BMJ Open

Cross-sectional survey on dental caries among preschool children in Guangzhou city in 2022

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To cite: Xu Z, Zeng L, Liang Y, *et al*. Cross-sectional survey on dental caries among preschool children in Guangzhou city in 2022. *BMJ Open* 2025;**15**:e097334. doi:10.1136/bmjopen-2024-097334

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-097334).

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Received 29 November 2024
Accepted 24 February 2025

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ABSTRACT

Objective To investigate the prevalence of deciduous dental caries in preschool children aged 36–71 months as well as the eruption and caries status of permanent teeth in children aged 60–71 months in Guangzhou city, providing references for oral health work.

Design This study was a cross-sectional study design.

Setting The study was conducted in 34 kindergartens in the central and non-central urban areas of Guangzhou city.

Participants 14 883 preschool children aged 36–71 months in Guangzhou city were included in the ultimate analysis.

Main outcome measures The prevalence of dental caries and other indicators of deciduous teeth, eruption and caries status of permanent teeth in children aged 60–71 months.

Results The prevalence of dental caries in children aged 36–47 months, 48–59 months and 60–71 months were 41.6% (95% CI: 40.1%, 43.1%), 57.1% (95% CI: 55.8%, 58.5%) and 65.2% (95% CI: 64.0%, 66.4%), respectively. Mean decayed–missing–filled teeth increased with age, with differences between genders and areas. The percentage of permanent first molars and central incisors eruption in children aged 60–71 months differed, and caries conditions varied.

Conclusion The problem of early childhood caries in preschool children in Guangzhou city is prominent. Prevention should be strengthened from early life, and oral health education and publicity enhanced to narrow regional oral health gaps.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Large sample: A sample of 14 883 preschool children in Guangzhou, covering different urban areas, provides a solid basis for understanding oral health status.
⇒ Comprehensive data assessment: Thorough evaluation of various dental caries indicators and the percentage of eruption of permanent teeth offers a detailed view of children's oral health.
⇒ Insensitive examination standard: The WHO-based examination standard is less sensitive in detecting early caries compared with advanced systems, and the decayed–missing–filled teeth index has limitations.
⇒ Data collection flaw: Failed to gather data on children's caries-related knowledge and behaviours via surveys and lacked laboratory examination methods.

INTRODUCTION

Oral diseases rank among the most prevalent chronic diseases globally, affecting 3.5 billion people.[1] Early childhood caries (ECC) pertains to children under 6 years old who have one or more decayed primary teeth. This includes cases with or without cavity formation, regardless of whether the tooth is missing due to caries or has a filled tooth surface.[2] ECC is affected by a variety of elements, including dietary habits, behaviours related to oral health, socioeconomic status and biological factors.[3–6] ECC can lead to pulpitis or periapical periodontitis, resulting in the premature loss of primary teeth, which has a significant impact on the eruption of permanent teeth.[7] Additionally, ECC can also affect overall health and even have an impact on the child's psychological state.[8] Hence, understanding the prevalence of ECC in children and formulating reasonable preventive measures is of particular significance. Currently, the oral health condition of preschool children is a cause for concern, and ECC has become a global public health burden.[9] Approximately 532 million children globally were found to have untreated primary tooth caries in 2017.[9] An analysis of data from 193 countries from studies published between 2007 and 2017 indicated that the average prevalence rate of caries among children aged 3–6 years was 57.3%.[10] A systematic review that examined the prevalence of ECC in children worldwide from 1995 to 2019 found that the prevalence of dental caries among 80 405 children was 46.2%.[11]

China has implemented four national oral health surveys. However, the frequency of collecting caries data is only once every 10

years, which fails to capture the dynamic changes in oral health behaviours and status.[12] Additionally, significant regional differences exist in both oral health awareness and implemented policies, highlighting the need for in-depth studies at the local level. This brings us to the selection of Guangzhou, the vibrant capital city of Guangdong province, as our research site. Gross domestic product (GDP) is the final result of a region's production activities during a certain period of time. Over the past decade, Guangzhou has witnessed remarkable economic growth, with its per capita GDP surging from US$15 137 to US$22 840.[13] This economic prosperity has led to profound lifestyle changes, including an increased focus on early childhood education. As of 2022, there were 2223 kindergartens in Guangzhou, attended by over 600 000 children, providing a favourable educational environment for preschool children.[13] Such a rich educational resource provides an ideal setting for conducting comprehensive oral health studies on preschool children. In the domain of oral health, Guangzhou has been at the forefront of preventive initiatives. The long-running free pit and fissure sealing project for children's first permanent molars has achieved certain results. On this basis, the city is now actively expanding the promotion of local fluoride application techniques and conducting pilot programmes for comprehensive intervention of primary tooth caries in preschool children.

However, a crucial knowledge gap persists. Previous oral health surveys in Guangzhou have overlooked the age group of 3–4 years, leaving a significant portion of the preschool population unexamined.[14 15] Compounding this issue, other investigations were confined to small-scale efforts in specific areas or particular age cohorts, providing only a fragmented view.[16 17] To address this, the current study specifically targets preschool children aged 3–5 years. This age range is of particular importance for several reasons. First, it is the peak period for the occurrence of ECC, as children's dietary patterns change and their oral hygiene practices are still in the formative stage. Second, 5-year-old children are at a critical juncture where the eruption of permanent teeth begins. Therefore, this study investigates the prevalence of ECC among preschool children aged 3–5 years in Guangzhou city and the eruption situation of permanent teeth in 5-year-old preschool children. By precisely targeting this population and location, we aim to gain a deeper understanding of the current public health situation, and ultimately offer invaluable references for future oral health work in Guangzhou.

MATERIALS AND METHODS

Object selection and sampling design

The target subjects of this study were children aged 36–71 months attending kindergartens in the surveyed area. The selected city was Guangzhou, a mega-city in Guangdong province, southern China, with a population of 18.73 million. According to the urban planning

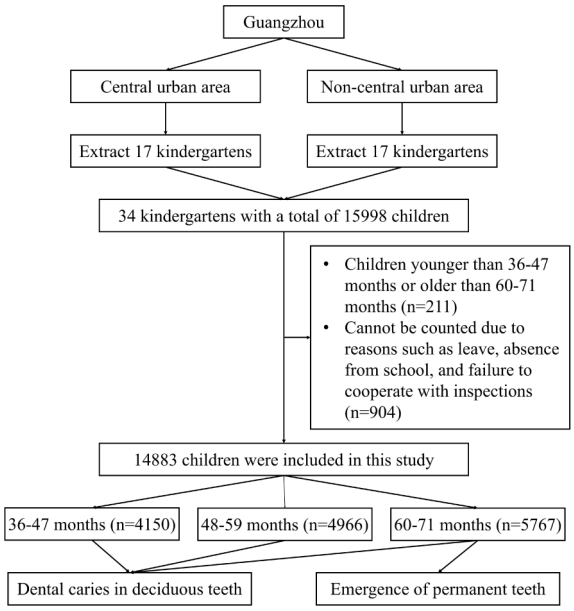

Figure 1 Flow diagram of the study.

of Guangzhou, the 11 districts of Guangzhou are divided into central urban areas and non-central urban areas. By considering the estimated prevalence of dental caries (p=62.5%, the prevalence of dental caries among children aged 3–5 years in the fourth National Oral Health Survey in 2015), the design effect (deff=3), the significance level (α=0.05), the margin of error (β=10%) and the non-response rate (20%) and stratifying by the central urban area, non-central urban area, male and female into four layers, the minimum required sample size for each age group was approximately 3458 people, totaling 10 374 people. To enhance the accuracy of the results, the sample size of this study was set at 14 883 people. In this study, 17 kindergartens were randomly selected from both the central urban area and the non-central urban area, respectively. The standard for selecting kindergartens was to choose registered kindergartens in each district, which can ensure that they had basic qualifications for running kindergartens and standardised management. Exclusion criteria: (1) kindergartens with too few children aged 36–71 months to meet the survey sample size. (2) Kindergartens unwilling to cooperate with the investigation work. Cluster sampling was conducted among children aged 36–71 months in 34 kindergartens to examine their oral health status (figure 1). Informed consent of each child's guardian has been obtained.

Inclusion criteria: (1) aged 36–71 months; (2) parents sign the informed consent form; (3) children can cooperate with the oral examination. Exclusion criteria: (1) children who cannot be examined due to school suspension, leave and other reasons. (2) Children requiring dental emergency treatment or with systemic diseases.

The oral examination method was carried out in accordance with the methods and standards of the WHO's 'Basic Methods for Oral Health Surveys' (fifth edition). The examiner and the recorder worked in

pairs. Children were examined under sufficient artificial light. The examiner wore a mask, a protective face shield and gloves and used instruments such as the Community Periodontal Index probe and a mouth mirror, combined with visual inspection and probing, to check the caries status of deciduous teeth. To ensure the accuracy of the examination, cotton swabs could be used to wipe off the soft deposits. In addition, the percentage of eruption of first permanent molars and permanent incisors in 5-year-old children was examined. The caries status and pit and fissure sealing status of the erupted teeth were checked. If the crown of the erupted tooth did not reach half, it was recorded as 'Erupted without record'. The survey form has been included as an (online supplemental file 1).

Four examiners from the School and Hospital of Stomatology of Guangzhou Medical University participated in the oral health survey training and passed the caries standard consistency test, with kappa values all above 0.8. Each examiner was paired with a recorder, and all recorders participated in the oral health survey record training and filled in the forms according to the unified record codes.

The prevalence of dental caries and the decayed–missing–filled teeth (dmft) index were used to evaluate the caries status and severity. Cavities were recorded as dt, teeth missing due to caries were recorded as mt and filled teeth were recorded as ft.[18] The prevalence rate of deciduous teeth caries=the percentage of the number of people with caries among the examined people. The calculation formula for the filling rate was: (total number of ft / total number of dt and ft) × 100%.[19] The Significant Caries Index (SiC) of deciduous teeth=the average caries of one-third of the population with the highest caries score.

Statistical analysis

Microsoft Excel 2021 was used to establish a database, and SPSS software (V.26.0) was used for statistical analysis. All statistical tests were two-sided tests, and the significance level was 0.05. The analysis excluded those children with incomplete data. First of all, we conducted a descriptive analysis. Count data were expressed as rates, and the caries status was exhibited as average dmft and the prevalence of dental caries. Then, the χ^2 test was used to test the correlation between the prevalence of dental caries and the selected variables. Since the mean caries did not conform to the normal distribution, non-parametric tests (Mann-Whitney test or Kruskal-Wallis H test) were used for comparison.

Patient and public involvement

Patient and public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

In this study, we invited 15 998 preschool children from 34 kindergartens in Guangzhou city to participate in the survey, and achieved a remarkable response rate of 93.0%. The comprehensive data regarding the caries-related aspects of 14 883 preschool children aged 36–71 months were presented in detail in table 1, figure 2 and online supplemental file 2. These data included a series of parameters such as the prevalence rate of ECC, the filling rate and the SiC.

Notably, as the age of the children increased from 36 to 47 months to 60–71 months, multiple caries-related indicators showed a continuous upward trend. Statistical analysis revealed that the differences among different age groups were highly significant ($p<0.001$). Additionally, significant differences in caries-related outcomes were observed when comparing different genders and urban areas. There was a statistically significant difference in terms of gender ($p<0.05$). However, the filling rate did not exhibit a significant gender-based difference. The prevalence of dental caries in non-central urban areas was higher than that of children in central urban areas. Moreover, with the increase in age, the filling rate of children in non-central urban areas gradually became lower than that of children in central urban areas, indicating the influence of regional factors on children's oral health status.

The distribution of caries teeth in children aged 36–71 months was shown in figure 2B. In children aged 36–47 months and 48–59 months, the highest prevalence of dental caries was observed in the upper primary central incisors, followed by the mandibular second primary molars. In children aged 60–71 months, the highest prevalence of dental caries was also in the upper primary central incisors, followed by the mandibular first primary molars, and the prevalence of dental caries of the mandibular central incisors was the lowest. It can be seen from figure 2C that almost all the affected anterior teeth were untreated caries.

For children aged 60–71 months, table 2 comprehensively depicted the development status of the first permanent molars and central incisors. This included the percentage of these teeth eruption in the maxilla and mandible, as well as the percentages of teeth without caries and without pit-and-fissure sealing. These data revealed notable differences in these parameters between the maxillary and mandibular teeth, offering valuable insights into the early-stage development of the permanent dentition and the oral health condition of this age group.

DISCUSSION

This study comprehensively investigated the dental caries status of preschool children aged 36–71 months in Guangzhou. The results revealed that the prevalence of dental caries and average dmft score of children in this age group remained relatively high, and both exhibited

Table 1 The status of early childhood caries of different ages, genders and residences

Age group	Variables	Number of subjects n (%)	Per cent affected (dmft>0) % (95% CI)	Filling rate % (95% CI)	Mean (SD) dmft	SiC (SD)
36–47 months	Gender					
	Male	2283 (15.3)	41.9 (39.9, 43.9)	2.8 (2.3, 3.3)	1.7 (3.0)	4.9 (3.5)
	Female	1867 (12.5)	41.2 (39.0, 43.5)	3.5 (2.9, 4.2)	1.7 (3.1)	4.9 (3.6)
	Residence					
	Central region	2358 (15.8)	37.1 (35.2, 39.1)	2.6 (2.1, 3.1)	1.5 (2.9)	4.8 (3.5)
	Non-central region	1792 (12.0)	47.5 (45.2, 49.9)	3.6 (3.0, 4.3)	2.0 (3.2)	4.9 (3.6)
	Total	4150 (27.9)	41.6 (40.1, 43.1)	3.1 (2.7, 3.5)	1.7 (3.0)	4.9 (3.6)
48–59 months	Gender					
	Male	2705 (18.2)	56.0 (54.2, 57.9)	6.7 (6.1, 7.3)	2.8 (3.8)	7.1 (3.8)
	Female	2261 (15.2)	58.5 (56.4, 60.5)	7.4 (6.8, 8.1)	2.9 (3.9)	7.2 (3.8)
	Residence					
	Central region	2811 (18.9)	52.4 (50.6, 54.3)	7.5 (6.8, 8.1)	2.4 (3.5)	6.8 (3.6)
	Non-central region	2155 (14.5)	63.3 (61.3, 65.3)	6.7 (6.1, 7.2)	3.4 (4.2)	7.6 (3.9)
	Total	4966 (33.4)	57.1 (55.8, 58.5)	7.0 (6.6, 7.5)	2.8 (3.9)	7.2 (3.8)
60–71 months	Gender					
	Male	2986 (20.1)	63.8 (62.1, 65.5)	9.5 (9.0, 10.1)	3.6 (4.3)	8.8 (3.7)
	Female	2781 (18.7)	66.7 (65.0, 68.5)	9.4 (8.8, 9.9)	3.7 (4.3)	8.6 (3.7)
	Residence					
	Central region	3313 (22.3)	61.4 (59.8, 63.1)	10.7 (10.1, 11.3)	3.2 (4.1)	8.6 (3.8)
	Non-central region	2454 (16.5)	70.3 (68.5, 72.1)	8.2 (7.6, 8.7)	4.2 (4.5)	8.8 (3.6)
	Total	5767 (38.7)	65.2 (64.0, 66.4)	9.5 (9.1, 9.8)	3.6 (4.3)	8.7 (3.7)
36–71 months	Gender					
	Male	7974 (53.6)	54.9 (53.8, 56.0)	7.4 (7.0, 7.7)	3.1 (4.1)	7.3 (3.8)
	Female	6909 (46.4)	57.1 (56.0, 58.3)	7.8 (7.4, 8.2)	3.1 (4.1)	7.3 (3.8)
	Residence					
	Central region	8482 (57.0)	51.7 (50.6, 52.7)	8.3 (7.9, 8.6)	2.9 (4.0)	7.0 (3.8)
	Non-central region	6401 (43.0)	61.6 (60.4, 62.8)	6.9 (6.5, 7.2)	3.3 (4.2)	7.5 (3.9)
	Total	14 883 (100.0)	55.9 (55.1, 56.7)	7.6 (7.3, 7.8)	2.8 (3.9)	7.3 (3.8)

dmft, decayed–missing–filled teeth; SiC, Significant Caries Index.

an increasing trend with age. Similar trends had also been demonstrated in previous studies.[20–23] The development of dental caries was a gradual and cumulative process, reflecting the various influences that a specific dentition undergoes over an extended period.[24] As children grew older, the duration of their teeth's exposure to cariogenic environments lengthened. This accumulation of exposure time continuously increased the likelihood of caries occurrence, which was consistent with the role of time factors in the pathogenesis of dental caries.[25] Notably, the significant difference in the caries status between the central urban area and the non-central urban area is still concerning. In all three age groups, the prevalence rates in both the central urban area and the non-central urban area showed a significant upward trend. Moreover, with the increase in age, the prevalence of dental caries in the non-central urban area was higher and the filling rate was lower. This difference may be closely related to factors such as family income levels, parental education levels and the uneven distribution of urban and rural oral healthcare resources.[26–28]

In China, there are distinct differences in the dental caries prevalence and related indicators among children in different cities. Taking Guangzhou as an example, the dmft index of preschool children aged 60–71 months is 3.6, which is higher than that of Hong Kong (2.7) and Shanghai (2.46), but lower than the national average in China (4.24), as well as the values in Guangdong province (5.69), Xinjiang (5.16), Wenzhou (4.6), Huizhou (5.81), Guizhou (4.43), Zhejiang (5.75) and Sichuan (4.23).[20 24 29–35] In terms of the filling rate, the filling rate of children aged 3–5 years increased, with an overall rate

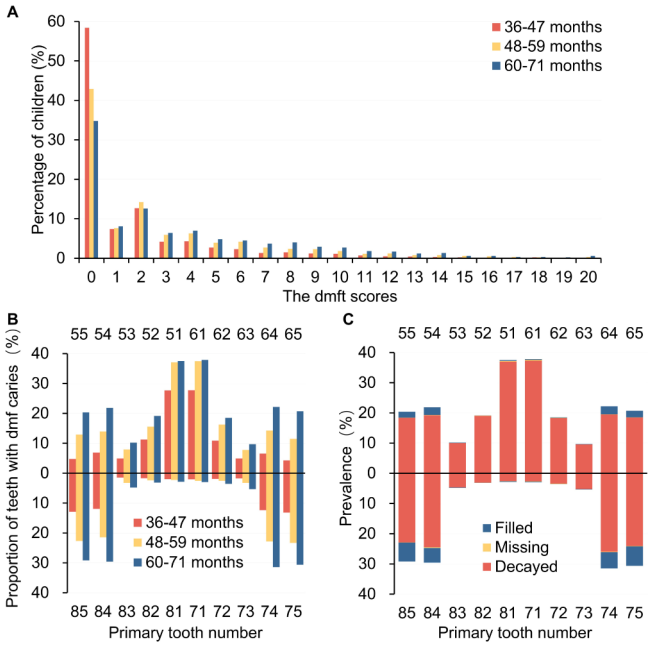

Figure 2 Frequency distribution, caries teeth distribution and prevalence of dental conditions in children aged 36–47 months, 48–59 months and 60–71 months. (A) The frequency distribution of dmft for children at 36–47 months, 48–59 months and 60–71 months. (B) Distribution of teeth with dmf caries of the children aged 36–47 months, 48–59 months and 60–71 months by tooth position. (C) Prevalence of 'Decayed', 'Missing' and 'Filled' teeth of each tooth of children aged 60–71 months. dmft, decayed–missing–filled teeth.

of 7.6% in Guangzhou in this study, which was higher than the national level (3.1%), the level in Guangdong province (1.25%) and the level in Sichuan province (0.98%), but lower than the level in Shenzhen (8.0%) and far from reaching the lower limit goal of WHO global oral healthcare (30%).[33 35–37] This difference is closely associated with factors such as regional economic development levels, relevant policies and the oral health awareness of caregivers.[20 23 38–40] For instance, Shanghai actively conducts oral health management during the 'first 1000 days of life', a critical period for the development of children's oral diseases. Since 2015, it has provided children with one oral examination and two applications of topical fluoride foam annually, along with long-term oral hygiene monitoring.[30] In Hong Kong, the reduction in the prevalence of dental caries among children benefits from the water fluoridation measures implemented since 1961, the improvement of education levels, the establishment of dental schools and the development of the social economy.[41–43] As of March 2020, approximately 68% of kindergartens in Hong Kong had joined the oral health promotion programme, which effectively enhanced the oral health awareness of children and their parents.[41]

Compared with other countries, there is still a substantial gap in children's oral health in China. The prevalence rate of primary tooth caries in children aged 2–5 years in the USA is approximately 23%.[44] The prevalence of dental caries in 5-year-old children in Germany is 26.2%, and that in Tanzania is 43.2%.[45 46] Given that the global prevalence rate of ECC is 48%, whether viewed from a national perspective or based on the 55.9% ECC prevalence rate found in this study, the situation in China is not optimistic.[47] This highlights the necessity of early prevention of dental caries in preschool children in China. The reasons for these differences are multifaceted. The USA has incorporated dental caries into the management of chronic diseases, effectively promoting the management of ECC and the realisation of oral health equity.[48] In Germany, comprehensive and systematic oral health prevention policies have been implemented since children's early years in terms of oral hygiene education.[49] In the medical security system, Germany provides oral examinations and fluoride applications for children over 30 months old, and these items are included in the statutory medical insurance catalogue. Research has shown that there is a positive correlation between the coverage of adult dental care in medical assistance and children's dental visits, indicating that such assistance can help reduce dental caries problems among children from low-income families.[50] In addition, a German study has found that pre-packaging food labels, as an effective intervention measure, has the potential to significantly inhibit the increase in dental caries.[51]

Compared with previous studies, the data found in this study on caries prevalence (65.2%) and severity (dmft 3.6) among preschool children aged 60–71 months in Guangzhou city were higher than the data collected in the same city in 2008 (56.11%, 3.04) and lower than those in 2015 (76.8%, 5.47) as reported in two epidemiological studies described in the literature.[14 15] China's 'Healthy Mouth Action Plan (2019–2025)' emphasises strengthening the monitoring of key populations.[52] Infants and preschool children are high-risk groups for deciduous dental caries. Focused monitoring on them can help detect the early signs of caries in a timely manner, enabling the implementation of intervention measures to prevent the further development of caries. In terms of public health strategies, various regions actively promote the popularisation of oral health knowledge. Taking the 'World Oral Health Day' on 20 March each year and China's 'Love Teeth Day' on 20 September as opportunities, they promote oral health education.[53] In accordance with these guidelines and strategies, Guangzhou has implemented a series of intervention measures. In 2018, Guangzhou city launched a pilot project for comprehensive intervention of primary tooth caries in preschool children, and carried out a 'local fluoride application for caries prevention' project in some kindergartens. It provided free oral examinations for preschool children and local fluoride application for caries prevention every 6 months, and carried out publicity and education for preschool children, parents and kindergarten teachers. However, it can be seen from the results of this survey that the situation of preschool children with caries is still common, and it is far from reaching the goal of

Table 2 Emergence of the first permanent molars and central incisors in children aged 60–71 months

Tooth position	Index	Number of teeth	Percentage % (95% CI)
Maxillary first permanent molars	Eruption		
	No caries but without pit and fissure sealing	1515	13.1 (12.5, 13.8)
	Erupted without record	108	0.9 (0.8, 1.1)
	DFT	14	0.1 (0.1, 0.2)
	Pit and fissure sealing	14	0.1 (0.1, 0.2)
	Non-eruption	9883	85.7 (85.0, 86.3)
Mandibular first permanent molars	Eruption		
	No caries but without pit and fissure sealing	2445	21.2 (20.5, 21.9)
	Erupted without record	240	2.1 (1.8, 2.3)
	DFT	39	0.3 (0.2, 0.4)
	Pit and fissure sealing	33	0.3 (0.2, 0.4)
	Non-eruption	8777	76.1 (75.3, 76.9)
Maxillary central incisors	Eruption		
	No caries	398	3.5 (3.1, 3.8)
	Erupted without record	133	1.2 (1.0, 1.3)
	DFT	6	0.1 (0.0, 0.1)
	Non-eruption		
	Deciduous central incisors have not lost	10652	92.4 (91.9, 92.8)
	Deciduous central incisors lost	345	3.0 (2.7, 3.3)
Mandibular central incisors	Eruption		
	No caries	2758	23.9 (23.1, 24.7)
	Erupted without record	190	1.6 (1.4, 1.9)
	DFT	3	0.0 (0.0, 0.1)
	Non-eruption		
	Deciduous central incisors have not lost	8473	73.5 (72.7, 74.3)
	Deciduous central incisors lost	110	1.0 (0.8, 1.1)

DFT, Decayed–filled Teeth.

50% caries-free rate among 5-year-old children defined by the WHO in 2020. This may be due to the fact that the coverage of the project is not extensive enough, and some kindergartens and schools have not participated in the project. In addition, since 2011, Guangzhou city has carried out a free pit and fissure sealing project for the first permanent molars of second-grade primary school students. Although it has provided a certain degree of protection for students' oral health to some extent, the prevalence of dental caries still remains at a relatively high level. This prompts us to further reflect on and improve the existing preventive measures. This study focused on the development and caries status of the first permanent molars and central incisors of preschool children aged 60–71 months for the first time, which is of great significance. 5-year-old children are in a critical period of transition from deciduous teeth to permanent teeth. The status of their permanent teeth can provide a prospective reference for the oral prevention work of school-age children. For preschool children at high risk of dental caries, in addition to topical fluoride application, pit-and-fissure sealing of primary molars should be prioritised.

The task of preventing deciduous dental caries is arduous. Conducting caries risk assessment (CRA) in a timely manner is the crucial and first step to reduce the risk of ECC. Currently, some paediatric and dental organisations have developed user-friendly CRA tools.[9 54] This study found that 94.7%, 85.1% and 80.2% of ECC cases were concentrated in one-third of the children aged 36–47 months, 48–59 months and 60–71 months, respectively. The treatment needs for most dental caries are concentrated in a small portion of the population. Thus, it is of considerable significance to formulate caries management plans for preschool children targeting different caries risk groups.[55] Children with different levels of caries risk differ in terms of oral examinations, diet control and the frequency and dosage of fluoride use.[7] However, a survey on the use of CRA by Chinese dentists found that only 35.4% of the respondents used

CRA in their routine practice.[56] In addition, expanding the scope of the comprehensive intervention programme for children's oral diseases is required. The application of fluoride in oral healthcare has been widely recognised.[57] In Japan, fluoridated toothpaste has a market share of over 90%.[58] Studies have shown that applying fluoride varnish is more effective and cost-effective in preventing ECC in children who cannot obtain fluoridated drinking water compared with the control group.[59] Moreover, compared with systemic fluoride use, topical fluoride application also reduces the risk of complications caused by excessive intake of this ion.[60–62] Therefore, the scope of application of topical fluoride should be expanded to benefit more preschool children who meet the indications.

Study limitations

This study adopted the examination standards based on the WHO standards. This standard is less advantageous than the International Caries Detection and Assessment System in terms of early caries detection.[63–65] Meanwhile, compared with the decayed–missing–filled surface, the dmft index has lower sensitivity. Since a tooth has multiple surfaces, simply relying on the dmft index to evaluate cannot accurately determine the situation of severe ECC. Second, caries risk assessment is of crucial significance for both individual caries prevention and public health decision-making. However, this study did not conduct appropriate questionnaire surveys on children's knowledge, attitudes and behaviours related to caries, nor did it carry out relevant laboratory examinations, thus making it impossible to conduct risk assessment. Finally, in terms of data collection, there were omissions. Information regarding children's socioeconomic backgrounds, such as family income, parents' education levels and parents' ages, was not comprehensively gathered. Additionally, details about children's dietary habits, height and weight, which could potentially be related to the development of dental caries, were also not collected. This lack of data limits the in-depth analysis of the factors contributing to dental caries.

CONCLUSION

Among preschool children in Guangzhou city, especially those in non-central urban areas, the problem of ECC is rather prominent. In view of this, great importance should be attached to the prevention of ECC from the early stage of life. On the one hand, efforts should be made to vigorously strengthen the construction of social support for oral health. On the other hand, it is of utmost importance to enhance oral health education and promotional activities in non-central urban areas. By doing so, we can effectively bridge the oral health divide among diverse regions.

Acknowledgements The authors are deeply grateful for the support of government departments. Heartfelt thanks also go to kindergarten teachers, parents, teachers and children for their cooperation. Their contributions have been crucial to the success of this study.

Contributors ZX and LZ were responsible for drafting the manuscript. LZ, YL and ZZ contributed to the design of the study. YL, GZ, ZZ, JX and JW participated in the data collection process. ZX and LZ conducted the data analysis and interpretation. LY reviewed and revised the manuscript. LY is the guarantor. ZX and LZ contributed equally to this work. All authors read and approved the paper.

Funding This study was funded by the Guangzhou Conghua District Health Literacy Promotion Project, and the Scientific Research Projects of Higher Learning Institutions of Guangzhou Municipal Education Bureau (2024312218).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Consent obtained from parent(s)/guardian(s).

Ethics approval The study was approved by the Medical Ethics Committee of the Medical Ethics Committee of School and Hospital of Stomatology, Guangzhou Medical University (approval number: LCYJ2022050).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information. Not applicable.

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REFERENCES

1 Bernabe E, Marcenes W, Hernandez CR, *et al*. Global, Regional, and National Levels and Trends in Burden of Oral Conditions from 1990 to 2017: A Systematic Analysis for the Global Burden of Disease 2017 Study. *J Dent Res* 2020;99:362–73.
2 Altner S, Stroj D, Bekes K. Impact of Silver Diamine Fluoride Therapy on the Oral Health-Related Quality of Life of Preschool Children with Behavioral Problems after Three Months: A Pilot Study. *J Clin Med* 2022;11:3071.
3 Wen J, Tao Y, Pang L, *et al*. Parental Feeding Styles and Risk of a New Carious Lesion in Preschool Children: A Longitudinal Study. *Nutrients* 2023;15:4387.
4 Amend S, Hartmann T, Heinzel-Gutenbrunner M, *et al*. Caries Experience and Increment in Children Attending Kindergartens with an Early Childhood Caries Preventive Program Compared to Basic Prophylaxis Measures-A Retrospective Cohort Study. *J Clin Med* 2022;11:2864.
5 Sun X, Bernabé E, Liu X, *et al*. Early life factors and dental caries in 5-year-old children in China. *J Dent* 2017;64:73–9.
6 Rojas-Briceño NB, Oc Carrasco OJ, Silva Díaz YA, *et al*. Knowledge and Attitudes of Parents about Oral Health in the Primary Dentition Stage in a Peruvian High Andean City. *Int J Environ Res Public Health* 2024;21:154.
7 Force U, Davidson KW, Barry MJ, *et al*. Screening and Interventions to Prevent Dental Caries in Children Younger Than 5 Years: US Preventive Services Task Force Recommendation Statement. *JAMA* 2021;326:2172–8.
8 Yu KF, Wen W, Liu P, *et al*. Effectiveness of Family-Centered Oral Health Promotion on Toddler Oral Health in Hong Kong. *J Dent Res* 2022;101:286–94.
9 Zou J, Du Q, Ge L, *et al*. Expert consensus on early childhood caries management. *Int J Oral Sci* 2022;14:35.

10 El Tantawi M, Folayan MO, Mehaina M, *et al*. Prevalence and Data Availability of Early Childhood Caries in 193 United Nations Countries, 2007-2017. *Am J Public Health* 2018;108:1066–72.
11 Kazeminia M, Abdi A, Shohaimi S, *et al*. Dental caries in primary and permanent teeth in children's worldwide, 1995 to 2019: a systematic review and meta-analysis. *Head Face Med* 2020;16:22.
12 Li F, Wu S-C, Zhang Z-Y, *et al*. Trend on dental caries status and its risk indicators in children aged 12 years in China: a multilevel analysis based on the repeated national cross-sectional surveys in 2005 and 2015. *BMC Public Health* 2021;21:2285.
13 Guangzhou Municipal Bureau of Statistics, Survey Office of the National Bureau of Statistics in Guangzhou. Guangzhou Statistical Yearbook (in Chinese). Beijing: China Statistical Publishing House, 2023.
14 Lin L, Weijia L, Lihua X, *et al*. Dental caries of deciduous teeth in children in Guangzhou during 2008-2015 (in Chinese). *Chinese Journal of School Health* 2018;39:415–7.
15 Wei L, Lihua X, Rong L, *et al*. Comparison of status and risk factors for caries among 5-year-old children in Guangzhou between 2008 and 2015 (in Chinese). *Chinese Journal of Child Health Care* 2018;26:1267–70.
16 Liu W, Xiong L, Li J, *et al*. The anticaries effects of pit and fissure sealant in the first permanent molars of school-age children from Guangzhou: a population-based cohort study. *BMC Oral Health* 2019;19:156.
17 Liang J-J, Zhang Z-Q, Chen Y-J, *et al*. Dental caries is negatively correlated with body mass index among 7-9 years old children in Guangzhou, China. *BMC Public Health* 2016;16:638.
18 Du MQ, Li Z, Jiang H, *et al*. Dental Caries Status and its Associated Factors among 3- to 5-year-old Children in China: A National Survey. *Chin J Dent Res* 2018;21:167–79.
19 Gao YB, Hu T, Zhou XD, *et al*. Dental Caries in Chinese Elderly People: Findings from the 4th National Oral Health Survey. *Chin J Dent Res* 2018;21:213–20.
20 Li Y, Wulaerhan J, Liu Y, *et al*. Prevalence of severe early childhood caries and associated socioeconomic and behavioral factors in Xinjiang, China: a cross-sectional study. *BMC Oral Health* 2017;17:144.
21 Park YH, Choi YY. Feeding Practices and Early Childhood Caries in Korean Preschool Children. *Int Dent J* 2022;72:392–8.
22 Fu T, Liu Y, Shen J, *et al*. Oral Health Status of Residents in Jiangsu Province, China: An Epidemiologic Survey. *Int Dent J* 2022;72:519–28.
23 Su H, Yang R, Deng Q, *et al*. Deciduous dental caries status and associated risk factors among preschool children in Xuhui District of Shanghai, China. *BMC Oral Health* 2018;18:111.
24 Zhou N, Zhu H, Chen Y, *et al*. Dental caries and associated factors in 3 to 5-year-old children in Zhejiang Province, China: an epidemiological survey. *BMC Oral Health* 2019;19:9.
25 Zhang M, Zhang X, Zhang Y, *et al*. Assessment of risk factors for early childhood caries at different ages in Shandong, China and reflections on oral health education: a cross-sectional study. *BMC Oral Health* 2020;20:139.
26 Zeng L, Zeng Y, Zhou Y, *et al*. Diet and lifestyle habits associated with caries in deciduous teeth among 3- to 5-year-old preschool children in Jiangxi province, China. *BMC Oral Health* 2018;18:224.
27 Du S, Cheng M, Cui Z, *et al*. Decomposing Socioeconomic Inequality in Early Childhood Caries Among 3 to 5-Year-Old Children in China. *Int Dent J* 2024;74:968–77.
28 Zhang T, Hong J, Yu X, *et al*. Association between socioeconomic status and dental caries among Chinese preschool children: a cross-sectional national study. *BMJ Open* 2021;11:e042908.
29 Duangthip D, Chen KJ, Gao SS, *et al*. Early childhood caries among 3- to 5-year-old children in Hong Kong. *Int Dent J* 2019;69:230–6.
30 Liu Y, Zhu J, Zhang H, *et al*. Dental caries status and related factors among 5-year-old children in Shanghai. *BMC Oral Health* 2024;24:459.
31 Wang X, Wei Z, Li Q, *et al*. A longitudinal study of early childhood caries incidence in Wenzhou preschool children. *BMC Oral Health* 2017;17:105.
32 Chen J, Chen W, Lin L, *et al*. The prevalence of dental caries and its associated factors among preschool children in Huizhou, China: a cross-sectional study. *Front Oral Health* 2024;5:1461959.
33 Li J, Fan W, Zhou Y, *et al*. The status and associated factors of early childhood caries among 3- to 5-year-old children in Guangdong, Southern China: a provincial cross-sectional survey. *BMC Oral Health* 2020;20:265.
34 Wu J, Chen L, Guan M, *et al*. Analysis of 5-Year-old children's oral health service utilization and influencing factors in Guizhou Province, China (2019–2020). *BMC Oral Health* 2019;23:627.
35 Yin W, Yang Y-M, Chen H, *et al*. Oral health status in Sichuan Province: findings from the oral health survey of Sichuan, 2015-2016. *Int J Oral Sci* 2017;9:10–5.
36 National Committee for Oral Health(NCOH). In fourth national epidemiological survey of oral health [in chinese]. Beijing People's Medical Publishing House; 2018.
37 Liu K, Ruan S. An epidemiological survey of oral health in Shenzhen [in chinese]. Guangzhou Guangdong Science & Technology Press; 2021.
38 Xu M, Yuan C, Sun X, *et al*. Oral health service utilization patterns among preschool children in Beijing, China. *BMC Oral Health* 2018;18:31.
39 de Lucena EHG, da Silva RO, Barbosa ML, *et al*. Influence of socioeconomic status on oral disease burden: a population-based study. *BMC Oral Health* 2021;21:608.
40 Elkhodary HM, Abdelnabi MH, Swelem AA, *et al*. Individual, familial and country-level factors associated with oral hygiene practices in children: an international survey. *BMC Oral Health* 2023;23:50.
41 Zheng FM, Yan IG, Sun IG, *et al*. Early Childhood Caries and Dental Public Health Programmes in Hong Kong. *Int Dent J* 2024;74:35–41.
42 Chen KJ, Gao SS, Duangthip D, *et al*. Dental caries status and its associated factors among 5-year-old Hong Kong children: a cross-sectional study. *BMC Oral Health* 2017;17:121.
43 Sun IG, Duangthip D, Yan IG, *et al*. Caries Incidence and Its Associated Factors in Hong Kong Kindergarten Children. *Int Dent J* 2024;00151–5.
44 Clark MB, Braun PA. Promotion of Oral Health and Prevention of Dental Caries Among Children in Primary Care. *JAMA* 2021;326:2139–40.
45 Grund K, Goddon I, Schüler IM, *et al*. Clinical consequences of untreated dental caries in German 5- and 8-year-olds. *BMC Oral Health* 2015;15:140.
46 Mbawalla HS, Nyamuryekung'e KK, Mtaya-Mlangwa M, *et al*. Dental Caries Pattern Amongst Tanzanian Children: National Oral Health Survey. *Int Dent J* 2023;73:731–7.
47 Uribe SE, Innes N, Maldupa I. The global prevalence of early childhood caries: A systematic review with meta-analysis using the WHO diagnostic criteria. *Int J Paediatr Dent* 2021;31:817–30.
48 Edelstein BL, Basch CE, Zybert P, *et al*. Chronic Disease Management of Early Childhood Dental Caries: Practices of US Pediatric Dentists. *Prev Chronic Dis* 2025;22:E01.
49 Santamaría RM, Splieth CH, Basner R, *et al*. Caries Level in 3-Year-Olds in Germany: National Caries Trends and Gaps in Primary Dental Care. *Children (Basel)* 2024;11:1426.
50 Lipton BJ, Finlayson TL, Decker SL, *et al*. The Association Between Medicaid Adult Dental Coverage And Children's Oral Health. *Health Aff (Millwood)* 2021;40:1731–9.
51 Jevdjevic M, Wijn SRW, Trescher AL, *et al*. Front-of-Package Food Labeling to Reduce Caries: Economic Evaluation. *J Dent Res* 2021;100:472–8.
52 Zeng XJ, Zhou XD, Chen WX. Development and improvement of Chinese oral public health system. *Zhonghua Kou Qiang Yi Xue Za Zhi* 2020;55:361–6.
53 Si Y, Tai B, Hu D, *et al*. Oral health status of Chinese residents and suggestions for prevention and treatment strategies. *Global Health Journal* 2019;3:50–4.
54 Gormley A, Haworth S, Simancas-Pallares M, *et al*. Subtypes of early childhood caries predict future caries experience. *Community Dent Oral Epidemiol* 2023;51:966–75.
55 Kalhan TA, Un Lam C, Karunakaran B, *et al*. Caries Risk Prediction Models in a Medical Health Care Setting. *J Dent Res* 2020;99:787–96.
56 Fang X, Hua F, Chen Z, *et al*. Caries risk assessment-related knowledge, attitude, and behaviors among Chinese dentists: a cross-sectional survey. *Clin Oral Invest* 2023;27:1079–87.
57 Weyant RJ, Tracy SL, Anselmo TT, *et al*. Topical fluoride for caries prevention: executive summary of the updated clinical recommendations and supporting systematic review. *J Am Dent Assoc* 2013;144:1279–91.
58 Matsuyama Y, Fujiwara T, Aida J. Tap water natural fluoride and parent-reported experience of child dental caries in Japan: Evidence from a nationwide birth cohort survey. *Community Dent Oral Epidemiol* 2023;51:1141–9.
59 Zaror C, Muñoz-Millán P, Espinoza-Espinoza G, *et al*. Cost-effectiveness of adding fluoride varnish to a preventive protocol for early childhood caries in rural children with no access to fluoridated drinking water. *J Dent* 2020;98:103374.
60 Rozier RG, Adair S, Graham F, *et al*. Evidence-based clinical recommendations on the prescription of dietary fluoride supplements for caries prevention: a report of the American Dental Association Council on Scientific Affairs. *J Am Dent Assoc* 2010;141:1480–9.

61 Dong H, Yang X, Zhang S, *et al*. Associations of low level of fluoride exposure with dental fluorosis among U.S. children and adolescents, NHANES 2015-2016. *Ecotoxicol Environ Saf* 2021;221:112439.
62 Opydo-Szymaczek J, Ogińska M, Wyrwas B. Fluoride exposure and factors affecting dental caries in preschool children living in two areas with different natural levels of fluorides. *J Trace Elem Med Biol* 2021;65:126726.
63 Anderson M, Dahllöf G, Soares FC, *et al*. Impact of biannual treatment with fluoride varnish on tooth-surface-level caries progression in children aged 1-3 years. *J Dent* 2017;65:83–8.
64 Kim S-Y, Kim H-N. Assessment of early childhood caries using ICDAS and Snyder caries activity test among preschool children: a cross-sectional study. *J Clin Pediatr Dent* 2023;47:163–70.
65 Rai A, Sundas S, Dhakal N, *et al*. Assessment of dental caries based on ICDAS and WHO criteria: A comparative study. *Int J Paediatr Dent* 2024;34:77–84.