

Effect of Cow's Milk Protein Allergy on the Frequency of Dental Caries in 2–6-year-old Children

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ABSTRACT

Cow's milk protein allergy is the most common type of food allergy in the first year of life, in which the child's dairy consumption should be limited, and it can have a significant impact on dental health. This study aimed to assess the frequency of dental caries in children with cow's milk protein allergy and to examine the relationship between this outcome and cow's milk protein allergy.

In this matched case-control study, 51 children aged 2 to 6 years with cow's milk protein allergy, and 51 healthy children were studied in 2 groups. A questionnaire regarding general information, socioeconomic status, health conditions, habits, nutritional information, dental history, and oral hygiene was completed for all children by asking their parents. Dental examinations were also performed, and the decayed, missing, and filled teeth (dmft) index was calculated. The Wilcoxon signed-rank and McNemar tests were used for statistical analyses, at a significance level of 0.05.

The mean dmft score was 5.74 ± 5.55 in children with cow's milk protein allergy and 1.92 ± 2.55 in the control group. A significant relationship existed between cow's milk protein allergy and increased frequency of dental caries. Also, the number of caries-free children was significantly lower in the group with cow's milk allergy.

Given the significant impact of dairy consumption in the early years of life on dental health, it seems necessary to implement more serious caries prevention measures, such as fluoride therapy and follow-up sessions, in children with cow's milk protein allergy.

Keywords: Child; Cow's milk protein allergy; Dental caries; Hypersensitivity

INTRODUCTION

Dental caries is recognized as one of the most common oral diseases in children and is a serious public

health dilemma. This chronic disease has a high prevalence in children, and can cause pain and infection, as well as disrupt eating and speech. It can also have long-term effects on children's quality of life, academic

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performance, and psychosocial development.^{1,2}

Dental caries usually occurs due to an imbalance between the demineralization and remineralization processes on the surface of tooth enamel. The key factor in the initiation of dental caries in children is the formation of microbial biofilm on tooth surfaces, along with the presence of predisposing factors such as tooth structure, quality and quantity of the saliva, and dietary habits. Bacteria use sugars in the diet, especially sucrose, and produce acid, which over time leads to a reduction in pH below the critical threshold of 5.5, causing the dissolution of enamel minerals. If this situation is not controlled, it will lead to the formation of incipient carious lesions and ultimately result in complete destruction of the tooth structure.³ Among the predisposing factors, nutrition is an important determining factor.³

Food allergies refer to abnormal reactions of the body that are caused by the immune system's response to food components. Cow's milk protein allergy is the most common type of food allergy in the first year of life, occurring in approximately 0.3% to 6% of children under 6 years of age.^{4,5} One reason for the high prevalence of cow's milk protein allergy is that proteins are also transmitted to the infant through dairy products consumed by the mother, in addition to direct ingestion of cow's milk protein by the infant.⁵ Cow's milk contains more than 20 protein components; beta-lactoglobulin and casein are the 2 main proteins responsible for causing allergies, both of which are also present in breast milk.^{6,7}

When the body is exposed to an allergenic protein, the immune system recognizes the protein and is stimulated to mount a response, including the release of histamine and other immune mediators. The release of these chemicals causes the signs and symptoms of cow's milk allergy, manifesting as a wide range of acute symptoms, including urticaria, itching, and airway constriction, and delayed symptoms, such as gastrointestinal disorders, including gastroenterocolitis, enteropathy, and proctocolitis. These signs and symptoms are variable and can recur by the age of 6 years.^{6,7} Children with cow's milk protein allergy may have several oral and dental problems, such as inflammation and swelling of the oral mucosa and discomfort when eating and talking, dry mouth and decreased salivation, an increased risk of dental caries, decreased dairy consumption and calcium deficiency, and increased enamel hypoplasia, as well as tooth

erosion caused by reflux of stomach acid into the oral cavity.

Since cow's milk has higher calcium and lower sugar content than breast milk, it can have a positive effect on increasing enamel remineralization and exert cariostatic properties; thus, it is recommended to be included in children's diet.⁸

Studies have confirmed that the frequency of dental caries increases from early childhood in children with lower dairy intake. Therefore, cow's milk protein allergy can cause stress for parents and families due to a milk-free diet and, if not treated properly, can lead to subsequent nutritional deficiencies.⁹⁻¹²

Previous studies that examined oral conditions and dental caries showed that cow's milk protein allergy and lactose intolerance increase the rate of dental caries.¹³⁻¹⁵ On the other hand, it has been shown that dental abnormalities such as hypoplasia have a higher frequency in these children, but no significant association was observed with early childhood caries.¹⁵ Also, dental erosion due to gastroesophageal reflux had a higher frequency in these children.¹³

Studies on Iranian children with cow's milk protein allergy have only addressed their growth and development and treatment of symptoms,¹⁶⁻²⁰ and to the best of the authors' knowledge, no study has addressed dental caries in these children. Therefore, this study was designed to assess the frequency of dental caries in a sample of Iranian children with cow's milk protein allergy.

MATERIALS AND METHODS

This matched case-control study was ethically approved by Tehran University of Medical Sciences with the ethics code IR.TUMS.DENTISTRY.REC.1400.100 and was conducted on 2 groups of children with and without cow's milk protein allergy. The sample size was calculated to be a minimum of 48 in each of the 2 groups according to a study by Moimaz et al,¹⁴ using the paired means power analysis feature of PASS version 11 and considering $\alpha=0.05$, $\beta=0.05$ and the mean standard deviation of the decayed, missing, and filled teeth (dmft) index score equal to 1.87 to detect a significant difference equal to 1 unit between the 2 groups.

Children aged 2–6 years were selected among those referred to the pediatric allergy clinic of Mofid

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Children's Hospital, Iran, based on the inclusion criteria (no systemic respiratory, cardiac, or renal diseases; no seizures; toothbrushing at least once a day; and consuming sweets less than twice a day) and the exclusion criteria (allergy to specific foods, use of specific medications, presence of enamel hypoplasia, presence of oral habits such as thumb sucking or mouth breathing, and lack of daily toothbrushing). The selection process continued from summer 2022 to winter 2023 until 51 children were included in the patient (allergy) group. All were being treated by a specialist and had their medical records with all tests at the clinic. Next, 51 children without a history of cow's milk protein allergy were selected from the referrals to the department of dentistry of the hospital, matched by age and sex.

The parents received necessary information about the study and were assured that their child's information would remain confidential and that their child's treatment would not be disrupted if they did not participate in the study. After obtaining their written informed consent, a questionnaire was provided to the child's parents to record the patient's personal information. This questionnaire included questions related to the patient's demographic information, duration of allergy, medications used, breastfeeding of the child, and special formula feeding.

The children then underwent a clinical dental examination, and their dmft index score was calculated according to the World Health Organization criteria²¹ to assess their oral health status. A trained, calibrated dental student performed the clinical oral examinations. To assess intra-examiner agreement, the clinical oral examination was randomly repeated after 2 weeks for 30 children, and the reproducibility of the results was

calculated to be 100% (Kappa=1). All children were examined in a room within the school premises, under good natural lighting. When necessary, illumination was provided by a portable flashlight. The examiner wore a surgical facemask and gloves and performed the examination in a standing position. He used probes with ball tips and sterile dental mirrors in compliance with biosafety standards. For each child, the clinical examination was started by assessing the buccal, lingual, palatal, and occlusal surfaces of the teeth in the maxillary right quadrant, followed by the maxillary left quadrant, mandibular left quadrant, and mandibular right quadrant, and the dmft of each child was recorded.

The Wilcoxon signed-rank and McNemar tests were used in SPSS version 25 to analyze the data regarding the study variables. The significance level was set at 0.05.

RESULTS

Of a total of 102 children that were enrolled, 51 children with cow's milk protein allergy were assigned to the patient (allergy) group, and 51 healthy children were assigned to the control group. The mean age of the children was 47.8 ± 15.57 months in the allergy group, and 48.5 ± 15.42 months in the control group. Also, there were 32 boys (62.7%) and 19 girls (37.2%) in the allergy group, and 31 boys (60.7%) and 20 girls (39.2%) in the control group.

The mean dmft scores in the 2 study groups are presented in Table 1. The number of caries-free individuals was 13 (25.49%) in the patient group and 25 (49.01%) in the control group. A dmft score above 10 was reported in 25% of cases ($n=13$) and 1.9% of controls ($n=1$).

Table 1. Frequency distribution of sound, decayed, filled, and missing (due to caries) teeth in the two study groups

Group	Decayed Teeth (dt), mean (SD)	Filled Teeth (ft), mean (SD)	Missing Teeth (mt), mean (SD)	dmft, mean (SD)
Patient (allergy) group	5.33 (5.14)	0.27 (0.86)	0.20 (0.74)	5.74±5.55
Control (healthy) group	1.62 (2.30)	0.27 (0.93)	0.02 (0.14)	1.92±2.55
Mean Diff (95% CI)	3.71 (2.25 to 5.16)	0.18 (-0.35 to 0.39)	0.00 (-0.32 to 0.32)	3.82 (2.28 to 5.36)
<i>p</i>	<0.001	0.877	0.048	<0.001

CI: confidence interval; dmft: decayed, missing, and filled teeth; dt: decayed teeth; ft: filled teeth; mt: missing teeth; SD: standard deviation.

The Wilcoxon signed-rank test showed that the 2 groups had statistically significant differences in terms of the mean mt, dt, and dmft.

The frequency of sound, decayed, filled, and missing (due to caries) teeth was extracted separately for each tooth in both the patient and control groups. The highest rate of caries was related to the primary second molars, and the lowest caries rate was related to the mandibular lateral incisors. The distribution of caries frequency by

tooth in the two groups is presented in Figures 1 and 2. The McNemar test showed a statistically significant difference in caries rate between the two groups ($p<0.038$), such that the patient group had a significantly higher rate of caries. Also, the number of caries-free children in the patient group was significantly lower than that in the healthy control group ($p<0.001$). Carious mandibular incisors and dental erosion were also observed in the patient group.

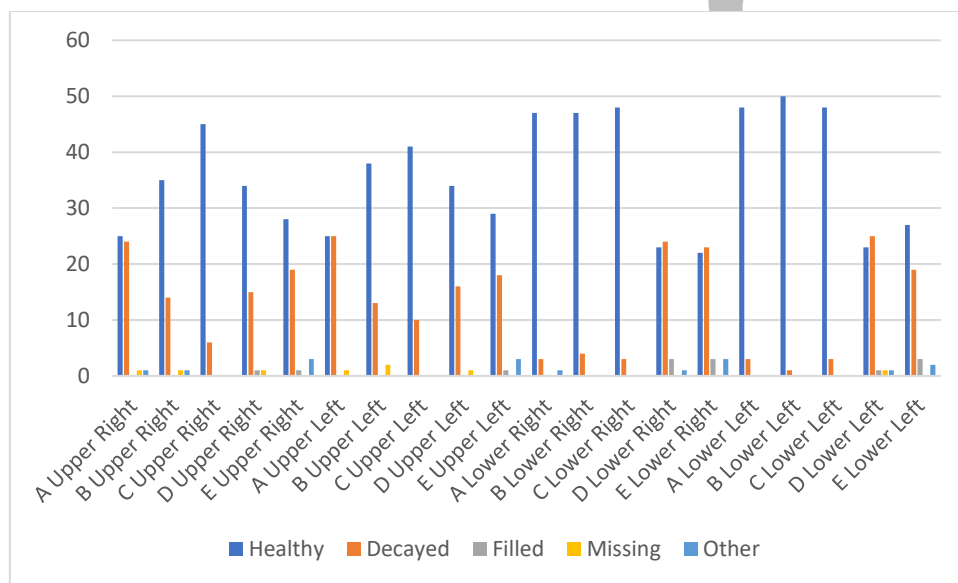


Figure 1. Frequency distribution of sound, decayed, filled, and missing (due to caries) teeth by tooth type in the group with cow's milk protein allergy.

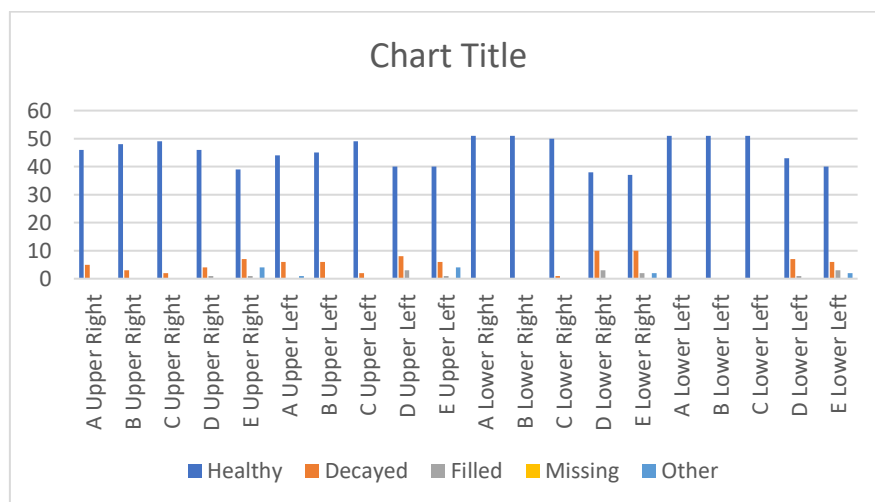


Figure 2. Frequency distribution of sound, decayed, filled, and missing (due to caries) teeth by tooth type in the group without cow's milk protein allergy.

DISCUSSION

The present results showed that there was a statistically significant relationship between the dmft index and cow's milk protein allergy, such that compared with healthy children, children with this type of allergy had a higher frequency of dental caries. Also, the number of caries-free individuals among children with cow's milk allergy was significantly lower than that in the healthy control group, and a dmft score above 10 was significantly more frequent among children in the allergy group than in the healthy control group. Moreover, regarding the pattern of dental caries, caries in the mandibular incisors, which rarely occurs, was observed in the allergy group.

Moimaz et al,¹⁴ in their study (2018) investigated the oral status of children with cow's milk protein allergy and reported that the mean dmft score was significantly higher in those with cow's milk protein allergy, which is consistent with the current results. They added that the majority of the dmft score (74%) was related to the decayed teeth component, which is in agreement with the present results. Moreover, the current results revealed that although the rate of dental caries was high in the allergy group, the ratio of the number of filled teeth to the dmft score in the patient group was 4.4%, while this ratio was 14% in the control group. This ratio indicates that despite the greater need for treatment in the allergy group, dental treatment was less performed in this group.

The present results regarding dental erosion revealed that 2 children with cow's milk protein allergy had dental erosion, whereas none of the children in the control group had dental erosion. Also, no statistically significant relationship was found between dental erosion and allergy to cow's milk protein in children. In a review study by Altan et al¹³ in 2019, it was stated that based on the reviewed studies, 40% of infants are allergic to cow's milk, which delays gastric emptying and causes symptoms of reflux and vomiting. They stated that these children suffer from gastroesophageal reflux disease (GERD) due to multiple refluxes. It was further stated that children with GERD have a higher rate of dental erosion than healthy children of the same age, which is inconsistent with the present results. This discrepancy could be because most cases of reflux caused by allergies are treated and controlled before the child's first tooth erupts.¹³

Among the causes of increased frequency of dental caries in children with cow's milk protein allergy is the increased reflux of acid and stomach contents. Linnett et al,²² in their study on children with GERD, stated that caries in the form of total DMFT/dmft was higher in affected children than in healthy children, which is in agreement with the current results. They also added that there was no difference in the number of eroded primary teeth between the 2 groups of children with GERD and healthy children, which is in line with the current results. In another study, Ersin et al²³ did not report a significant difference in the dmft score, but they concluded that the risk of caries in children with GERD was higher than that in healthy children of the same age, and the former group needs more attention.²³ Another noteworthy topic is the consumption of formulae that replace milk and dairy products by these children. Some of these formulae contain sugar and can increase dental caries. Evidence shows that the formulation of some of these formulae increases the *Streptococcus mutans* count.^{24,25} In the present study, a large number of children with cow's milk protein allergy consumed formula, which could be an underlying cause for the increased risk of caries in these children.

Children were selected based on the inclusion criteria, such as toothbrushing at least once a day, and consuming sweets less than twice a day, and the exclusion criteria, such as mouth breathing and lack of daily toothbrushing, which are important influencing factors for dental caries. Therefore, these factors could not be considered confounders in this study. Additionally, children were selected from referrals to the Allergy clinic, and they were from families with the similar levels of education or socioeconomic status.

The present results were obtained considering limitations such as lack of sufficient information on the long-term oral health of children. Future studies on larger populations are recommended to address these limitations.

Based on the results, children with cow's milk protein allergy may be at increased risk of dental caries, especially if they consume formula containing sugar or have a poor diet. There is also a possibility of enamel erosion due to associated GERD. Therefore, oral health monitoring through regular dental check-ups and attention to enamel and signs of erosion, education of parents to perform oral hygiene procedures and fluoride therapy for their children, as well as the appropriate

selection of alternative milk formula with less sugar, should be part of the routine care for these children. It is also necessary for dentists to be cautious about prescribing toothpastes containing milk protein.

STATEMENT OF ETHICS

This matched case-control study was ethically approved by Tehran University of Medical Sciences with the ethics code IR.TUMS.DENTISTRY.REC.1400.100.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

AI ASSISTANCE DISCLOSURE

No artificial intelligence (AI) tools were used in the preparation of this manuscript.

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