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Effects of early preventive dental visits and its associations with dental caries experience: a cross-sectional study

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Abstract

Objectives: Limited information is known about preventive dental visits (PDVs) before seven years of age among children in China. This study aimed to examine the early PDV rate, identify the impact of PDV on dental caries and untreated dental caries, and explore the factors related to PDV among Chinese sampled children under seven years old.

Methods: A cross-sectional survey was conducted in five selected primary health care facilities in Chengdu, China, from May to August 2021. Parent–child dyads during regular systematic medical management were recruited to participate. Children’s dental caries were identified through dental examinations and documented as decayed, missing and filled teeth index (dmft) by trained primary care physicians. Dental-related information was collected through a questionnaire. Zero-inflated negative binomial (ZINB) regression was used to test the effect of early PDV on the dmft value, and logistic regression was used to analyse impact factors on the early PDV.

Results: A total of 2028 out of 2377 parent–child dyads were qualified for analysis. Half of the children (50.4%) were male, with a mean age of 4.8 years. Among all the children, 12.1% had their first dental visit for preventive purposes, 34.4% had their first dental visit for symptomatic purposes, and more than half had never visited a dentist. The results showed that a lower dmft value (adjusted OR: 0.69, 95% CI: 0.48–0.84), a higher rate of caries-free (aOR: 6.5, 95% CI: 3.93–10.58), and a lower rate of untreated dental caries (aOR: 0.40, 95% CI: 0.21–0.76) were associated with early PDV utilization. Children who had a higher rate of PDV were positively associated with living in a family with better parental behaviours (aOR: 2.30, 95% CI: 1.71–3.08), better parental oral health perception (aOR: 1.23, 95% CI: 1.06–1.32), fathers who had no untreated caries (aOR: 0.68, 95% CI: 0.47–0.97), families with higher socioeconomic status (aOR: 1.09, 95% CI: 1.04–1.16), and dental health advice received from well-child care physicians (aOR: 1.47, 95% CI: 1.08–2.00).

Conclusions: Early PDV was associated with a lower rate of dental caries prevalence and untreated dental caries among sampled children younger than seven in Western China. Underutilization and social inequities existed in PDV utilization. Public health strategies should be developed to increase preventive dental visits and eliminate social disparities that prevent dental care utilization.

Keywords: Dental Caries, Office Visits, Dental Care for Children, Dental Health Services, Primary Prevention

Introduction

Dental caries is one of the most common chronic diseases among children [1]. Untreated caries in deciduous teeth is the 10th-most prevalent condition, affecting 621 million children worldwide, especially in low-income

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families [2, 3]. Multiple risk factors were associated with early childhood caries (ECC), such as a high number of cariogenic oral bacteria, frequent intake of high sugar food, insufficient saliva flow, lower fluoride exposure, poor oral hygiene, and low socioeconomic demographic status [4]. Therefore, use of comprehensive methods for ECC prevention may be more effective.

The specific preventive interventions could be categorized into passive and active interventions [5]. A well-known passive preventive intervention is community fluoridated water. Compared to passive prevention, active preventive intervention requires a person to implement actions to change their lifestyle by including or excluding living habits [6]. Early preventive dental visits (PDVs) are one of the most critical active preventive interventions. Many dental professional academics recommend that parents take their children to the dental office when the first tooth erupts or no later than one year old [7, 8]. Early PDVs can provide more effective and less costly dental care than dental care provided in emergency care facilities or hospitals [9, 10]. However, there are significant disparities in access to early dental care among the population. The age of the first dental visit varies from one to six worldwide [11, 12]. Underutilization of early dental care was associated with ethnic minorities [13], lower family income [14], poorer parents' perceptions and attitudes on dental health [15], less multidisciplinary cooperation [16], and lower access to dental services [17]. Understanding these factors is essential for developing strategies to eliminate disparities in early dental care utilization.

ECC remains a substantial public health issue in China, as in other countries in the world. According to the Fourth Chinese National Oral Health Survey, the prevalence of dental caries was 50.8%, 63.6%, and 71.9% for 3-, 4- and 5-year-olds, respectively [18]. Untreated dental caries were reported in 16.2% to 83.6% of different cities [19, 20]. Children's oral health has not been effectively improved in recent decades [18]. In 2019, China's National Committee of Health issued the Medium-to-Long Term Plan for the Prevention and Treatment of Chronic Diseases [21]. In this plan, early dental health management for children was proposed for the first time. There have been an increasing number of Chinese studies on children's dental service utilization in recent years. All-cause dental care utilization among children was reported to range from 17.5 to 45.5% [22–24]. However, most of these studies indicated that more dental utilization was associated with a higher prevalence of dental caries. One reason to explain this was that those studies could not distinguish the time sequence between dental utilization and dental caries onset within a cross-sectional design. The other reason was that those studies did

not differentiate between dental services for prevention and treatment purposes. This information is not good for supporting public health strategies targeting ECC.

This study aimed to investigate the current status of early PDV utilization among children under seven years old in western China. It seeks to address the following research questions: 1) what is the rate of early PDV among young children in a metropolitan city in Western China; 2) can early PDV play a positive role in reducing ECC and untreated dental caries; and 3) what family background characteristics are associated with PDV?

Methods

Study participants

A cross-sectional survey was conducted in the selected primary care settings in Chengdu, China, from May 2021 to August 2021. Following the judgemental sampling method, we selected primary care facilities that cover at least 80 thousand persons per facility (average cover scope is approximately 30 to 50 thousand) in the serving area and has two or more paediatric primary care physicians (PCPs) working in the facility [25]. Nine facilities satisfied the selection criteria, and five facility directors agreed to participate. Parent–child dyads were invited to participate by fifteen trained PCPs during regular systematic medical management. Children under seven years old who had no systemic disease were eligible for the study. Children's parents or other caregivers who refused to participate were excluded from the study.

The sample size was calculated via the formula $n = p(1 - p)(\frac{Z}{E})^2$, where Z is the value from the standard normal distribution reflecting the confidence level that will be used ($Z = 1.96$ for 95%) and E is the desired margin of error ($E = 0.05$). P is the proportion of caries rate referred from the fourth national oral health survey [18]. The value of p was 0.508. Therefore, the sample size should be 385 in each facility. The minimum total sample size was 385×5 facilities = 1925. Considering a 10% error rate, the total sample size should be 2118.

During the systematic examination, children's parents or other caregivers were invited to enroll in the survey by PCP in the office. When they agreed, they were asked to scan a QR code to electronically sign a consent form and subsequently complete an online questionnaire. The questionnaire included demographic status, parental oral health-related behaviours, and oral health status of the parents. Pretest and auto skip questions were set to avoid illogic errors in the questionnaire. Then, a dental examination was performed for the enrolled children.

Primary outcome: dental caries and untreated dental caries

Children's dental caries were measured by the decay/missing/filling teeth (dmft) index. Considering that

dental caries were examined by PCPs, the decayed, missing and filled index (DMF) was used to identify evident caries. Compared to the International Caries Detection and Assessment System (ICDAS) and the Caries Assessment Spectrum and Treatment (CAST), the DMF may underestimate the occurrence of caries lesions in individuals but is the fastest method to apply [26]. Dental examination was performed and documented by the PCP during systematic medical management. For children under 18 months, the oral examination is conveniently performed in a “knee-to-knee” position. For children nearing two years of age, the PCP performed a dental exam with a flashlight for children who sat on the baby stool assisted by parents. For children over 30 months old, PCP performed dental examination with a flashlight with the child laid on the checking bed.

PCPs were required to perform a comprehensive evaluation for children following the guidelines of the National Basic Public Health Service for Children in China. This evaluation includes children’s physical development, vision health, and oral health. The PCPs who performed the evaluation should also give appropriate advice to parents. All the PCPs had studied basic oral health in college education and continuous education after they had graduated. In the present study, to strengthen PCP’s knowledge and update them on new paediatric dental knowledge, licenced paediatric dentists conducted two-hour face-to-face training for all participating PCPs [27]. The training content was about oral health knowledge and dental caries examination skills. The purpose of the training was to deepen their dental examination ability and ensure the accuracy of dental examinations. All PCPs passed a ten-question dental examination quiz after the training [28]. The average score was 81 out of 100. All single scores were above 70.

Untreated dental caries were collected both by examination and the questionnaire. If $dmft > 0$, parents were asked in the questionnaire, “Did you take your children to treat dental caries?” (“Yes” or “No”). A child who had dental caries but took no treatment was defined as having untreated dental caries.

Secondary outcomes: early preventive dental visits

Information on early preventive dental visits was collected using a self-report questionnaire. The first dental visit experience and age were collected by questions of “Did you ever take your child to visit a dentist?” (“Yes” or “No”). If “Yes”, “At what age did you take him or her to the first dental visit?”. We asked the question “Why do you take your child to the dental office at the first dental visit?” to assess the information for early preventive dental care. There are four options to answer this question: 1) had preventive care, e.g., regular checks, fluoride varnish,

pit, and fissure sealant; 2) found a tooth decay onset; 3) the child reported a toothache or chewing issue; or 4) for other dental issues. If their parents or other caregivers chose option 1, we considered the children to have an early PDV. The age of PDV was used as the independent variable in the first step and the outcome variable in the second step. If they chose any other options from 2 to 4, we considered the children to have symptomatic dental visits. If they selected “no” dental visits in the first question, we considered the children to have no dental visits.

Covariates

We adjusted selected covariates that were associated with PDV to explore more expected and unexpected factors. All covariates were selected according to previous studies. The covariates included children’s demographic information, parental oral health status, parent-performed dental hygiene behaviours, and family functioning.

Demographic information collected in this study included the child’s sex, age, family income level, living area, and distance from the dental clinic with paediatric dentistry. According to the Average Wage of Urban Workers of 2020 published by the Sichuan Provincial Bureau of Statistics [29], the average annual wage was Renminbi (RMB) 74,520. Converting RMB into US dollars was \$11,291 per person, and the exchange rate was 6.6 in 2020. The average annual family income was estimated to be approximately \$22,582 in families with two parents. In this study, we defined “low family income” as family income lower than the average level of \$22,582; “middle family income” as equal to the upper two times the average level of \$45,164; and “high family income” as family income higher than three times the average of \$67,746. The family living area was measured as “urban” and “rural”. Dental clinic distance from home [30] was measured by driving time (within half an hour and more than half an hour).

Parental dental health perception and behaviours may impact the dental status and dental utilization of children [31, 32]. Parents’ caries status was measured by the following question: “Do any parent have dental caries but let it untreated? (Nobody, mother, father)”. The American Paediatric Dentistry Association recommended “cleaning baby’s mouth and gums with a soft cloth or infant toothbrush at bath time before the teeth erupt, and parents should brush children teeth and supervise the brushing for school-age children until they are 7 to 8 years of age” [33]. We used the following two questions to represent parents’ dental care behaviour and perception. Dental care behaviour was represented by the question: “When did you start to brush or wipe gums/teeth for babies?” (“Before child one year old” or “After one year old”). “Before child one year old” represents

better parental dental behaviour. Parental dental health perception was represented by the question: "At what age do you think your child could independently brush their teeth without parental supervision?" The options were 2–8 years. Older age indicates better parental dental perception and knowledge. Parents' dental knowledge sources [24] were also collected (from the internet, books, friends, kindergarten teachers, and PCPs).

Family functioning includes partner relations, organization, and mother's education [34]. In this study, family functioning included the number of children per family ("one", "two children", or "more"), parental marital status ("married", "divorced/separated"), and main caregivers of children ("parents", "grandparents/babysitter").

We also controlled for toothache status, which was reported to be an important indicator impacting dental health utilization among children in China [22]. The question was "Did your child have a toothache in the past six months? ("Yes" or "No")."

Statistical methods

A three-step analysis was performed to achieve the study aims. First, descriptive information of the sampled population was summarized. Chi-square analysis was used to identify the difference in the proportion of PDV and the other service types in different subgroups. Second, to test the PDV effect on dmft, the zero-inflated Poisson model (ZIP) and zero-inflated negative binomial model (ZINB) [35] were employed because the dmfs index was not normally distributed (Kolmogorov–Smirnov test, $P < 0.001$) and was not fit for the condition of conventional regression models. The Vuong test [36] was used to determine whether estimating a zero-inflation component is more appropriate than the standard model. The variance inflation factor (VIF) was calculated to assess the multicollinearity across independent variables before ZIP and ZINB were performed. The Akaike information criterion (AIC) and the Bayesian information criterion (BIC) were used to report the model fitness, and the smaller the value was, the better. Then, logistic regression was used to test the PDV effect on untreated dental caries among the children who already had dental caries. Third, stepwise logistic regression was used to test the associations with PDV.

Statistical significance was set at 0.05. All analyses were performed by STATA 14.0 (Stata Corporation, College Station TX, USA).

Results

Descriptive information

A total of 2377 parent–child dyads were invited to the survey. A total of 135 children older than seven years and 214 parents who did not complete the questionnaire were excluded as missing completely at random. Finally, 2028

(70.5%, 2028/2877) children were included for analysis. Among the total population (Table 1), the mean age of the children was 4.8 years (SD: 1.18), 50.4% ($N = 1023$) were male, and 39.9% (809) had siblings. Of the total population, 42.2% (855) of children had dental caries, the mean dmft was 1.51, the range was 0–17, and 18.1% (368) had toothache experience within six months. A total of 12.1% (245) of children had their first dental visit for prevention, 34.4% (698) of children had their first dental visit for treatment, and 53.5% had never visited a dentist ($P < 0.01$). The mean age was 5.3 years for SDV and 4.8 years for PDV. Only 1.1% (23) of children had PDV before three years of age.

Effect of PDV on dental caries level and untreated dental caries

The collinearity test results before the regression model showed that the VIF of the independent variables ranged from 1.02 to 1.31, indicating no collinearity. ZIP and ZINB were both performed. Since the Vuong test in ZIP was 12.74 and ZINB was 10.73, zero-inflated regression was more appropriate than linear regression for this dataset. According to the AIC and BIC (ZIP: 6057.9 and 6237.6, ZINB: 5694.5 and 5879.8) of the two models, ZINB fit the data better. Table 2 shows that preventive dental service utilization was significant in both parts of ZINB ($p < 0.05$), implying that a lower level of dental caries was among children who had more PDV (aOR: 0.60, 95% CI: 0.58–0.82) and more caries-free cases among children who had more PDV (aOR: 5.21, 95% CI: 3.59–7.57) after covariates were controlled.

Among children who had dental caries, the association between untreated dental caries and PDV was estimated by multivariable logistic regression. As shown in column 3–4 in Table 2, Model 1 showed the crude odds ratio of the PDV effect on untreated dental caries. Then, Model 2 added covariates of child sex, age, family child count, dmft, toothache, age at toothbrushing start, and age at first dental visit plus Model 1. Model 3 was the final model containing all covariates of parents' perception of age at supervised toothbrushing, whether mother or father has untreated dental caries, children's main caregivers, rural or urban living area, parents' marital status, mother's age and education, and family income, plus Model 2. Model 3 showed that preventive dental utilization was steadily associated with lower untreated dental caries (aOR: 0.4, 95% CI: 0.21–0.76).

Factors associated with early preventive dental visits

Among all the children (Table 3), multivariable logistic regression results showed that children's father had no untreated caries (aOR: 0.7, 95% CI: 0.47–0.97), longer distance from the dental clinic (aOR: 4.8, 95%

Table 1 Descriptive information of total sampled individuals divided by the first dental service utilization patterns

| | Total N (%) | Symptomatic user N (%) | Preventive user N (%) | No visit N (%) | P value |
|---------------------------|----------------|---------------------------|--------------------------|-------------------|---------|
| Total | 2028 (100) | 698 (34.4) | 245 (12.1) | 1085 (53.5) | |
| Sex | | | | | |
| Male | 1023 (50.4) | 355 (50.9) | 132 (53.9) | 536 (49.4) | 0.433 |
| Female | 1005 (49.6) | 343 (49.1) | 113 (46.1) | 549 (50.6) | |
| Age | | | | | |
| < 2 | 68 (3.4) | 9 (1.3) | 6 (2.4) | 53 (4.9) | < 0.001 |
| 2 ≤ y < 3 | 110 (5.4) | 14 (2.0) | 17 (6.9) | 79 (7.3) | |
| 3 ≤ y < 4 | 631 (31.1) | 129 (18.5) | 84 (34.3) | 418 (38.5) | |
| 4 ≤ y < 5 | 587 (28.9) | 218 (31.2) | 69 (28.2) | 300 (27.6) | |
| 5 ≤ y < 6 | 563 (27.8) | 282 (40.4) | 62 (25.3) | 219 (20.2) | |
| 6 ≤ y < 7 | 69 (3.4) | 46 (6.6) | 7 (2.9) | 16 (1.5) | |
| Mean age (SD) | 4.8 (1.18) | 5.3 (0.96) | 4.8 (1.09) | 4.5 (1.23) | |
| Children count | | | | | |
| One child | 1219 (60.1) | 414 (59.3) | 165 (67.3) | 640 (59.0) | < 0.05 |
| Two or more children | 809 (39.9) | 284 (40.7) | 80 (32.7) | 445 (41.0) | |
| Dental caries | | | | | |
| No | 1173 (57.8) | 153 (21.9) | 185 (75.5) | 835 (77.0) | < 0.001 |
| Yes | 855 (42.2) | 545 (78.1) | 60 (24.5) | 250 (23.0) | |
| Mean dmft | 1.51(2.7) | 3.14(3.4) | 0.71(1.8) | 0.63(1.6) | < 0.001 |
| Education level of mother | | | | | |
| High school or blew | 524 (25.8) | 178 (25.5) | 33 (13.5) | 313 (28.8) | < 0.001 |
| College | 1364 (67.3) | 473 (67.8) | 179 (73.1) | 712 (65.6) | |
| Master or above | 140 (6.9) | 47 (6.7) | 33 (13.5) | 60 (5.5) | |
| Family income category | | | | | |
| Low | 637 (31.4) | 233 (33.4) | 53 (21.6) | 351 (32.4) | < 0.001 |
| Middle | 915 (45.1) | 304 (43.6) | 102 (41.6) | 509 (46.9) | |
| High | 476 (23.5) | 161 (23.1) | 90 (36.7) | 225 (20.7) | |
| Child's main caregiver | | | | | |
| Parents | 1840 (90.7) | 638 (91.4) | 230 (93.9) | 972 (89.6) | 0.236 |
| Grandparents or others | 188 (9.3) | 60 (8.6) | 15 (6.1) | 113 (10.4) | |
| Parental marital status | | | | | |
| Normal | 1954 (96.4) | 671 (96.1) | 236 (96.3) | 1047 (96.5) | 0.994 |
| Divorce or separate | 74 (3.6) | 27 (3.9) | 9 (3.7) | 38 (3.5) | |
| Living area | | | | | |
| Urban | 1955 (96.4) | 681 (97.6) | 240 (98.0) | 1034 (95.3) | < 0.05 |
| Rural | 73 (3.6) | 17 (2.4) | 5 (2.0) | 51 (4.7) | |

The P value shows the difference in dental service utilization among subgroups
dmft decay/missing/filling teeth index

CI: 3.54–6.57), and dental health knowledge from well-child care physicians (aOR: 1.5, 95% CI: 1.08–2.00), were associated with more PDV, in addition to the child who was younger age, family with a single child, better parents' oral perception, and higher socioeconomic status. On the other hand, the relationship was not significant for children's sex, caregivers, dental health information from the internet, books, friends, school-teachers, or parental marriage.

Discussion

The primary finding of this study demonstrated that early PDV was associated with a lower rate of dental caries and untreated dental caries among children younger than seven in western China. This finding identified that early PDV was underutilized in the study sample. Social inequities existed in preventive dental care utilization. A lower rate of PDV was associated with children who lived in families with more children, poorer parental oral care

Table 2 ZINB model and multivariable regression model of early preventive dental care effects on dental caries and untreated dental caries

| | dmft | | Untreated dental caries | | |
|---------|-------------------------------|---------------------------|---|----------------|----------------|
| | ZINB model | | Multivariable logistic regression model | | |
| | (1) | (2) | (3) | (4) | (5) |
| | Negative Binomial part | Zero-inflated part | Model 1 | Model 2 | Model 3 |
| OR | 0.69 | 5.21 | 0.41 | 0.34 | 0.40 |
| 95% CI | 0.58–0.82 | 3.59–7.57 | 0.24–0.71 | 0.18–0.65 | 0.21–0.76 |
| P value | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

ZINB model: Zero-inflated negative binomial model

Column (1) and (2) showed the effect of PDV on dmft. Zero-inflated part showed a logit model for zero dmft (caries-free) children, predicting whether a child was in caries-free group. Negative binomial part showed dmft counts for those children who were not caries free. ZINB model was adjusted for children's sex, age, family children count, age at which toothbrushing started, parents' oral health perception for children, whether mother or father has untreated dental caries, children's caregivers, rural or urban living area, parents' marriage status, mother's age and education, family income. Full table is in Additional file 1: S1

Column (3) Model 1: crude odds ratio indicating the effect of PDV on untreated dental caries. Column (4) Model 2: odds ratio adjusted by child's sex, age, family children count, dmft, toothache, age at which toothbrushing started, age at first dental visit. Column (5) Model 3: odds ratio adjusted by Model 2 plus parents' oral health perception for children, whether mother or father has untreated dental caries, children's main caregivers, rural or urban living area, parents' marriage status, mother's age and education, and family income. Full table is in Additional file 1: S2

behaviours, fathers with untreated caries, and lower socioeconomic levels.

This study identified that the rate of first dental visits for prevention purposes was 12.1% among all children younger than seven in Chengdu, China. The rate of preventive dental care utilization was 24.3% in Beijing [24], and the average all-cause dental utilization rate at the national level was 17.6% [22]. The difference could be explained by socioeconomic-related inequality in dental utilization in different places [37]. In addition, we also identified that a higher education level of the mother, higher family income [14], better parental oral health perception and behaviours [15], and single children in the family [38] were associated with a higher rate of PDV, which is consistent with earlier research. This finding proved that there were social inequalities in utilizing early preventive dental care in Western China. The children who lived in families with higher educated mothers and higher family income had a significantly higher rate of preventive dental care utilization in the present study, which was consistent with previous studies [39–41]. Many social determinants for health tend to cluster among individuals living in underprivileged conditions and interact with each other. According to the framework for tackling social determinants, health inequities [42] are important predictors of health, especially in developing countries. More comprehensive actions should be

Table 3 Adjusted odds ratio of multivariable logistic regression for associated factors of preventive dental visits

| | OR _{adjusted} (95%CI) | P |
|---|--------------------------------|-------|
| Sex | 0.96 (0.71–1.28) | 0.773 |
| Age | 0.88 (0.78–1.00) | <0.05 |
| More children (Ref: single child) | 0.72 (0.54–0.97) | <0.05 |
| Age at starting brushing gum or teeth by parents' earlier than one year old (Ref: later than one) | 2.30 (1.71–3.08) | <0.01 |
| Age at parental perception on supervised tooth brushing (Continuous variable) | 1.23 (1.06–1.32) | <0.01 |
| Mother has untreated caries | 1.16 (0.79–1.71) | 0.459 |
| Father has untreated caries | 0.68 (0.47–0.97) | <0.05 |
| Grandparents as child caregiver (Ref: Parents) | 0.66 (0.37–1.12) | 0.121 |
| Resource of oral health information (Ref: None of above) | | |
| Internet | 0.75 (0.55–1.02) | 0.064 |
| Book | 1.26 (0.87–1.82) | 0.217 |
| Friends | 1.03 (0.69–1.53) | 0.891 |
| Well-child physician | 1.47 (1.08–2.00) | <0.05 |
| School teachers | 0.85 (0.60–1.20) | 0.354 |
| Living in urban (Ref: rural) | 1.27 (0.46–3.40) | 0.633 |
| More than half hour from dental clinics (Ref: Less or equal than half hour) | 4.82 (3.54–6.57) | <0.01 |
| Parental divorced (Ref: normal) | 1.21 (0.61–2.38) | 0.591 |
| Mother's age | 1.04 (1.00–1.08) | <0.05 |
| Education years of mother | 1.31 (1.10–1.56) | <0.01 |
| Family income category | 1.09 (1.04–1.16) | <0.01 |
| Constant | 0.01 (0.00–0.07) | <0.01 |

taken to eliminate the social disparities of dental care among young children. For example, clarify the mechanisms by which social determinants generate oral health inequities and provide a framework for evaluating which social determinants are the most important to address among children in different areas.

The findings revealed that health advice from PCP had a positive effect on children's PDV, which is consistent with previous international studies [43]. This result highlighted the potential oral benefits of the almost full cover of the National Basic Health Service Program in China, which covered 92.7% of children under seven in 2018[44]. Dental implementation by PCPs has been reported to be rare in China until now. More research should evaluate the advantages and cost-effectiveness of reducing caries by controlling common risk factors from the perspective of primary care. In addition, we unexpectedly found that higher PDV was associated with further living distance from dental clinics. Similar to patients who would like to seek orthodontics and dental implant services in further places to find a specific dentist [45], this unexpected result may reflect an extreme imbalance between paediatric dentistry supply and preventive dental demand. Parents who lived near the central city could access dental care knowledge through the Internet or social media development, yet a shortage of paediatric dentists broadly exists in China [46]. Children who live in suburban care may travel a long distance to access preventive dental care in the central city. Therefore, according to these results, we proposed that Chinese health policy-makers consider improving preventive dental visits by encouraging interdisciplinary cooperation between primary care and paediatric dentistry. However, in the long term, more paediatric dentists are needed to satisfy children's dental care needs.

There are several limitations to this study. First, we could not observe continuous preventive dental service utilization in the present study, which is a better independent variable than the one-time variable [47]. Panel data should be collected to accurately evaluate the results of future studies. Second, hidden caries may be missing without mouth mirrors for examinations by PCPs, resulting in a lower number of dental caries. This may cause the association between dental caries and PDV to be underestimated. Third, sample selection bias was inevitable. The sample could partially represent the children who lived around the large primary care centre in the metropolitan city in western China. Besides, disparities between urban and rural areas could not be identified, and the differences may be larger. Fourth, we used a single parental report question to measure toothache, considering the time cost of responding, which may

underestimate the actual proportion of children who suffer from toothache [48]. Future research is warranted to generalize our findings.

Despite these limitations, the present study has several contributions. The major strength of the present study is that it is the first study to find that early preventive dental utilization was associated with lower dental caries prevalence and lower untreated dental caries, which is inconsistent with some international studies [10, 49] and opposite to some domestic studies [18, 22]. The explanation is that we identified the time sequence and pattern of dental care services by using the first dental visit and its purpose as the independent variable. Dental caries can occur throughout life, both in primary and permanent dentitions [50]. Therefore, it is challenging to evaluate the real association between preventive dental care utilization and dental caries prevalence in a cross-sectional study. The advantage of using the first dental visit to identify the time sequence is that the first dental visit occurred previously or simultaneously with dental caries onset. The first dental visit is usually not interfered with by dentists' examination but spontaneously performed relying on parents' oral knowledge, attitude, and perception. Therefore, the purpose of the first dental visit could appropriately reflect parents' active prevention perception. Notably, this variable could be better used in a survey targeting young children to reduce memory bias.

Conclusions

Early PDV utilization was insufficient, and huge socioeconomic disparities existed among children. Preventive health policy strategies should focus on eliminating these disparities and increasing PDV access to promote dental health for young children. More longitudinal studies should evaluate the effect of PDV on dental health outcomes in China.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12903-022-02190-6>.

Additional file 1. S1. ZIBN regression results of association between tooth decay and preventive dental visits among children. **S2.** Multivariable regression results of association between untreated dental caries and preventive dental visits among children who had dental caries.

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Author contributions

Xing Qu: Writing—original draft, Methodology; Shannon H. Houser: Methodology, Validation, review & editing; Meirong Tian: Data processing, Methodology, Conceptualization; Qiong Zhang and Jay Pan: Writing—review & editing;

Zhang Wei: Conceptualization, supervision, writing, review & editing. All authors read and approved the final manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All study procedures were conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of Stomatology School, Sichuan University (IRB reference number: WCHSIRB-D-2019-013). Each study participant received an electronic written informed consent form to explain the content of the survey before they completed the questionnaire.

Consent for publication

Not applicable.

Competing interests

There is no conflict of interest or disclosure of any conflict of interest that may exist.

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References

- Martins-Junior PA, Vieira-Andrade RG, Correa-Faria P, Oliveira-Ferreira F, Marques LS, Ramos-Jorge ML. Impact of early childhood caries on the oral health-related quality of life of preschool children and their parents. *Caries Res.* 2013;47(3):211–8.
- Kassebaum NJ, Bernabe E, Dahiya M, Bhandari B, Murray CJ, Marcenes W. Global burden of untreated caries: a systematic review and meta-regression. *J Dent Res.* 2015;94(5):650–8.
- Peres MA, Macpherson LMD, Weyant RJ. Oral diseases: a global public health challenge (vol 394, pg 249, 2019). *Lancet.* 2019;394(10203):1010–1010.
- Kirithiga M, Murugan M, Saikia A, Kirubakaran R. Risk factors for early childhood caries: a systematic review and meta-analysis of case control and cohort studies. *Pediatr Dent.* 2019;41(2):95–112.
- Williams AF. Passive and active measures for controlling disease and injury: the role of health psychologists. *Health Psychol.* 1982;1(4):399–409.
- Kroon J, Lalloo R, Tadakamadla SK, Johnson NW. Dental caries experience in children of a remote Australian Indigenous community following passive and active preventive interventions. *Commun Dent Oral Epidemiol.* 2019;47(6):470–6.
- American Academy of Pediatric Dentistry. Clinical affairs committee—infant oral health S: guideline on infant oral health care. *Pediatr Dent.* 2012;34(5):e148–152.
- Children's teeth -Healthy body [<https://www.nhs.uk/live-well/healthy-body/taking-care-of-childrens-teeth/>]
- Lee HH, Faundez L, Nasseh K, LoSasso AT. Does preventive care reduce severe pediatric dental caries? *Prev Chronic Dis.* 2020;17:E136–E136.
- Nowak AJ, Casamassimo PS, Scott J, Moulton R. Do early dental visits reduce treatment and treatment costs for children? *Pediatr Dent.* 2014;36(7):489–93.
- Alshahrani NF, Alshahrani ANA, Alahmari MA, Almanie AM, Alosbi AM, Togoo RA. First dental visit: age, reason, and experiences of Saudi children. *Eur J Dent.* 2018;12(4):579–84.
- Mika A, Mitus-Kenig M, Zeglen A, Drapella-Gasior D, Rutkowska K, Josko-Ochojska J. The child's first dental visit. Age, reasons, oral health status and dental treatment needs among children in Southern Poland. *Eur J Paediatr Dent.* 2018;19(4):265–70.
- Darmawikarta D, Chen Y, Carsley S, Birken CS, Parkin PC, Schroth RJ, Maguire JL. Factors associated with dental care utilization in early childhood. *Pediatrics.* 2014;133(6):e1594–600.
- Badri P, Saltaji H, Flores-Mir C, Amin M. Factors affecting children's adherence to regular dental attendance: a systematic review. *J Am Dent Assoc.* 2014;145(8):817–28.
- Gao XL, Ding M, Xu MR, Wu HJ, Zhang CZ, Wang X, Feng XP, Tai BJ, Hu DY, Lin HC, et al. Utilization of dental services and associated factors among preschool children in China. *BMC Oral Health.* 2020;20(1):1–10.
- Meyer BD, Danesh DO. The impact of COVID-19 on preventive oral health care during wave one. 2021, 2(1).
- Heidenreich JF, Kim AS, Scott JM, Chi DL. Pediatric dentist density and preventive care utilization for medicaid children. *Pediatr Dent.* 2015;37(4):371–5.
- Du MQ, Li Z, Jiang H, Wang X, Feng XP, Hu Y, Lin HC, Wang B, Si Y, Wang CX, 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(3):167–79.
- Yun Q, Liu M, Zhao M, Chen W, Zhang H, Hou W, Chang C. Ten-year changes in children's oral health disparities: findings from the 3rd and 4th oral health surveys in Beijing, China. *Commun Dent Oral Epidemiol.* 2021;49(6):513–21.
- Wang X, Wei Z, Li Q, Mei L. A longitudinal study of early childhood caries incidence in Wenzhou preschool children. *BMC Oral Health.* 2017;17(1):105.
- Kong LZ. China's medium-to-long term plan for the prevention and treatment of chronic diseases (2017–2025) under the healthy china initiative. *Chronic Dis Transl Med.* 2017;3(3):135–7.
- Gao X, Ding M, Xu M, Wu H, Zhang C, Wang X, Feng X, Tai B, Hu D, Lin H, et al. Utilization of dental services and associated factors among preschool children in China. *BMC Oral Health.* 2020;20(1):9.
- Xu M, Yuan C, Sun X, Cheng M, Xie Y, Si Y. Oral health service utilization patterns among preschool children in Beijing, China. *BMC Oral Health.* 2018;18(1):31.
- Xu MR, Yuan C, Sun XY, Cheng ML, Xie YY, Si Y. Oral health service utilization patterns among preschool children in Beijing, China. *BMC Oral Health.* 2018;18:1–9.
- Community Health Center list [http://cdwjw.chengdu.gov.cn/cdwjw/whq/wy_list2.shtml]
- Castro ALS, Vianna MIP, Mendes CMC. Comparison of caries lesion detection methods in epidemiological surveys: CAST, ICDAS and DMF. *BMC Oral Health.* 2018;18(1):122–122.
- Pierce KM, Rozier RG, Vann WF Jr. Accuracy of pediatric primary care providers' screening and referral for early childhood caries. *Pediatrics.* 2002;109(5):E82–82.
- Qiong H, Chunhua D, Tao Y, Qiong Z. [Survey on oral health knowledge questionnaire of young children among child health care physicians in Chengdu]. *Matern Child Health Care China* 2020, 35(15).
- Average Wage of Urban Workers of 2020 [<http://tjj.sc.gov.cn/scstjj/c105897/2021/6/1/cd4887e719634d1a88ef1111cbc5b23a.shtml>]
- Dumas SA, Polk D. Pediatric dental clinic location and utilization in a high-resource setting. *J Public Health Dent.* 2015;75(3):183–90.

31. Zeedyk MS, Longbottom C, Pitts NB. Tooth-brushing practices of parents and toddlers: a study of home-based videotaped sessions. *Caries Res.* 2005;39(1):27–33.
32. Davidovich E, Grender J, Zini A. Factors associated with dental plaque, gingivitis, and caries in a pediatric population: a records-based cross-sectional study. *Int J Environ Res Public Health.* 2020;17(22):8595.
33. FAST FACTS [<https://www.aapd.org/assets/1/7/FastFacts.pdf>]
34. Duijster D, Verrips GHW, van Loveren C. The role of family functioning in childhood dental caries. *Commun Dent Oral Epidemiol.* 2014;42(3):193–205.
35. Lambert D. Zero-inflated poisson regression, with an application to defects in manufacturing. *Technometrics.* 1992;34(1):1–14.
36. Desmarais BA, Harden JJ. Testing for zero inflation in count models: bias correction for the Vuong test. *Stand Genom Sci.* 2013;13(4):810–35.
37. Chang Q, Gao X, Xu M, Zhang C, Du S, Wang X, Feng X, Tai B, Hu D, Lin H, et al. Socioeconomic-related inequality in dental care utilization among preschool children in China. *Commun Dent Oral Epidemiol.* 2021;49(6):505–12.
38. Liu M, Yun Q, Zhao M, Chen W, Zhang H, Hou W, Chang C. Association of siblings' presence and oral health-related quality of life among children: a cross-sectional study. *BMC Oral Health.* 2021;21(1):153.
39. Rouxel P, Chandola T. Socioeconomic and ethnic inequalities in oral health among children and adolescents living in England, Wales and Northern Ireland. *Commun Dent Oral Epidemiol.* 2018;46(5):426–34.
40. Verlinden DA, Reijneveld SA, Lanting CI, van Wouwe JP, Schuller AA. Socio-economic inequality in oral health in childhood to young adulthood, despite full dental coverage. *Eur J Oral Sci.* 2019;127(3):248–53.
41. Baggio S, Abarca M, Bodenmann P, Gehri M, Madrid C. Early childhood caries in Switzerland: a marker of social inequalities. *BMC Oral Health.* 2015;15(1):82.
42. Organization WH. A conceptual framework for action on the social determinants of health. 2010.
43. Lutfiyya MN, Gross AJ, Soffe B, Lipsky MS. Dental care utilization: examining the associations between health services deficits and not having a dental visit in past 12 months. *BMC Public Health.* 2019;19(1):265.
44. 2018 Statistical Monitoring Report on the Implementation of China National Program for Child Development (2011–2020) [http://www.stats.gov.cn/english/PressRelease/202001/t20200103_1721247.html]
45. Shin H, Cho HA. Spatial barriers and the bypassing of nearby dental clinics for dental services: a secondary data analysis in Korea. *BMJ Open.* 2019;9(1): e024116.
46. Association CS. Bulletin on the development of specialist members. In., vol. 10; 2021.
47. Shaban R, Kassim S, Sabbah W. Socioeconomic inequality in the provision of specific preventive dental interventions among children in the UK: Children's Dental Health Survey 2003. *Br Dent J.* 2017;222(11):865–9.
48. Versloot J, Veerkamp JSJ, Hoogstraten J. Dental Discomfort Questionnaire: assessment of dental discomfort and/or pain in very young children. *Commun Dent Oral Epidemiol.* 2006;34(1):47–52.
49. Blackburn J, Morrissey MA, Sen B. Outcomes associated with early preventive dental care among Medicaid-enrolled children in Alabama. *Jama Pediatr.* 2017;171(4):335–41.
50. Pitts NB, Zero DT, Marsh PD, Ekstrand K, Weintraub JA, Ramos-Gomez F, Tagami J, Twetman S, Tsakos G, Ismail A. Dental caries. *Nat Rev Dis Primers.* 2017;3(1):17030.

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