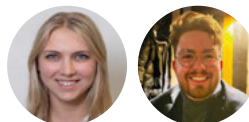


How does the frequency of dental visits affect future dental health?



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Abstract

Introduction This study investigates the impact of increased dental visits on children's dental health outcomes over a seven-year period. It assesses whether services such as consultations, X-rays, treatments for stomatitis, fillings, and extractions lead to better dental health, specifically focusing on the condition of the first permanent molars following comprehensive dental remediation.

Materials and Methods A retrospective study was conducted using data from the Vienna Public Health Insurance (ÖGK-W). The cohort included all children born in 2008 and 2009 who underwent extensive deciduous tooth rehabilitation in 2013. Inclusion criteria required each child to have received at least five dental procedures — including fillings and extractions — within a single quarter. The study comprised 465 patients, 196 females and 269 males. A score of 1 was assigned if restorative treatment was needed on any of the four molars, and a score of 0 if no treatment was required. This outcome was correlated with the frequency of dental visits over the seven-year period.

Results Boys exhibited a higher prevalence of caries compared to girls. Data analysis revealed that children with no restorative treatment on their first permanent molars (score = 0) attended an average of 10.49 dental examinations, whereas those requiring treatment (score = 1) attended an average of 7.18 dental visits. The logistic regression yielded an estimator of -0.0702, indicating a negative correlation between the number of dental visits and the need for restorative treatment. More frequent dental check-ups were associated with a lower likelihood of needing restorative treatment, highlighting the effectiveness of preventive measures and regular monitoring in improving dental health outcomes.

Conclusion The study underscores the importance of regular dental check-ups and comprehensive preventive care in maintaining children's oral health. The findings demonstrate that proactive and frequent dental consultations, combined with proper oral hygiene education, can significantly delay or prevent the need for tooth remediation. This emphasises the critical role of preventive dental care and the need for continued emphasis on regular dental visits to improve long-term oral health in children.

KEYWORDS Caries, dental visits, frequency, paediatric dentistry, restorative treatment.

Introduction

Dental caries is one of the most prevalent non-communicable diseases affecting children globally, leading to significant health problems and impacting their overall quality of life [Wen et al., 2022]. Despite considerable research and the introduction of various preventive strategies, the high prevalence and severity of dental caries in both primary and permanent teeth of children remains a significant public health concern [Peres et al., 2019; Kassebaum et al., 2015]. This issue is especially alarming as caries in childhood can have detrimental effects on a child's health, development, and well-being, with consequences that extend into adolescence and adulthood [Lam et al., 2022].

The progression of dental caries is a complex, multifactorial process influenced by the interaction of microbial activity, dietary habits, host susceptibility, and social factors. The primary cause of caries is the metabolism of fermentable carbohydrates by cariogenic bacteria such as *Streptococcus mutans*, which produces acids that demineralise tooth enamel [Selwitz et al., 2007]. However, the development of caries is not solely reliant on bacterial activity but also on the effectiveness of preventive practices, including proper oral hygiene, dietary management, and regular dental check-ups [Rugg-Gunn, 2013; Dag et al., 2021].

Fluoride is widely acknowledged as a key factor in the prevention of dental caries, due to its role in both inhibiting demineralisation and enhancing the remineralisation of tooth enamel [Jullien, 2021]. Various fluoride applications, including toothpaste, gels, varnishes, and fluoridated water, have significantly reduced the incidence of caries in numerous populations [Veneri et al., 2024]. Yet, disparities in the prevalence and severity of caries still exist, influenced by socioeconomic status, access to dental care, and the frequency of dental consultations.

In many countries, including Austria, there is no systematic

fluoridation of drinking water, which is also true for the Vienna study population. Consequently, children rely on alternative sources of fluoride intake, such as fluoride-containing toothpastes. However, these methods, along with other preventive measures against caries—such as enhanced oral hygiene and dietary modifications—demand active participation from caregivers. Additionally, they necessitate professional guidance and continuous motivation to uphold caries prevention practices, ideally supplemented by regular dental check-ups [Petersson and Bratthall, 1996; Esfahanizadeh, 2011].

This research aims to explore the potential indirect relationship between the frequency of dental visits and the incidence of dental caries in children. Specifically, it examines the impact of frequent dental consultations on the progression of dental caries. Utilising data from the Austrian Health Insurance Fund, this retrospective study focuses on a cohort of children born in 2008 and 2009 who underwent comprehensive rehabilitation of their primary dentition in 2013. The study evaluates the correlation between the frequency of dental check-ups and the incidence of invasive conservative procedures, such as fillings and extractions, which serve as indicators of caries progression. By analysing these associations, the study seeks to provide insights into the effectiveness of regular dental visits as a preventive measure against dental caries in children.

Material and Methods

Study Description

This study focused on four- and five-year-old children who had received at least five invasive dental services, such as extractions, surgical tooth removals, and fillings, performed by dentists affiliated with the insurance company within a single quarter from 2013 to 2020. The data were sourced from the comprehensive database of all health insurance dental offices in Vienna.

After seven years (in 2020), the same types of services were re-evaluated for the permanent first molars. The study analysed the correlation between these invasive procedures and the frequency of non-invasive services, including treatments for stomatitis, radiographs, consultations, treatment of sensitive cervical areas, tartar removal, and oral hygiene visits, which were categorized as control appointments.

Sample Size Calculation

The minimum sample size required for the study was calculated using a power analysis for logistic regression. Assuming an expected odds ratio of 0.7 for the association between the number of dental visits and the need for restorative treatment on first permanent molars, a significance level (alpha) of 0.05, and a desired power of 80%, it was determined that a minimum of 400 participants would be needed. The actual sample size of 465 patients exceeds this minimum requirement, ensuring adequate statistical power to detect a significant effect.

Inclusion and Exclusion Criteria

The study included all children aged four to five years who were insured by the Austrian Health Insurance Fund in Vienna in 2013 and had received at least five insurance-covered services, such as extractions, surgical tooth removals, and fillings, within a quarter. Exclusion criteria comprised children who moved away, passed away, or were no longer eligible for coverage by the Austrian Health Insurance Fund in Vienna during the study period, preventing complete data collection. The study was limited to data from conservative dental departments, thereby excluding any information related to orthodontics or other treatments. Approval for the study was granted by the Ethics Committee (397-2021).

Data Collection

Data were sourced from all health insurance dental offices in Vienna, excluding privately billed offices. The data collection

	Female Endpoint=0	Female Endpoint=1	Male Endpoint=0	Male Endpoint=1
Number of values	85	106	124	138
Minimum	1	1	1	1
25% Percentile	4	2,75	5	3
Median	8	6	8,5	6
75% Percentile	14	10	13,75	10
Maximum	33	32	43	30
Range	32	31	42	29
95% CI of median				
Actual confidence level	97,05%	95,91%	96,16%	95,02%
Lower confidence limit	7	4	7	5
Upper confidence limit	10	8	10	7
Mean	10,21	6,953	10,69	7,348
Std. Deviation	7,694	5,448	8,631	5,931
Std. Error of Mean	0,8345	0,5292	0,7751	0,5049

TABLE 1 Descriptive analysis of the study cohort

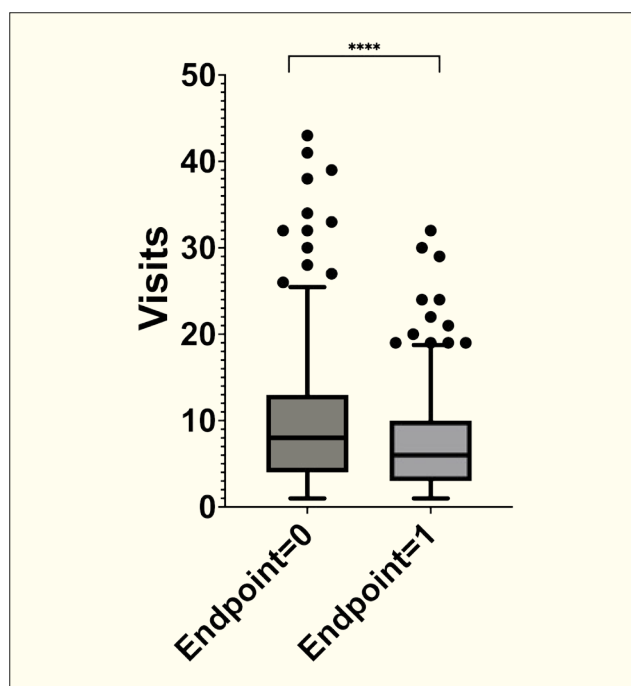


FIG. 1 Dental visits over the seven-year observational period. The average number of visits to the dentist was significantly higher for children who did not have caries in any of their permanent molars (endpoint=0) than for children who did have caries (endpoint=1).

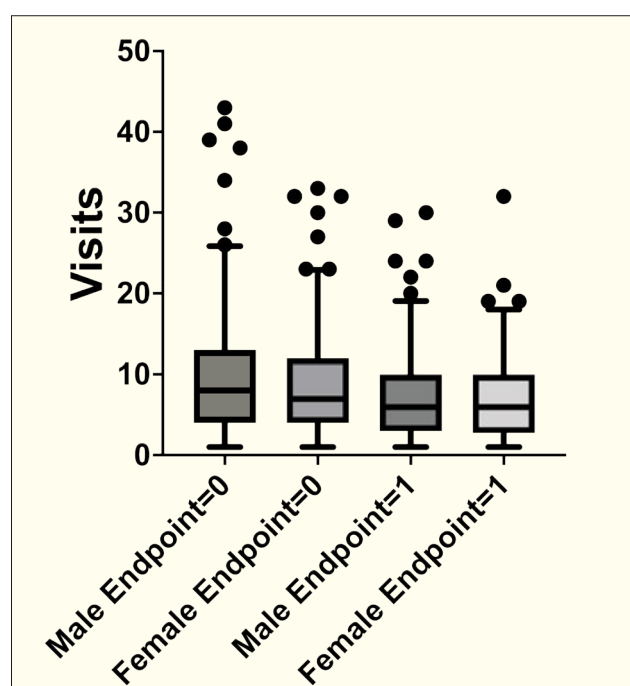


FIG. 2 Dental visits over the seven-year observational period, divided into two groups for boys and girls. Boys and girls had about the same number of visits to the dentist in this study even though boys demonstrated a higher prevalence of caries compared to girls.

and computations were conducted using SAS Enterprise Guide 8.3, utilising a binary logistic model. The Fisher information criterion was employed for optimisation. Additionally, GraphPad PRISM was used for data computation and visualization. Data confidentiality was ensured in compliance with the General Data Protection Regulation (GDPR), which permits the Austrian Health Insurance Fund to evaluate its own data for scientific purposes. The data were anonymised, provided without any personal identifiers, and used for further analysis.

Sample Collection

The year 2013 was chosen as the baseline, focusing on previously defined services and the age group of four to five years for sample collection. Each child needed to have at least five services billed within a quarter. However, the services from 2013 were excluded from the final analysis as they were used solely for initial sample inclusion. The study then followed a seven-year observation period from 2014 to the end of 2020. For the final analysis, all invasive services were correlated with the number of control appointments, which included services such as stomatitis treatments, radiographs, consultations, treatment of sensitive cervical areas, tartar removal, visits, and oral hygiene.

Criteria for Logistic Regression

The dependent variable was "restoration on first molar," a dichotomous variable indicating whether any identifiable services were billed on one of these permanent molars, including extractions, surgical tooth removals, and various fillings. The time at which these services first occurred during the study period (2014-2020) was added to the existing data pool. The endpoint was defined as follows:

- Endpoint = 0: No restoration by 2020.
- Endpoint = 1: Restoration by any identifiable service during the period.

The number of visits with control services was defined as an independent variable. Further independent variables are described in the following section.

Definition of Other Dependent and Independent Variables

In addition to the endpoint of restoration, the number of visits during 2014-2020 where services were billed was counted. Two services on the same billing date were considered as one visit, applying the same system for quarterly billing. Controlled services included billing for consultations, stomatitis treatment, dental radiography, treatment of sensitive cervical areas, tartar removal, radiograph status, panoramic radiography, visits, and oral hygiene.

Statistical Analysis

Statistical analyses were performed using SAS Enterprise Guide 8.3 and GraphPad PRISM for data computation and visualisation. Descriptive statistics, including means, standard deviations, and frequencies, were calculated for demographic variables such as age and gender. A binary logistic regression model was employed to assess the association between the frequency of dental visits (independent variable) and the need for restorative treatment on the first permanent molars (dependent variable). The Fisher scoring method was used for parameter estimation in the logistic regression model.

Several statistical tests and measures were utilised to evaluate the model and the predictors. The Wald Chi-Square Test was used to assess the significance of individual predictors within the logistic regression model. Odds Ratios (OR) with 95% confidence intervals were calculated to quantify the

strength and direction of the association between the number of dental visits and the likelihood of requiring restorative treatment. The Hosmer-Lemeshow test was conducted to evaluate the goodness-of-fit of the logistic regression model, ensuring that the model adequately fits the observed data. Throughout the analyses, a p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Data confidentiality was maintained throughout the study in compliance with GDPR regulations. The study was approved by the Ethics Committee (reference number 397-2021), and all data were anonymised to protect participant privacy.

Results

Study Cohort

The study included 465 patients who met the inclusion criteria of having at least five dental services within a quarter. Among these, 196 were female and 269 were male. Boys demonstrated a higher prevalence of caries compared to girls, suggesting a need for further research to explore whether boys are generally more susceptible to this condition. Of the cohort, 299 children were born in 2008 and 166 in 2009. The decrease of 133 children meeting the inclusion criteria after 2009 suggests potential positive changes in dietary and brushing habits over this period. Specifically, among the 299 children born in 2008, 131 were female and 168 were male. In the group born in 2009, 65 were female and 101 were male, again showing a majority of boys.

Descriptive Statistics

Table 1 shows that by 2020, after the seven-year observation period, 209 children (85 female and 124 male) did not reach the endpoint (Endpoint = 0), while 244 children (106 female and 138 male) did reach the endpoint (Endpoint = 1) through billings for services on one of the permanent molars. The average number of dental visits for those who did not reach the endpoint was 10.49, whereas those who reached the endpoint had an average of 7.18 visits until the first occurrence (Fig. 1). Boys demonstrated a higher prevalence of caries compared to girls, even though they had a similar number of visits in this study, or even slightly more in the "Endpoint = 0" group, highlighting the need for further research to explore whether boys are generally more susceptible to this condition (Fig. 2). The mean statistics for the independent variable "Total Control Visits to Endpoint" support the study's hypothesis: participants who reached the endpoint had fewer control visits at dentists in Vienna before requiring fillings, extractions, or surgical tooth removals. Conversely, those who did not reach the endpoint had more frequent control visits during the seven-year period.

Logistic Regression

The "Analysis of Maximum Likelihood Estimates" table indicates that the variable "Total Visits until the First Endpoint" significantly influences the model. The estimate of -0.0702 suggests that more control appointments decrease the likelihood of reaching Endpoint = 1, implying no billing for services on the first permanent molars. Conversely, fewer visits increase the likelihood of reaching Endpoint = 1. The negative sign indicates a directional relationship: more control visits correlate with a lower probability of reaching the endpoint. The intercept value of 0.7607 is significant,

indicating that even those who did not reach any endpoint during the study period still have a probability of reaching the endpoint in the future. This intercept is independent of the variable "Total Number of Visits until the First Endpoint" and applies to the group that has not yet reached any endpoint.

Discussion

This retrospective, quantitative, non-randomised, anonymised longitudinal study examined the occurrence of dental caries in children over a seven-year period, focusing on whether frequent dental visits can prevent the need for treatment of first permanent teeth. Our study provides compelling evidence that regular dental check-ups play a critical role in preventing the advancement of dental caries in children. The results demonstrate that children who have more frequent dental check-ups require fewer interventions for caries. Specifically, children without any service bills related to their first permanent molars visited the dentist more frequently than those with at least one service bill. This finding underscores the preventative power of regular dental care, highlighting that proactive dental visits can significantly reduce the need for caries-related treatments.

Our study aligns with previous research indicating that children with a high caries risk are less likely to attend toddler check-ups, suggesting a need for increased efforts to reach these children [Mühlemann and von Felten, 2021]. Moreover, older children with fewer dental check-ups showed more caries, both treated and untreated. This points to a gap in preventive care that, if addressed, could significantly improve children's oral health. Ensuring that high-risk children attend regular dental check-ups from an early age could be pivotal in mitigating caries onset. This is of paramount importance from a health policy perspective, as in some cases children are only taken for their first dental check-up when tooth decay is already present and needs to be treated [Mika et al., 2018].

Supporting our findings, studies have shown that protective factors such as regular dental check-ups and favorable socioeconomic conditions are strongly associated with better dental health outcomes [Hutchison, 2021]. Socioeconomic status has been identified as a significant risk factor for dental caries over time in young populations, suggesting that prevention programs should particularly focus on socioeconomically vulnerable groups [Östberg and Petzold, 2020; Cvikl et al., 2014]. Consistent regular check-ups could mitigate the impact of lower socioeconomic status on dental health, as early intervention and education play crucial roles.

The significance of regular check-ups is also highlighted by research indicating that children who received antenatal health care and had regular check-ups were significantly more likely to remain caries-free by age three [Nakai et al., 2016]. This finding emphasises the importance of early and regular dental care starting from a young age. Moreover, an oral health promotion intervention delivered via local Maternal and Child Health Nurses promoting early exposure to fluoride was shown to be effective in reducing caries in the second year of life, though its effectiveness diminished in older children with less contact with Maternal and Child Health Nurses [Neumann et al., 2011]. This suggests that continuous preventive measures and regular dental visits throughout the whole childhood are essential for sustained oral health.

Contrastingly, a study from Italy showed a significant difference in socioeconomic status but not in dental visit

execution, determined by a one-time questionnaire [Cianetti et al., 2017]. Older studies also indicated that the frequency of dental check-ups does not necessarily impact caries prevalence. For example, despite a decrease in the frequency of check-ups and preventive procedures between 1990 and 1995, there was no increase in caries prevalence [Kärkkäinen et al., 2001]. Additionally, caries prevalence in 8-year-old children halved between 1979 and 1989, despite no change in population structure or preventive measures [Varpio, 1992]. This could be interpreted as the effect of the fluoridation of toothpaste, especially in the 1970s, and the fact that dental check-ups focused more on the treatment of existing defects than on the prevention of new caries. It is only with the advent of modern individualized dentistry, in which the causes of caries development are discussed with the patient and individualized prophylaxis is considered, as in the ICDAS ICCMSTM system, that patients benefit from more frequent visits to the dentist.

One limitation of the study is that the data are exclusively from Vienna, Austria's capital. An East-West gradient in Austria indicates that children in Vienna generally have poorer oral health compared to other regions. Nevertheless, our findings show that regular dental check-ups significantly benefit children's oral health, and we assume this holds true for the rest of the country, warranting further studies for confirmation.

Additionally, only data from children treated by contracted dentists were included, excluding those whose treatment was privately paid. We assume that these children have fewer caries problems due to a better socioeconomic background but hypothesise they would also benefit from regular check-ups. This hypothesis needs verification through further studies.

Conclusion

Regular dental check-ups significantly reduce the need for restorative treatment on first permanent molars in children. Our study found that increased frequency of dental visits was associated with a lower likelihood of requiring invasive dental procedures over a seven-year period. These results emphasise the importance of consistent preventive dental care and support strategies promoting regular dental visits to enhance children's oral health.

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