introduction

Dental caries is among the most prevalent childhood diseases,[1] with untreated decay in primary teeth impacting 620 million children globally.[2] According to the 2017 findings of the 4th National Oral Health Survey conducted in mainland China, the prevalence of caries in children aged 3 to 5 years is alarming at 62.5%.[3] Children with caries, particularly early childhood caries (ECCs), often require systematic treatment[4]; however, the noncompliance of pediatric patients is a problem that cannot be ignored when planning pediatric treatment. Childhood dental fear (CDF) refers to the psychological state of tension, fear, and depression children with oral diseases have when faced with dental treatment plans. Epidemiological surveys have shown that the incidence of CDF ranges from 5%–80%.[5] Although most children with CDF can be guided through treatment with routine behavioral management, it is sometimes still difficult to achieve satisfactory results.[6] Therefore, how to allow children with CDF to receive treatment is an ongoing challenge for pediatric dentists.

General anesthesia in dentistry serves as a behavioral management strategy, using sedative medications to safely induce unconsciousness in pediatric patients under close monitoring.[7,8] This approach facilitates the completion of dental procedures without the need for active cooperation. Pediatric caries treatment under general anesthesia (PCTGA) enhances treatment quality and alleviates dental

anxiety in young patients.[9] Additionally, PCTGA enables the comprehensive resolution of all oral health issues in a single session.[10] As childhood dental caries has become more prevalent, the global demand for PCTGA has risen significantly.[11,12] PCTGA was first performed at the Hospital of Stomatology of Peking University School and in 1999 in mainland China and has attracted increasing attention and recognition from pediatric dentists because of its outstanding advantages. Over time, however, the primary location of PCTGA has shifted from dental clinics and stomatology hospitals to general pediatric hospitals.[8] To qualify for performing PCTGA, a medical institution must ensure adequate space to accommodate the required equipment and healthcare personnel[13]; however, most stomatology departments in general children's hospitals lack the appropriate equipment, space, and anesthesia personnel. Therefore, children treated in the stomatology departments of general children's hospitals usually undergo PCTGA in the operating room as inpatients, which is the premise of the present study.

COVID-19 is a highly contagious disease wreaking havoc worldwide. During this pandemic, both ECC-related hospitalization and disease burden were affected.[14] In Zhejiang Province, China, the ECC rate among children aged 3 to 5 years was 57.51%, significantly exceeding the rates observed in developed countries such as Japan (3 years: 9%; 5 years: 39%), the UK (5 years: 23%), and the USA (2–5 years: 21%).[15] To provide a more thorough understanding of the epidemiological characteristics and healthcare burden associated with PCTGA in mainland China, we utilized hospital medical records to conduct a multicenter retrospective study. We pulled patients' medical data from electronic medical records in the form of a face sheet of discharge medical records (FSMRs),[16] which can be used as reference material for hospitals or for related policy decisions by associations or governments.

Methods

Data sources

For this retrospective study, patient discharge data were retrieved from the FUTURE database, with further details published elsewhere previously.[17] The study received approval from the Ethics Committee of Beijing Children's Hospital, Capital Medical University (2020-k-10). Data spanning January 2020 to December 2022 were collected from three hospitals: Xi'an Children's Hospital (Northwest China), Shenzhen Children's Hospital (South China), and Children's Hospital of Nanjing Medical University (East China), all affiliated with the Futang Research Center of Pediatric Development.

Inclusion and exclusion criteria

Inclusion criteria

- Patients hospitalized with a primary diagnosis of "dental caries," "rampant caries," "ECCs," or "caries."
- Patients 1–18 years of age upon admission. The selection of the age range was based on relevant clinical research literature conducted in children's hospitals.[18,19]

Exclusion criteria

- Patients lacking complete vital information, such as sex, age, primary diagnosis, or healthcare burden.
- Operations not related to the treatment of dental caries.

Variables and outcomes

The variables collected from the FSMRs included sociodemographic and geographic variables, admission details, primary and secondary diagnoses, and patient hospitalization costs. Hospitalization costs were expressed in RMB, which stands for "Renminbi," the official currency of China, also known as the Chinese yuan. The cohort's epidemiological profile was analyzed by sex, age group, hospitals, year of hospitalization, and urban/rural area. Hospitalized patients were categorized into four age groups (toddlers: 1–3 years, preschool children: 4–6 years, school-aged children: 7–12 years, and adolescents:13–18 years).

Statistical analysis

Categorical variables, including sex, age, regional distribution, and year of hospitalization, were described as numbers and percentages, while combined systemic diseases were described as numbers. Hospitalization expenses were reported as median with interquartile range (IQR). Group differences in unordered categorical variables were analyzed using the chi-square test, whereas the Wilcoxon test was applied for comparisons involving ordered categories or data without a normal distribution. Statistical analyses were conducted with JMP Pro 17, and results with a *P*-value below 0.05 were deemed statistically significant.

Results

Demographics

We searched the FUTURE database using the aforementioned terms and gathered information on a total of 2707 children who underwent PCTGA at the three included hospitals between January 1, 2020, and December 31, 2022 (Table 1). Among the 2707 patients, 1594 (58.88%) were males, and 1113 (41.12%) were females, resulting in a male-to-female ratio of 1.43:1 (Table 1). Additionally, the proportion of males was higher than that of females when evaluated based on the following factors: residence, hospital, year of hospitalization, and age group. Among them, there were statistical differences in gender ratios among different hospitals and age groups (Figure 1A–D). Most patients (71.26%, 1929 cases) were aged 4–6 years,

Table 1. Demographic information of children receiving PCTGA between January 1, 2020, and December 31, 2022

Categories	Hospitalization (*n*, %)	
No. of patients	2707	
Gender		
Male	1594	58.88%
Female	1113	41.12%
Age (y)		
1–3	619	22.87%
4–6	1929	71.26%
7–12	149	5.50%
13–18	10	0.37%
Hospitals in FUTURE database (Region)		
Xi'an Children's Hospital (Northwest China)	618	22.83%
Shenzhen Children's Hospital (South China)	1259	46.51%
Children's Hospital of Nanjing Medical University (East China)	830	30.66%
Year of hospitalization		
2020	677	25.01%
2021	1217	44.96%
2022	813	30.03%
Residence		
Rural	730	26.97%
Urban	1977	73.03%
Expense (RMB, median IQR)	15201.94 (12819.51–17757.46)	

followed by children aged 1–3 years (22.87%, 619 cases), 7–12 years (5.50%, 149 cases), and 13–18 years (0.37%, 10 cases).

Regionally, Shenzhen Children's Hospital (South China) admitted the highest proportion of patients, at 46.51% (1259 cases), followed by the Children's Hospital of Nanjing Medical University (East China) with 30.66% (830 cases) and Xi'an Children's Hospital (Northwest China) with 22.83% (618 cases). The annual number of hospitalizations for PCTGA rose from 2020 to 2021, with 44.96% (1217 cases) of admissions occurring in 2021, though numbers declined in 2022 compared to the previous year. Urban-dwelling children accounted for 73.03% (1977 cases), while rural residents comprised 26.97% (730 cases) (Table 1).

Ratios of hospitalizations for PCTGA by hospital, residence, age, and year

We analyzed the ratios of hospitalizations for PCTGA based on hospitals, residence, age groups, and years, comparing them to the total hospitalizations. As shown in Figure 2A, the highest ratio of hospitalizations based on hospital was at Shenzhen Children's Hospital (0.60%, 1259/208 223), while those for Children's Hospital of Nanjing Medical University (0.39%, 830/215 060) and Xi'an Children's Hospital (0.29%, 618/211 314) were similar. Based on residence, the hospitalization rates for urban vs. rural children were 0.54% (1968/362 106) vs. 0.27% (729/272 464), respectively (Figure 2B). The highest hospitalization ratio for PCTGA was recorded among children aged 4–6 years, reaching 1.15% (1929/167 764), followed by children aged 1–3 years, 7–12 years and 13-18 years, at 0.36% (619/174 096), 0.09% (149/166 518), and 0.03% (10/33 982) respectively (Figure 2C). Meanwhile, we found that the rate of PCTGA-related hospitalizations increased annually from 0.34% (677/198 459) in 2020 to 0.55% (1217/223 200) in 2021, and decreased to 0.38% (813/212 938) in 2022 (Fig. 2D). There were statistical differences in the ratio of hospitalizations for PCTGA in terms of hospital ($P < 0.0001$), residence ($P < 0.0001$), age group ($P < 0.0001$) and year of hospitalization ($P < 0.0001$).

Seasonality of PCTGA-related hospitalizations

As shown in Figure 3, the number of admissions for children undergoing PCTGA may be seasonal, as hospitalizations appeared to peak in December in 2020 and 2021 (Figure 3). The sudden decrease in the number of children undergoing PCTGA in February 2020 and December 2022 may have been related to the COVID-19 epidemic.

Combined systemic diseases

To determine the status and safety of PCTGA in children with combined systemic diseases, we evaluated the secondary diagnoses listed in the FSMRs. The top six combined systemic diseases and associated number of patients are listed in Table 2. Reviewing the secondary diagnoses indicated that children with the following systemic diseases can still undergo PCGTA: childhood autism, mental retardation, dwarfism, congenital heart disease, upper respiratory tract infection, and asthma.

Hospitalization expenses

We analyzed the hospitalization cost of PCTGA, and the results are shown in Table 3. The median cost for all included patients was 15 201.94 RMB (IQR 12 819.51–17 757.46 RMB). As a portion of the cost of surgery at Shenzhen Children's Hospital was collected in the outpatient department, the financial information collected from the FSMRs did not truly reflect the total cost of PCTGA at this facility. As such, our statistical analysis of hospitalization expenses excluded data from the Shenzhen Children's Hospital, and since all children aged 13–18 years came from Shenzhen Children's Hospital, the hospitalization expenses of this age group were not statistically analyzed. The median hospitalization costs were 15 201.44 RMB (IQR, 12 730.76–17 622.81 RMB) for male patients and 15 214.34 RMB (IQR, 12 836.33–17 889.99 RMB) for female patients, with no statistical significance ($\chi^2 = 0.31$, $P = 0.58$). Among age groups, the highest median cost was recorded for children aged 4–6

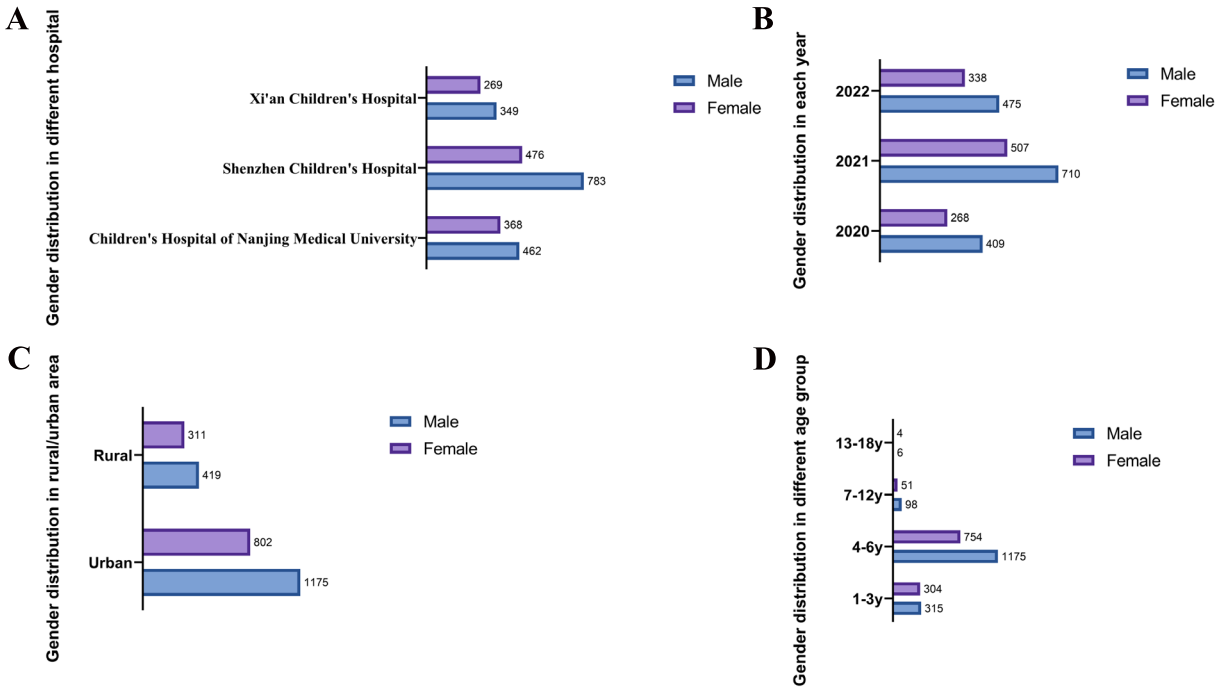

Figure 1. Gender proportion of hospitalized children for PCTGA in different hospitals (A) ($\chi2 = 10.73$, $P < 0.05$), years of hospitalization (B) ($\chi2 = 0.87$, $P = 0.65$), residence (C) ($\chi2 = 0.99$, $P = 0.32$), and age groups (D) ($\chi2 = 9.36$, $P < 0.05$). PCTGA, pediatric caries treatment under general anesthesia

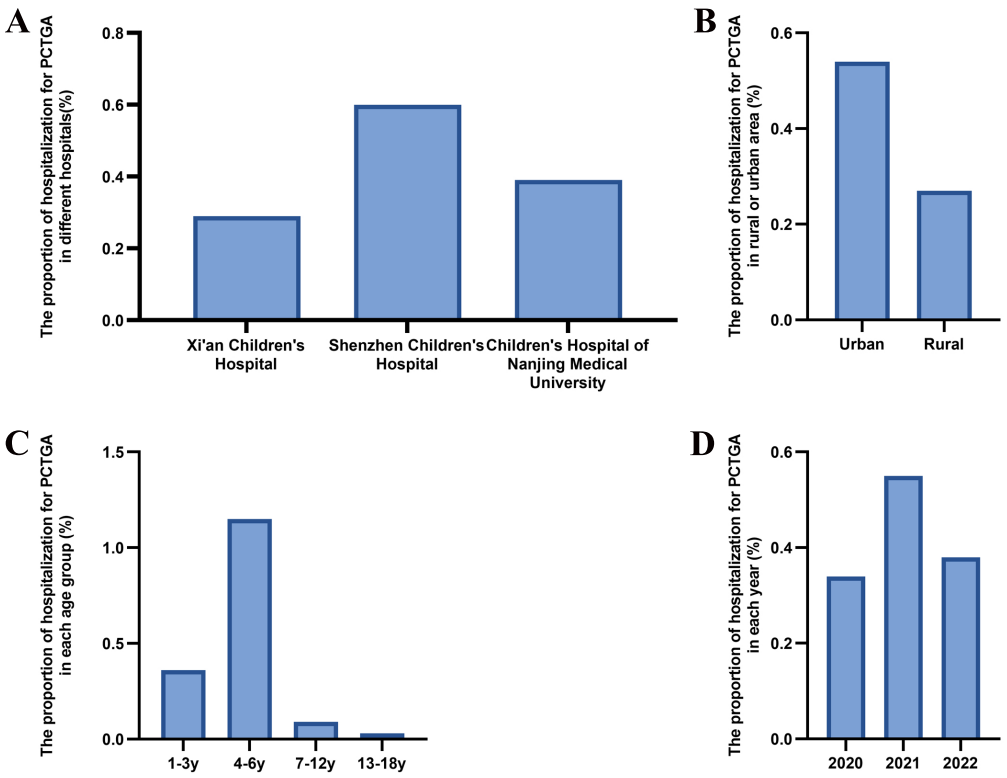

Figure 2. The ratio of hospitalizations for PCTGA to total hospitalizations in different hospitals (A) ($\chi2 = 253.29$, $P < 0.0001$), residence (B) ($\chi2 = 282.98$, $P < 0.0001$), age groups (C) ($\chi2 = 2704.04$, $P < 0.0001$), and years (D) ($\chi2 = 118.17$, $P < 0.0001$). PCTGA: pediatric caries treatment under general anesthesia

years, at 15 571.73 RMB (IQR 13 171.99–18 022.91 RMB), followed by the 1–3-year group at 14 528.72 RMB (IQR 12 265.60–17 209.90 RMB) and the 7–12-year group at 13 637.36 RMB (IQR 11 117.42–15 976.58 RMB). Significant differences in hospitalization expenses were observed ($\chi^2 = 32.1$, $P < 0.01$). For facility, the median hospitalization expenses were 15 092.14 RMB (IQR, 12 928.22–17 530.54 RMB) for Xi'an Children's Hospital

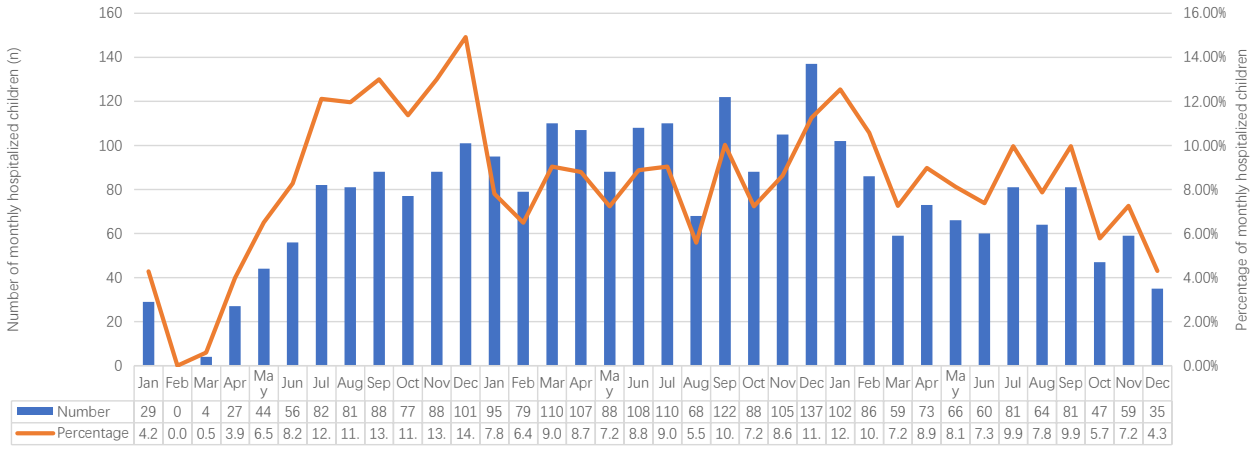

Figure 3. Monthly cases of children hospitalized for PCTGA from January 1, 2020, to December 31, 2022. PCTGA, pediatric caries treatment under general anesthesia

Table 2. Combined systemic diseases for children receiving PCTGA.

Combined systemic diseases	No. of patients (*n*)
Childhood autism	12
Mental retardation	10
Dwarfism	10
Congenital heart disease	9
Upper respiratory tract infection	5
Asthma	3

and 15 156.24 RMB (IQR, 12 548.39–17 740.70 RMB) for Children's Hospital of Nanjing Medical University, with no statistical significance ($\chi^2 = 0.73$, $P = 0.39$). For year of hospitalization, the expense in 2021 was the highest, and no statistical significance was found ($\chi^2 = 5.4$, $P = 0.07$).

Discussion

Previous studies on PCTGA have focused on a particular hospital as the research object or studied the success rate of a certain treatment, such as pulpectomy under general anesthesia,[20] or parental acceptance.[21,22] To the authors' knowledge, this is the first multicenter study to investigate the epidemiological features and disease burden of patients undergoing PCTGA. The study period we selected for our analysis ran from January 2020 to December 2022. It coincided with the time frame of the COVID-19 pandemic, during which routine pediatric dental care was largely halted due to the heightened risk of virus transmission.[23,24] Research by Tewfik et al revealed that the pandemic significantly curtailed general anesthesia procedures for pediatric patients with special needs in 2020, with activities gradually returning to pre-pandemic levels by 2021,[25] which is consistent with the results of our research, as evidenced by a proportion of 44.96% in 2021 compared with 25.01% in 2020.

The patients in this study were aged 1–18 years, as the complete eruption of deciduous teeth occurs after 1 year. Earlier research indicated that children aged 0–4 years are 1.3 times more likely to require PCTGA than those aged 5–9 years.[11] In the present study, approximately 94% of the patients were < 6 years old, highlighting the urgency of developing enhanced dental health prevention strategies for preschoolers. Barriers such as socioeconomic challenges, limited insurance coverage, and geographic constraints often hinder timely dental care for children. Therefore, oral health professionals and policymakers must prioritize resources for promoting oral health and implementing early interventions to combat dental caries in young children.[26]

In the present study, children living in urban areas accounted for 73.03% of the hospitalized patients, compared to 26.97% in rural areas. This urban-rural gap may reflect disparities in healthcare access and varying levels of awareness regarding oral hygiene. At a broader level, managing dental caries often involves tertiary healthcare services, which tend to be limited, costly, and inconsistently structured. Prior research indicates that children aged 5–19 from lower-income families are twice as likely to experience caries compared to those from wealthier households.[27] Enhancing rural children's oral health and ensuring timely treatment of pediatric caries would require strategies such as raising oral health awareness, improving access to PCTGA, and lowering the costs associated with general anesthesia.

The financial burden of PCTGA is a significant global concern. In Canada, the typical cost for treating ECCs under general anesthesia averages $1564 (The amount of $1564, converted to RMB, would be 11 372 RMB, based on the current exchange rate).[28-30] In the present study, our sample demonstrated the high financial burden of PCTGA in mainland China, with median hospitalization costs of 15 201.94 RMB. These substantial expenses are primarily attributed to the direct costs of dental procedures and anesthesia services for pediatric

Table 3. Basic information on hospitalization expense by gender, age, hospital, and year of hospitalization in Xi'an Children's Hospital and Children's Hospital of Nanjing Medical University

Categories	Expense (RMB), median (IQR)	χ^2	*P*
Gender			
Male	15201.44 (12730.76–17622.81)	0.31	0.58
Female	15214.34 (12836.33–17889.99)		
Age (y)			
1–3	14528.72 (12265.60–17209.90)	32.1	<0.01
4–6	15571.73 (13171.99–18022.91)		
7–12	13637.36 (11117.42–15976.58)		
Hospitals in FUTURE database (Region)			
Xi'an Children's Hospital (Northwest China)	15092.14 (12928.22–17530.54)	0.73	0.39
Children's Hospital of Nanjing Medical University (East China)	15156.24 (12548.39–17740.70)		
Year of hospitalization			
2020	15260.69 (12610.07–17661.20)	5.4	0.07
2021	15321.59 (13053.94–17872.97)		
2022	14659.31 (12468.93–17517.38)		

patients, with other indirect costs, which we were unable to report in the present study. We also found no statistical difference in hospitalization expenses among different hospitals, regions, and year of hospitalization, but there were statistical differences among different age groups. Specifically, hospitalization costs for children aged 4-6 years were notably higher than other age groups, with a median cost of 15 571.73 RMB (IQR: 13 171.99–18,022.91 RMB). This might be due to the increased incidence of primary dental caries, especially in occlusal and adjacent surfaces of primary molars, which increased the number of teeth treated and treatment costs.

The present study does have a few limitations that should be considered. First, many specialized dental hospitals and private clinics also provide PCTGA and the medical records from these facilities were not included in our analysis, making our results not comprehensive. Additionally, the data available in the FSMRs was considerably limited; therefore, additional factors, such as the number of treated teeth and a detailed breakdown of the total cost, might not have been available. Nonetheless, the large multicenter sample size in the present study offered valuable insights into the details of PCGTA in mainland China, which may prompt further research in this area. With the relaxation of COVID-19 restrictions, data collection will continue in future studies to provide a clearer understanding of the epidemiological and economic aspects of PCTGA.

Strengths and limitations

A key strength of this study is that it represents the first multicenter analysis in China of the epidemiological features and economic burden among pediatric patients undergoing PCTGA. However, one limitation is that the analysis did not include medical records from specialized dental hospitals and private clinics.

Conclusion

This study examined 2707 cases of children receiving PCTGA, representing 0.43% (2707/634,597) of all hospitalized patients between 2020 and 2022 at three children's hospitals. The male-to-female ratio was 1.43:1, with most cases occurring in the 4–6-year age group. The COVID-19 pandemic influenced the hospitalization rates and case numbers. Childhood autism was the most common comorbid condition in PCTGA patients. The median hospitalization cost was 15,201.94 RMB. These findings contribute to a better understanding of the epidemiological patterns and economic burden of PCTGA in China.

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Competing Interests
The authors have declared that no conflict of interest exists.

Data Availability Statement
The data are available upon request from the corresponding author.

Ethical Approval
The study is approved by the Ethics Committee of Beijing Children's Hospital of Capital Medical University (2020-k-10). Since this study does not involve the privacy of personal information such as names and addresses of children and only retrospectively collected indicators related to epidemiological analysis to conduct data analysis, patients' informed consent was waived. Our research data is completely anonymous and does not involve private patient information.

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