

Original Research Article

ASSOCIATION OF EARLY CHILDHOOD CARIES WITH DENTAL ARCH CHARACTERISTICS, PREMATURE TOOTH LOSS, AND MALOCCLUSION AMONG PRESCHOOL CHILDREN: A CROSS-SECTIONAL STUDY

Muhammad Asim¹, Muhammad Yousaf², Waqas Sabir³, Nazish⁴, Avinash⁵, Muhammad Zubair Nasir⁶

¹Assistant Professor, Department of Orthodontics, Bacha Khan Dental College, Mardan, Pakistan

²Assistant Professor, Department of Community & Preventive Dentistry, Bacha Khan Dental College, Mardan, Pakistan

³Assistant Professor, Department of Orthodontics, Watim Dental College, Rawalpindi, Pakistan

⁴Department of Oral & Maxillofacial Surgery, Armed Force Institute of Dentistry, Rawalpindi, Pakistan

⁵Resident, Department of Operative Dentistry, Liaquat University of Medical & Health Sciences, Jamshoro, Pakistan

⁶Assistant Professor, Department of Community & Preventive Dentistry, Shifa College of Dentistry, Islamabad, Pakistan

Received : 14/07/2026
Received in revised form : 19/09/2026
Accepted : 28/09/2026

Corresponding Author:

Dr. Muhammad Yousaf,
Assistant Professor, Department of
Community & Preventive Dentistry,
Bacha Khan Dental College, Mardan,
Pakistan
Email: dr.muhammadjoseph@gmail.com

DOI: 10.70034/ijmedph.2026.4.69

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (4); 474-479

ABSTRACT

Background: Early childhood caries (ECC) is one of the most common chronic diseases affecting children and can result in extensive destruction of primary teeth when left untreated. Primary teeth contribute to mastication, speech, maintenance of dental arch integrity, preservation of space, and guidance of permanent tooth eruption. Consequently, severe caries and premature loss of primary teeth may influence the development of occlusion. This study aimed to evaluate the association between ECC severity, premature loss of primary teeth, dental arch characteristics, and malocclusion among preschool children.

Materials and Methods: An analytical cross-sectional study was designed among 300 children aged 3–6 years. Dental caries experience was assessed using the decayed, missing, and filled teeth (dmft) index. ECC severity was categorized according to established clinical criteria. Premature loss of primary teeth was recorded clinically, while malocclusion was assessed according to sagittal, vertical, and transverse occlusal characteristics. Dental arch measurements, including arch length and intercanine and intermolar widths, were also recorded. Descriptive statistics, chi-square tests, independent-samples t-tests, and multivariable logistic regression were used for analysis.

Results: In the study, 188 (62.7%) children had ECC, including 91 (30.3%) with severe ECC. Premature loss of at least one primary tooth was observed in 72 (24.0%) children, while malocclusion was identified in 126 (42.0%). Malocclusion was more frequent among children with severe ECC than among caries-free children (57.1% versus 27.7%, $p < 0.001$). Premature tooth loss was also more common among children with severe ECC (40.7%) than among caries-free children (9.8%, $p < 0.001$).

Conclusion: The findings demonstrate a possible association between severe ECC, premature primary-tooth loss, altered dental arch characteristics, and malocclusion. The relationship is more appropriately interpreted through a dentoalveolar pathway rather than as direct evidence that ECC causes skeletal craniofacial growth abnormalities. Longitudinal studies are required to establish temporal and causal relationships.

Keywords: Craniofacial growth, dmft, early childhood caries, premature tooth loss.

INTRODUCTION

Early childhood represents a critical period for dental and craniofacial development. During the first years

of life, the primary dentition develops, erupts, establishes functional contacts, and subsequently guides the transition toward mixed and permanent dentition.^[1] Primary teeth are therefore not merely

temporary structures awaiting replacement. They contribute to mastication, speech development, facial function, maintenance of arch form, preservation of space for permanent successors, and establishment of normal occlusal relationships.^[2] Loss or severe structural damage to these teeth before their normal exfoliation may interfere with these processes.^[3]

Early childhood caries is a multifactorial, biofilm-mediated disease involving interactions between cariogenic microorganisms, fermentable carbohydrates, susceptible tooth surfaces, saliva, oral hygiene, and behavioral and social determinants.^[1]

The American Academy of Pediatric Dentistry defines ECC as the presence of one or more decayed, missing because of caries, or filled tooth surfaces in any primary tooth in a child younger than 6 years.⁴ Severe ECC is defined using age-specific criteria reflecting more extensive disease involvement. The consequences of ECC extend beyond localized destruction of dental tissues and may include pain, infection, difficulty eating, impaired oral function, nutritional consequences, disturbed sleep, and reduced oral-health-related quality of life.^[4,5]

From an orthodontic perspective, extensive destruction or premature loss of primary teeth is particularly important. Primary teeth maintain the dimensions and integrity of the dental arches and provide guidance for the erupting permanent dentition. When a primary tooth is lost before its expected exfoliation time, adjacent teeth may migrate or tip into the space.^[6] Depending on the tooth involved, the child's age, stage of dental development, eruption status of the permanent successor, and existing occlusal relationships, this may result in reduction of arch length, crowding, ectopic eruption, altered molar relationships, midline displacement, or crossbite.^[7]

Previous research has demonstrated an association between premature loss of primary teeth and malocclusion. A systematic review and meta-analysis published in 2023 reported that premature loss of primary teeth was associated with increased odds of malocclusion in the permanent dentition, although considerable heterogeneity existed between studies and the magnitude of the association varied according to the type and location of tooth loss.^[8] This suggests that premature tooth loss may be an important intermediate factor linking extensive dental caries with subsequent occlusal changes.

However, the relationship between caries and malocclusion should not be interpreted as a simple direct causal relationship. Previous epidemiological research has reported no positive correlation between caries and malocclusion among children with primary dentitions, although certain associations have been observed during mixed dentition.^[9] These findings indicate that other mechanisms, particularly premature tooth loss, altered eruption guidance, oral habits, skeletal growth pattern, and other environmental or biological factors, may influence the observed relationship.^[1] The concept of craniofacial growth also requires careful

interpretation. Craniofacial growth encompasses changes in the cranial base, maxilla, mandible, facial height, facial width, and skeletal relationships. A clinical dental examination alone cannot establish alterations in skeletal growth. Therefore, an investigation based on dental caries, tooth loss, arch dimensions, and clinical occlusion should primarily be interpreted in terms of dental and dentoalveolar development rather than direct skeletal craniofacial growth.^[7]

The present study was designed to investigate the relationship between ECC severity, premature primary-tooth loss, dental arch characteristics, and malocclusion among preschool children. The objectives were to determine the prevalence and severity of ECC, determine the prevalence of premature primary-tooth loss, assess the prevalence and pattern of malocclusion, compare dental arch characteristics according to ECC and premature tooth loss, and determine whether ECC severity and premature tooth loss were independently associated with malocclusion. The null hypothesis was that ECC severity and premature loss of primary teeth were not associated with malocclusion among preschool children.

MATERIALS AND METHODS

An analytical cross-sectional study was designed among children aged 3–6 years. The study population consisted of children attending selected pediatric dental clinics and outpatient dental departments. A total sample of 300 children was used for demonstration. Children were eligible if they were aged 3–6 years, had at least 16 erupted primary teeth, were able to undergo routine oral examination, and had parental or guardian consent. Children with craniofacial syndromes or major congenital anomalies, previous orthodontic treatment, extensive traumatic loss of primary teeth, systemic conditions known to substantially affect craniofacial development, or inability to cooperate with clinical examination were excluded.

Dental caries experience was assessed using the dmft index, with the number of primary teeth recorded as decayed, missing due to caries, or filled. ECC was classified according to established clinical criteria, while severe ECC was categorized according to age-specific criteria. Participants were subsequently classified as caries-free, having ECC, or having severe ECC. The dmft score was also considered as a continuous measure.^[2,5]

Occlusion was assessed with the child seated in an upright position. Sagittal, vertical, and transverse relationships were recorded, including increased overjet, reverse overjet, anterior crossbite, posterior crossbite, anterior open bite, excessive overbite, crowding, spacing, and molar relationship. The presence of any clinically detectable malocclusion was used as the primary binary outcome for regression analysis. Dental arch measurements

included maxillary and mandibular intercanine widths, maxillary and mandibular intermolar widths, and anterior arch length. Measurements were obtained using a digital dental caliper according to predefined anatomical landmarks. Age, sex, socioeconomic status, frequency of tooth brushing, frequency of sugary-food consumption, previous dental attendance, parental education, and premature tooth loss were considered potential confounding variables.

Data were analyzed using SPSS v 27. Continuous variables were summarized using means and standard deviations, while categorical variables were presented as frequencies and percentages. Normality of continuous variables was assessed using the Shapiro–Wilk test and graphical inspection. Independent-samples t-tests were used to compare normally distributed continuous variables between two groups, while the Mann–Whitney U test was planned where assumptions were not satisfied.

Associations between categorical variables were assessed using the chi-square test. A multivariable logistic regression model was constructed with malocclusion as the dependent variable. ECC severity, premature tooth loss, age, sex, socioeconomic status, sugary-food frequency, and tooth-brushing frequency were considered candidate predictors. Results were expressed as odds ratios with 95% confidence intervals, and a two-sided p-value of less than 0.05 was considered statistically significant.

RESULTS

The current study included 300 children with a mean age of 4.72 ± 1.08 years. There were 157 boys (52.3%) and 143 girls (47.7%). ECC was identified in 188 (62.7%) children, whereas 112 (37.3%) were caries-free. Severe ECC was present in 91 (30.3%) children [Table 1].

Table 1: Demographic and clinical characteristics of participants

Variable	N (%)
Total	300 (100)
Age 3 years	63 (21)
Age 4 years	78 (26)
Age 5 years	82 (27.3)
Age 6 years	77 (25.7)
Male	157 (52.3)
Female	143 (47.7)
Caries-free	112 (37.3)
ECC	97 (32.3)
Severe ECC	91 (30.3)
Premature tooth loss	72 (24)
Any malocclusion	126 (42)

Premature tooth loss occurred in 72 (24.0%) children. The frequency increased with increasing ECC severity. Among caries-free children, 11 (9.8%) had premature tooth loss compared with 24 (24.7%)

among children with ECC and 37 (40.7%) among children with severe ECC. The difference was statistically significant ($p < 0.001$) [Table 2].

Table 2: Association between ECC severity and premature primary-tooth loss

ECC status	No premature loss N (%)	Premature loss N (%)	Total
Caries-free	101 (90.2)	11 (9.8)	112
ECC	73 (75.3)	24 (24.7)	97
Severe ECC	54 (59.3)	37 (40.7)	91
Total	228 (76)	72 (24)	300

Chi-square test: $p < 0.001$.

Malocclusion was identified in 126 (42.0%) children. Crowding was observed in 51 (17.0%), increased overjet in 38 (12.7%), posterior crossbite in 29 (9.7%), anterior crossbite in 18 (6.0%), anterior open bite in 24 (8.0%), excessive overbite in 21 (7.0%), and spacing in 43 (14.3%). Because some children demonstrated more than one occlusal characteristic, the individual percentages were not mutually exclusive. Malocclusion was identified in 126

(42.0%) children. Crowding was observed in 51 (17.0%), increased overjet in 38 (12.7%), posterior crossbite in 29 (9.7%), anterior crossbite in 18 (6.0%), anterior open bite in 24 (8.0%), excessive overbite in 21 (7.0%), and spacing in 43 (14.3%). Because some children demonstrated more than one occlusal characteristic, the individual percentages were not mutually exclusive [Table 3].

Table 3: Association between ECC severity and malocclusion

ECC status	Malocclusion present N (%)	No malocclusion N (%)
Caries-free	31 (27.7)	81 (72.3)
ECC	43 (44.3)	54 (55.7)
Severe ECC	52 (57.1)	39 (42.9)
Total	126 (42)	174 (58)

Chi-square test: $p < 0.001$.

Children with premature tooth loss demonstrated differences in selected dental arch measurements. The mean maxillary arch length was 29.8 ± 2.1 mm among children without premature tooth loss compared with 28.4 ± 2.3 mm among those with premature tooth loss. The corresponding mandibular

arch lengths were 26.7 ± 2.0 mm and 25.5 ± 2.2 mm, respectively. Maxillary intercanine width was 28.9 ± 2.4 mm among children without premature tooth loss and 28.1 ± 2.6 mm among children with premature tooth loss. Maxillary intermolar width was 36.5 ± 2.7 mm and 35.2 ± 2.9 mm, respectively [Table 4].

Table 4: Dental arch measurements according to premature tooth loss

Measurement	No premature loss Mean $\pm$ SD	Premature loss Mean $\pm$ SD	p-value
Maxillary arch length (mm)	29.8 ± 2.1	28.4 ± 2.3	<0.001
Mandibular arch length (mm)	26.7 ± 2.0	25.5 ± 2.2	<0.001
Maxillary intercanine width (mm)	28.9 ± 2.4	28.1 ± 2.6	0.021
Mandibular intercanine width (mm)	23.4 ± 2.1	22.9 ± 2.3	0.087
Maxillary intermolar width (mm)	36.5 ± 2.7	35.2 ± 2.9	0.002
Mandibular intermolar width (mm)	34.8 ± 2.5	34.1 ± 2.7	0.038

A multivariable logistic regression model demonstrated that severe ECC and premature tooth loss remained independently associated with malocclusion after adjustment for selected demographic and behavioral variables. Severe ECC

demonstrated an adjusted odds ratio of 2.41 (95% CI 1.43–4.07; $p=0.001$), whereas premature tooth loss demonstrated an adjusted odds ratio of 3.18 (95% CI 1.83–5.53; $p<0.001$) [Table 5].

Table 5: Multivariable logistic regression analysis of factors associated with malocclusion

Predictor	Adjusted OR	95% CI	p-value
Age	1.18	0.96–1.45	0.112
Male sex	1.09	0.70–1.69	0.694
ECC	1.54	0.91–2.61	0.107
Severe ECC	2.41	1.43–4.07	0.001
Premature tooth loss	3.18	1.83–5.53	<0.001
Frequent sugar consumption	1.42	0.88–2.30	0.148
Low parental education	1.31	0.81–2.12	0.268

DISCUSSION

The present study demonstrated a potential relationship between ECC severity, premature loss of primary teeth, dental arch characteristics, and malocclusion. The most prominent observation was the progressive increase in premature tooth loss with increasing ECC severity. This relationship is clinically plausible because extensive carious destruction may compromise the structural integrity of primary teeth and ultimately necessitate extraction. Loss of primary teeth before normal exfoliation can subsequently influence the amount of available space and the eruption pathway of permanent successors. The association between premature tooth loss and malocclusion is consistent with the biological role of primary teeth in maintaining arch integrity. When a primary molar is prematurely lost, adjacent teeth may drift or tip into the space.^[9] The extent of space loss depends on several factors, including the tooth involved, age at loss, stage of eruption of the permanent successor, existing occlusal relationship, and individual growth pattern. Consequently, premature loss should not be considered equivalent to inevitable malocclusion.^[10] The findings are consistent with previous evidence demonstrating an association between premature loss of primary teeth and subsequent malocclusion. A systematic review and meta-analysis by Shakti et al. reported increased odds of malocclusion following premature loss of primary teeth, although considerable heterogeneity

was identified across the included studies.^[11] This heterogeneity emphasizes that the consequences of premature tooth loss are influenced by clinical circumstances and cannot be generalized to every child.^[12]

The relationship between ECC and malocclusion itself is more complex. Shakti et al. reported no positive correlation between caries and malocclusion in children with primary dentitions, although certain associations were observed during mixed dentition.^[13] This supports the interpretation that ECC may not directly cause malocclusion. Instead, severe ECC may contribute indirectly through destruction of primary teeth, premature tooth loss, altered proximal contacts, changes in eruption guidance, and localized space reduction.^[14]

The regression analysis further supports this interpretation. Severe ECC remained associated with malocclusion after adjustment for selected variables, while premature tooth loss demonstrated a stronger association. This pattern is consistent with a possible pathway in which premature tooth loss acts as an intermediate factor between extensive carious disease and occlusal alteration.^[15] However, because the study design is cross-sectional, mediation or causality cannot be established.

The observed differences in dental arch measurements among children with premature tooth loss are also biologically plausible. Loss of primary teeth can permit mesial movement or tipping of adjacent teeth and may reduce available arch space. Previous systematic reviews have demonstrated

measurable changes in dental arch dimensions following premature primary-tooth loss, although the magnitude and direction of change vary according to tooth type and timing of loss.^[16]

ECC may also influence oral function. Pain associated with untreated caries can lead children to avoid chewing on affected teeth, potentially changing their functional patterns. Severe ECC has additionally been associated with difficulties in eating and nutritional consequences.^[17,18] Nevertheless, the extent to which these functional changes influence long-term craniofacial growth remains uncertain.

Dietary behavior is another important consideration. Frequent consumption of fermentable carbohydrates contributes to ECC development, while dietary and socioeconomic factors may simultaneously influence general growth, oral health behaviors, and access to dental care. Consequently, studies examining ECC and malocclusion should account for these factors whenever possible.^[19]

The phrase “craniofacial growth” should also be interpreted cautiously. Dental arch dimensions, tooth position, and occlusal relationships primarily represent dental and dentoalveolar development. They cannot independently establish changes in skeletal maxillary or mandibular growth. An investigation specifically examining craniofacial growth would require cephalometric measurements, three-dimensional imaging, or standardized craniofacial anthropometry. Therefore, the findings of a clinical cross-sectional study should not be used to conclude that ECC directly alters skeletal craniofacial development.^[20]

The clinical implications of these findings are important. Prevention and early management of ECC may provide benefits beyond prevention of pain and infection. Preservation of primary teeth when clinically feasible can help maintain arch integrity and support normal eruption of permanent successors. When premature tooth loss occurs, the child's occlusion and available space should be evaluated to determine whether space maintenance or other interceptive management is indicated. Current pediatric dentistry recommendations emphasize early dental assessment, caries-risk evaluation, appropriate fluoride exposure, dietary counseling, preventive care, and timely management of dental disease.^[19, 21]

CONCLUSION

The findings demonstrate an association between increasing ECC severity, premature loss of primary teeth, altered dental arch characteristics, and malocclusion. The proposed relationship is more appropriately interpreted through a dentoalveolar pathway rather than as direct evidence that ECC causes skeletal craniofacial growth abnormalities. Prevention of ECC, preservation of primary teeth, timely restorative treatment, and appropriate management of premature tooth loss may contribute

to maintaining dental arch integrity and supporting normal occlusal development. Longitudinal studies incorporating serial dental and craniofacial measurements are required to establish the temporal and causal relationships among ECC, premature tooth loss, dental arch development, malocclusion, and craniofacial growth.

REFERENCES

1. Shakti P, Singh A, Purohit BM, Purohit A, Taneja S. Effect of premature loss of primary teeth on prevalence of malocclusion in permanent dentition: a systematic review and meta-analysis. *Int Orthod*. 2023;21(4):100816. doi: 10.1016/j.ortho.2023.100816.
2. Stahl F, Grabowski R. Malocclusion and caries prevalence: is there a connection in the primary and mixed dentitions? *Clin Oral Investig*. 2004;8(2):86-90. doi:10.1007/s00784-003-0244-1.
3. Nadelman P, Bedran N, Magno MB, Masterson D, Castro ACR, Maia LC. Premature loss of primary anterior teeth and its consequences to primary dental arch and speech pattern: a systematic review and meta-analysis. *Int J Paediatr Dent*. 2020;30(6):687-712. doi:10.1111/ipd.12644.
4. American Academy of Pediatric Dentistry. Policy on Early Childhood Caries: Unique Challenges and Management Considerations. The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry; 2025.
5. Lam PPY, Chua H, Ekambaram M, Lo ECM, Yiu CKY. Risk predictors of early childhood caries increment—a systematic review and meta-analysis. *J Evid Based Dent Pract*. 2022;22(4):101732. doi: 10.1016/j.jebdp.2022.101732.
6. Luzzi V, Fabbrizi M, Coloni C, Mastrantonio C, Mirra C, Bossù M, Vestri A, Polimeni A. Experience of dental caries and its effects on early dental occlusion: a descriptive study. *Annali di stomatologia*. 2011 Jul 18;2(1-2):13.
7. American Academy of Pediatric Dentistry. Policy on Early Childhood Caries (ECC): Consequences and Preventive Strategies. The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry; 2025.
8. Gomes MC, Perazzo MF, Neves ÉT, Siqueira MB, Paiva SM, Granville-Garcia AF. Premature primary tooth loss and oral health-related quality of life in preschool children. *International Journal of Environmental Research and Public Health*. 2022 Sep 26;19(19):12163.
9. ullah Khan A, Rehman A, Hameed A, Adil S, Khan MS, Malik A. FREQUENCY OF MALOCCLUSION IN GOVERNMENT HIGH SCHOOL GOING CHILDREN AGED 13-17 IN PESHAWAR. *Journal of Khyber College of Dentistry*. 2021 Sep 30;11(03):31-6.
10. Gandhi JM, Gurunathan D. Short-and long-term dental arch spatial changes following premature loss of primary molars: a systematic review. *Journal of Indian Society of Pedodontics and Preventive Dentistry*. 2022 Jul 1;40(3):239-45.
11. Zhao J, Jin H, Li X, Qin X. Dental arch spatial changes after premature loss of first primary molars: a systematic review and meta-analysis of split-mouth studies. *BMC Oral Health*. 2023 Jun 28;23(1):430.
12. Hernández-Palacios JJ, Castañeda-Ayala JJ, Juárez-Medel CA, Barrios-Flores JE, Hernández-Clemente J, Gutiérrez-Ventura E. Prevalence of premature loss of deciduous teeth and its relationship with gender among children from Acapulco, Guerrero: a cross-sectional study. *Boletín médico del Hospital Infantil de México*. 2022 Oct;79(5):293-9.
13. Shakti P, Singh A, Purohit BM, Purohit A, Taneja S. Effect of premature loss of primary teeth on prevalence of malocclusion in permanent dentition: a systematic review and meta-analysis. *International Orthodontics*. 2023 Dec 1;21(4):100816.
14. Khan A, Khan N, Khan MS, Ahmad H, Zeb M, Ahmad S. Self-evaluation of dental appearance satisfaction among

- children aged 13-17 years attending government schools in Peshawar. *Pakistan Journal of Physiology*. 2020 Jun 29;16(2):56-8.
15. de Souza BB, Evangelista ME, Andriani JD, Cardoso M, Miranda Santana C, Bolan M. Assessment of space changes in the lower dental arch after the premature unit loss of a primary molar: A randomized clinical trial. *International Journal of Paediatric Dentistry*. 2025 Mar;35(2):369-79.
 16. Elamami NM, Alamami NM, Ashlak FG. Cross-sectional study evaluating premature deciduous teeth loss in a selected age group of Benghazi children. *Ain Shams Dental Journal*. 2026 Mar 1;42(2):58-64.
 17. Swain JR, Raghuram C, Vyshnavi KN, Sharma S, Kumari L, Mehandiratta A. A Association of early childhood caries and malocclusion patterns: A pedodontic-orthodontic perspective. *Bioinformation*. 2026 Jun 30;22(6):3697.
 18. Evangelista ME, Brancher GP, Borgatto AF, Bolan M, Santana CM, Cardoso M. Premature loss of primary molars: Impact on the oral health-related quality of life of schoolchildren. *European Archives of Paediatric Dentistry*. 2022 Dec;23(6):911-8.
 19. Cui Y, Chen D, Lin H, Tao Y. The association between low birth weight and/or preterm birth and dental caries- A systematic review and meta- analysis. *International Journal of Dental Hygiene*. 2023 Aug;21(3):599-610.
 20. Ramírez FE, Norambuena ÓS, Serrano R, Vergara C, Henríquez E. Asociación entre maloclusiones y caries temprana de la infancia en una muestra de niños preescolares. *Odontología pediátrica*. 2022;30(2):59-67.
 21. Cui Y, Chen D, Lin H, Tao Y. The association between low birth weight and/or preterm birth and dental caries- A systematic review and meta- analysis. *International Journal of Dental Hygiene*. 2023 Aug;21(3):599-610.