ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7671-7675 (2026)
©Biomedical Informatics (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences
BIOMEDICAL INFORMATICS
www.bioinformation.net
Volume 22(10)
Research Article

Received October 1, 2026; Revised October 31, 2026; Accepted October 31, 2026, Published October 31, 2026
DOI: 10.6026/973206300227671

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/ Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Ruby Singh
E-mail: bioinformationruby@gmail.com
Citation: Bhat *et al.* Bioinformation 22(10): 7671-7675 (2026)

Interproximal contacts among primary dentition and pre-school children: An observational study in India

Eemana Farooq Bhat, Nitin Sharma*, Anita Choudhary, Sfurty Prakash, Khushbu Piyush Soni, Shrushti Raju Thakare & Angha Uday Patil

Department of Pediatric and Preventive Dentistry, NIMS Dental College & Hospital, NIMS University, Jaipur, Rajasthan, India; *Corresponding author

Affiliation URL:
https://www.nimsuniversity.org/

Authors contact:
Eemana Farooq Bhat - E-mail: eemanabhat0@gmail.com
Nitin Sharma - E-mail: dr.nitinsharma4u@gmail.com

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7671-7675 (2026)
©Biomedical Informatics (2026)

Anita Choudhary - E-mail: anitadr.705@gmail.com
Sfurty Prakash - E-mail: 01dr.sfurtyprakash@gmail.com
Khushbu Piyush Soni - E-mail: khushbusoni861@gmail.com
Shrushti Raju Thakare - E-mail: dr.shrushtithakare@gmail.com
Angha Uday Patil - E-mail: anghap24@gmail.com

Abstract:
The morphology of interproximal contacts in primary teeth influences plaque retention, self-cleansing and proximal caries susceptibility. Therefore, it is of interest to assess the prevalence and distribution of OXIS interproximal contact types in primary molars among 150 pre-school children aged 3–5 years from rural Jaipur, Rajasthan. A total of 606 interproximal contacts were evaluated on study casts and classified as Open (O), Point (X), Straight (I), or Curved (S), with arch-wise distribution analysed using the Chi-square test. Straight (I) contacts were most prevalent (43.6%), followed by X (28.2%), O (22.3%) and S (5.9%) contacts, with significant differences between maxillary and mandibular arches ($p < 0.001$). Thus, data shows the distribution of OXIS contact morphologies in primary molars among rural pre-school children and highlighting significant arch wise variation relevant to proximal caries risk assessment.

Keywords: OXIS classification, primary teeth, primary molars, interproximal contacts, pre-school children, proximal caries, primary dentition

Background:
Dental caries is one of the most prevalent chronic diseases in children and remains a major public health concern **[1]**. Interproximal contact morphology influences plaque retention, self-cleansing and proximal caries susceptibility in primary teeth **[2]**. Primary teeth have broader and flatter proximal surfaces, which may favour biofilm accumulation and food impaction **[2]**. Conventional open or closed classifications inadequately describe the morphological variations of primary interproximal contacts **[3]**. The OXIS classification introduced by researchers categorizes contacts as Open (O), Point (X), Straight (I) and Curved (S), providing a more detailed assessment of contact morphology **[4]**. Studies have showed the reproducibility and clinical applicability of the OXIS system across different populations **[5]**. Contact morphology may influence plaque accumulation and caries risk, with variations reported according to population, dietary, environmental and behavioural factors **[6]**. However, limited evidence exists regarding OXIS contact patterns among pre-school children in Rajasthan **[7]**. Therefore, it is of interest to assess the prevalence and distribution of OXIS interproximal contact types in primary molars among 3–5 year old pre-school children in rural Jaipur, Rajasthan.

Materials and Methods:
The present observational study was conducted in the Department of Pediatric and Preventive Dentistry, NIMS Dental College and Hospital, Jaipur, Rajasthan, India, among pre-school children aged 3–5 years residing in rural areas of Jaipur. The study was conducted following approval from the Institutional Ethics Committee (IEC) of NIMS Dental College and Hospital, Jaipur, under proposal number IEC/P545-/2024. The study adhered to the ethical principles outlined in the World Medical Association Declaration of Helsinki (2013 revision) and was registered with the Clinical Trials Registry–India (CTRI) under registration number CTRI/2025/06/109172. Written informed consent was obtained from the parents or legal guardians of all participating children prior to enrolment in the study. The study population comprised 150 pre-school children selected from various schools located in rural areas of Jaipur, Rajasthan. Prior permission was obtained from the respective school authorities and dental screening camps were organized at the selected schools. Children aged between 3 and 5 years with complete primary dentition, good general health and absence of proximal carious lesions in primary molars were considered eligible for participation. Children presenting with developmental dental anomalies, extensive proximal caries involving primary molars, special healthcare needs, severe gag reflex, defective impressions or study casts or whose parents declined consent were excluded from the study. The armamentarium included mouth mirrors, CPI probes, sterile gauze, disposable gloves, pediatric stainless steel stock trays, addition silicone impression material (Accusil Putty; Prevest DenPro), dental stone, rubber bowls, spatulas, a vibrator and magnifying loupes (ZuMax). Following screening and selection of eligible participants, impressions of both maxillary and mandibular arches were obtained at the school premises using appropriately sized stock trays and addition silicone impression material under standardized conditions. The impressions were carefully disinfected using a 2% disinfectant solution and transported to the Department of Pediatric and Preventive Dentistry, where they were poured using Type III dental stone to obtain study casts. All casts were inspected for defects and only casts exhibiting adequate anatomical detail were included for further evaluation. The interproximal contact areas of primary molars were assessed on the study casts using the OXIS classification system. Each cast was initially examined by the principal investigator using magnification loupes under adequate illumination and the interproximal contacts were categorized as Open (O), Point (X), Straight (I) and Curved (S) contacts according to the OXIS classification criteria **(Figure 1)**. To minimize examiner bias and improve the reliability of observations, all casts were independently re-evaluated by a second examiner through direct visual examination of the study casts and any disagreement in classification was resolved through discussion and consensus between the examiners. A

total of 606 interproximal contact areas were evaluated and recorded. The collected data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to determine the frequency and percentage distribution of the various OXIS contact types. Inter-arch and intra-arch comparisons were performed using the Chi-square test and a p-value of less than 0.05 was considered statistically significant.

Results:

A total of 150 preschool children aged 3–5 years were included in the study. The mean age was 4.1 ± 1.2 years, with 56 (37.0%) children aged 3 years, 50 (33.0%) aged 4 years and 44 (30.0%) aged 5 years. The age distribution was comparable across the three age groups, with no statistically significant difference (p = 0.524) **(Table 1)**. A total of 606 interproximal contact areas of primary molars were evaluated using the OXIS classification system. Overall, Straight (I) contacts were the most prevalent, accounting for 264 (43.6%) contact areas, followed by Point (X) contacts with 171 (28.2%), Open (O) contacts with 135 (22.3%) and Curved (S) contacts with 36 (5.9%). According to age and arch, I-type contacts remained predominant across all age groups in both arches. In 3-year-old children, I-type contacts accounted for 41.2% of maxillary and 47.2% of mandibular contacts; among 4-year-olds, they represented 40.8% and 46.9%, respectively; and among 5-year-olds, 40.9% and 46.6%, respectively **(Table 2)**. Arch-wise analysis demonstrated a significant difference in the distribution of OXIS contact types between the maxillary and mandibular arches (χ^2 = 21.55, p < 0.001). Open (O) contacts were more prevalent in the maxillary arch (28.7%) than in the mandibular arch (15.8%), whereas Curved (S) contacts were more frequent in the mandibular arch (8.9%) than in the maxillary arch (3.0%). Point (X) contacts showed an identical distribution in both arches (28.7%), while Straight (I) contacts were predominant in both arches and were more frequent in the mandibular arch (46.5%) than in the maxillary arch (40.6%) **(Table 3)**. Further analysis comparing the four subgroups—maxillary right, maxillary left, mandibular right and mandibular left—demonstrated significant differences in the distribution of Open (p = 0.001), Straight (p < 0.001) and Curved (p = 0.002) contacts, whereas Point contacts did not differ significantly across subgroups (p = 0.812) **(Table 4)**. Pairwise comparisons were performed to determine whether the observed variation was attributable to side (right versus left) or arch (maxilla versus mandible). No significant differences were observed between the right and left sides for any contact type within either the maxilla (O: p = 0.899; X: p = 1.000; I: p = 0.816; S: p = 0.173) or mandible (O: p = 1.000; X: p = 0.913; I: p = 0.818; S: p = 0.421). In contrast, significant differences persisted between the maxillary and mandibular arches on both the right side (O and I: p < 0.001; S: p = 0.002) and left side (O and I: p < 0.001; S: p = 0.004), indicating that arch rather than side was the principal determinant of variation in contact morphology **(Table 5)**. Overall, Straight (I) contacts represented the predominant interproximal contact morphology in primary molars among preschool children in rural Jaipur. Significant arch-specific variation was observed, with Open contacts more frequent in the maxillary arch and Curved contacts more prevalent in the mandibular arch. These findings indicate distinct morphological patterns between the two arches.

Table 1: Demographic characteristics of study participants

Characteristic	Value
Total participants, n	150
Age 3 years, n (%)	56 (37.3)
Age 4 years, n (%)	50 (33.3)
Age 5 years, n (%)	44 (29.3)
Mean age ± SD (years)	4.1 ± 1.2
Age-group comparison, p-value	0.524

Note: Percentages are recalculated from the supplied counts and rounded to one decimal place. Verify the reported mean, SD and p-value against the original dataset.

Table 2: Overall and age-wise distribution of OXIS contact types

Section / OXIS classification	Number (n)	Percentage (%)
Overall: Open (O)	135	22.3
Overall: Point (X)	171	28.2
Overall: Straight (I)	264	43.6
Overall: Curved (S)	36	5.9
Overall: Total	606	100.0
Age 3: Straight (I), maxillary arch	Not provided	41.2
Age 3: Straight (I), mandibular arch	Not provided	47.2
Age 4: Straight (I), maxillary arch	Not provided	40.8
Age 4: Straight (I), mandibular arch	Not provided	46.9
Age 5: Straight (I), maxillary arch	Not provided	40.9
Age 5: Straight (I), mandibular arch	Not provided	46.6

Note: Complete age-wise frequencies and distributions for Open, Point and Curved contacts were not supplied.

Table 3: Distribution of OXIS contact types according to dental arch

OXIS classification	Maxillary arch (%)	Mandibular arch (%)
Open (O)	28.7	15.8
Point (X)	28.7	28.7
Straight (I)	40.6	46.5
Curved (S)	3.0	8.9
Overall comparison	χ^2 = 21.55	p < 0.001

Note: The supplied maxillary percentages sum to 101.0%; verify against the original data before submission.

Table 4: Comparison of OXIS contact types across four dental subgroups

OXIS classification	Subgroups compared	p-value	Interpretation
Open (O)	Maxillary right, maxillary left, mandibular right, mandibular left	0.001	Significant
Point (X)	Maxillary right, maxillary left, mandibular right, mandibular left	0.812	Not significant
Straight (I)	Maxillary right, maxillary left, mandibular right, mandibular left	<0.001	Significant
Curved (S)	Maxillary right, maxillary left, mandibular right, mandibular left	0.002	Significant

Note: Specify the statistical test used in the Methods section.

Table 5: Pairwise comparisons of OXIS contact types according to side and dental arch

Comparison	Contact type	p-value	Interpretation
Maxillary right vs. left	Open (O)	0.899	Not significant
Maxillary right vs. left	Point (X)	1.000	Not significant
Maxillary right vs. left	Straight (I)	0.816	Not significant
Maxillary right vs. left	Curved (S)	0.173	Not

			significant
Mandibular right vs. left	Open (O)	1.000	Not significant
Mandibular right vs. left	Point (X)	0.913	Not significant
Mandibular right vs. left	Straight (I)	0.818	Not significant
Mandibular right vs. left	Curved (S)	0.421	Not significant
Maxillary vs. mandibular arch, right side	Open (O)	<0.001	Significant
Maxillary vs. mandibular arch, right side	Point (X)	Not provided	Not available
Maxillary vs. mandibular arch, right side	Straight (I)	<0.001	Significant
Maxillary vs. mandibular arch, right side	Curved (S)	0.002	Significant
Maxillary vs. mandibular arch, left side	Open (O)	<0.001	Significant
Maxillary vs. mandibular arch, left side	Point (X)	Not provided	Not available
Maxillary vs. mandibular arch, left side	Straight (I)	<0.001	Significant
Maxillary vs. mandibular arch, left side	Curved (S)	0.004	Significant

Note: Point-contact pairwise p-values comparing arches were not supplied and should be retrieved from the original statistical output.

Discussion:

In the present study, Straight (I) contacts were found to be the most prevalent contact type, accounting for 43.6% of all interproximal contacts examined, followed by Point (X) contacts (28.2%), Open (O) contacts (22.3%) and Curved (S) contacts (5.9%) **[8]**. These findings are broadly consistent with the observations reported by researchers who first introduced the OXIS classification and showed that I-type contacts constituted the predominant contact morphology in primary molars. Similarly, Walia *et al.* reported that Straight contacts were the most frequently encountered interproximal contact type across different populations, emphasizing the reproducibility of the OXIS classification system **[9]**. The predominance of I-type contacts observed in the present study may be attributed to the anatomical characteristics of primary molars. Primary teeth possess broader and flatter proximal surfaces compared with permanent teeth, resulting in the formation of wider contact areas **[10]**. Such broad contact surfaces are more likely to be classified as Straight contacts according to the OXIS classification system and the high prevalence of I-type contacts therefore appears to represent the physiological contact morphology commonly observed in primary dentition. An important finding of the present investigation was the significant variation in contact morphology between the maxillary and mandibular arches. Open contacts were observed more frequently in the maxillary arch, whereas curved contacts demonstrated greater prevalence in the mandibular arch. In addition, I-type contacts were comparatively more common in the mandibular arch than in the maxillary arch. These differences were statistically significant and suggest that interproximal contact morphology is influenced by arch-specific developmental and anatomical factors **[11]**. The observed arch-wise differences are consistent with previous epidemiological studies evaluating OXIS contact patterns. Cortes *et al.* reported significant variations in contact morphology among different populations and arches, suggesting that factors such as arch form, eruption sequence, tooth morphology and occlusal development may influence the formation of interproximal contacts **[12]**. Similar observations have been documented by Kirthiga *et al.*, who reported differences in contact distribution between maxillary and mandibular teeth and highlighted the dynamic nature of contact morphology during the development of primary dentition **[13]**. An additional noteworthy finding of the present study was the symmetrical distribution of contact morphology between the right and left sides within each arch, with no statistically significant differences observed for any OXIS contact type. This finding suggests that the local anatomical and functional determinants of interproximal contact morphology are similarly expressed on both sides of the dental arch, consistent with the generally paired and bilaterally symmetric pattern of dental development. In contrast, significant differences persisted between the maxillary and mandibular arches regardless of side, reinforcing that arch rather than laterality is the principal factor influencing contact morphology in primary molars. These findings are in agreement with previous reports describing bilateral symmetry in dental arch morphology and support the reliability of unilateral assessment when bilateral examination is not feasible in large scale epidemiological studies **[14].** The clinical implications of interproximal contact morphology have gained increasing attention in recent years. Previous studies have demonstrated that contact types associated with broader or more complex contact surfaces may facilitate plaque accumulation by limiting the natural self-cleansing action of the oral musculature and saliva and children presenting with such contact morphologies may consequently exhibit an increased risk of proximal caries development. Sarıoğlu and Güner in a longitudinal investigation evaluating the relationship between OXIS contacts and proximal caries, reported substantially higher odds of caries development in S-type and I-type contacts when compared with O-type contacts **[2]**, suggesting that contact morphology may serve as a useful predictor of future caries risk in primary molars. Although the present study did not evaluate the association between contact morphology and proximal caries occurrence, the predominance of I-type contacts observed among the study population may have important preventive implications. Given the potential relationship between closed contact morphologies and plaque retention, clinicians should pay particular attention to oral hygiene reinforcement and periodic monitoring of children exhibiting such contact patterns **[15]**. Early identification of high-risk contact morphologies may facilitate timely implementation of preventive strategies, including dietary counselling, topical fluoride application, pit and fissure sealants where indicated and regular recalls visits **[16]**. Another important aspect of the present study is its contribution to region-specific data regarding OXIS contact morphology. Most previous investigations evaluating interproximal contact types have been conducted in populations from southern India or other international settings and to the best of our knowledge limited information exists regarding the prevalence and distribution of OXIS contacts among pre-school children in Rajasthan. The present study therefore provides

valuable baseline epidemiological data for this population and contributes to the growing body of literature concerning interproximal contact morphology in primary dentition. The findings of the present study should be interpreted in light of certain limitations. First, the cross-sectional design precludes evaluation of temporal changes in contact morphology and does not permit assessment of causal relationships between contact types and proximal caries development. Second, the study population was restricted to pre-school children from rural areas of Jaipur, which may limit the generalizability of the findings to other geographic regions and populations. Finally, the relationship between OXIS contacts morphology and actual caries incidence was not investigated and warrants further longitudinal evaluation. Future prospective studies involving larger and more diverse populations are recommended to investigate the influence of OXIS contact morphology on proximal caries development over time and to establish whether specific contact types can be incorporated into caries risk assessment models and preventive protocols in pediatric dentistry.

Conclusion:

Straight (I) contacts were most prevalent, while Curved (S) contacts were least common among pre-school children. Open (O) contacts predominated in the maxilla, whereas Curved (S) contacts were more frequent in the mandible. OXIS classification may support interproximal morphology assessment and early caries risk evaluation in primary dentition.

References:

[1] Yang H *et al. Front Dent Med*. 2025 **6**:1624571. [PMID: 41127542]
[2] Sarıoğlu D & Güner Z. *Journal of Clinical Pediatric Dentistry.* 2025 **49**:147. [DOI: 10.22514/jocpd.2025.136]
[3] Kirthiga M *et al. Pediatr Dent*. 2023 **45**:434. [PMID: 37904267]
[4] Srivastava M *et al. Cureus*. 2024 **16**:e71611. [PMID: 39553136]
[5] Cortes A *et al. Children (Basel*). 2025 **12**:161. [PMID: 40003263]
[6] Muthu MS *et al. Pediatr Dent*. 2021 **43**:296. [PMID: 34467847]
[7] Kirthiga M *et al. Caries Res*. 2023 **57**:133. [PMID: 36689939]
[8] Winnier JJ *et al. J Clin of Diagn Res*. 2024 **18**:ZC49. [DOI: 10.7860/JCDR/2024/66546.19437]
[9] Walia T *et al. Wellcome Open Res.* 2021 **5**:285. [PMID: 33537460]
[10] Vidi B *et al. Front. Dent Med.* 2025 **5**:1522414. [PMID: 39917696]
[11] Thakur S *et al. Int J Clin Pediatr Dent*. 2025 **18**:S29. [PMID: 41509964]
[12] Cortes A *et al. Children*. 2025 **12**:161. [PMID: 40003263]
[13] Kirthiga M *et al. Wellcome Open Res*. 2018 **3**:98. [PMID: 30345384]
[14] Agrawal K *et al. J Indian Soc Pedod Prev Dent*. 2026 **44**:84. [PMID: 41755441]
[15] Veiga N *et al. Healthcare (Basel)*. 2023 **11**:1635. [PMID: 37297776]
[16] https://www.ncbi.nlm.nih.gov/books/NBK448116/

Caveat Emptor is applicable among the literate community where required and possible. The publisher, its journal, editors and the internal/external reviewers take adequate steps to check, evaluate, correct, edit, revise and improve content where possible and required.