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# Relationship of Physiological Spacing and Caries in Primary Dentition: A Cross-Sectional Study

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**Submitted** 11 July 2025 **Accepted** 22 August 2025 **Published** 26 November 2025

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**Citation**

"Dallakoti P, Upadhyay S, Dahal S. Relationship of Physiological Spacing and Caries in Primary Dentition: A Cross-Sectional Study. JBPKIHS. 2025;8(1):35-40."

https://doi.org/10.3126/jbpkihs.v8i1.81319



**Abstract**

**Background:** Numerous factors may lead to caries in primary dentition, among them one of the important factor could be the absence of spaces between the teeth. There are not sufficient literatures available for etiologies of dental caries in primary dentition. The result of the studies performed in permanent dentition is generalised with primary dentition. So, this study aims to find out the relation of caries and absence of spacing in primary dentition.

**Methods:** A cross-sectional observational study was conducted among patients of age three to six years in the Department of Pediatric and Preventive Dentistry, KUSMS, Dhulikhel hospital. After oral examination of the selected candidates, primate space, interdental space and intermolar spaces were recorded. Along with that, the mean of decayed, missing and filled teeth (deft) score and decayed, missing and filled surface (defs) score were recorded.

**Results:** The mean dmft score of the study participants was 5.96 ± 4.47 and the mean dmfs score was 8.72 ± 7.97. The analysis was done using Mann-Whitney U test which showed significant difference in dmft and dmfs scores between those with and without primate space and interdental space. Moreover, children without spacing presented with significantly higher dmft scores than those with the presence of any form of spacing in between teeth ($p < 0.001$).

**Conclusion:** This study demonstrates that spacing in the primary dentition is significantly related with a lower dental caries experience. Hence, this justifies its role as a protective developmental feature against dental caries.

**Keywords:** Caries; Caries susceptibility; Physiological spacing

## Declarations

**Ethics approval and consent to participate:** This study was conducted with prior ethical approval from Ethical Review Board of Kathmandu University School of Medical Sciences Institutional Review Committee (KUSMS-IRC) and informed consent has been obtained from participants prior to the enrollment.

**Consent for publication:** Informed consent was obtained from the patient for the publication of identifying features along with the manuscript.

**Availability of data and materials:** The full data set supporting this research is available upon request by the readers).

**Competing interest:** The authors have no conflicts of interest to declare.

**Funding:** This study was self-funded by principal author.

**Authors' contributions:** PD contributed to the concept, design of the study, proposal writing. PD, SU, RS and SD did oral examination and data collection, data analysis and interpretation. PD prepared the manuscript. All authors read and approved the final manuscrip.

**Acknowledgement:** We would like to thank Dr. Swagat Mahanta for providing assistance at all times during the study. Similarly, we appreciate the help of our patients and their parents during the process of data collection.

## BACKGROUND

Early childhood caries is a global public health issue, impacting nearly half of preschoolers [1]. It is a multifactorial disease which may result from a variety of etiologies [2]. Numerous factors may be related to caries in primary dentition, including the caregiver's active dental caries, low socioeconomic status, low health literacy, and frequent sugar exposoure [3]. In addition to these, one of the important contibuting factors could be the absence of spacing between teeth in primary dentition. It is believed that close contact between teeth makes plaque removal more difficult, allowing it to remain undisturbed in the oral cavity for extended periods and thereby increasing the risk of caries [4]. Furthermore, lack of spacing hampers effective oral hygiene practices, making them less accessible. Interproximal caries also usually is not seen until proximal contact develops between the teeth [5]. This also supports the potential risk of caries in primary dentition lacking developmental spaces. There are not sufficient literatures available for the etiology of dental caries in primary dentition as compared to permanent dentition. The result of the studies performed in permanent dentition is generalised with primary dentition. Although, many researchers have done studies focusing on the presence or absence of spacing in primary dentition to predict possible malocclusion in future but there are not enough studies done for the prediction of dental caries. To the best of the authors' knowledge no such studies have been conducted in Nepal. So, this study aimed to find out the relation of caries and absence of spacing in primary dentition.

## METHODS

An observational cross sectional study was done among the patients of age three to six years visiting the Department of Pediatric and Preventive Dentistry, KUSMS, Dhulikhel hospital. The ethical clearance was obtained from the Institutional Review Committee, Kathmandu University School of Medical Sciences (Ref. 96/24). The study consisted of 455 convenient samples which was calculated using the formula $N = [(Z\alpha+Z\beta)/C]2 + 3$ by taking reference from study by Warren et al. [6] where the value of r was 0.131, which means the expected correlation coefficient.

Oral examination was done as a part of a routine examination in children aged three to six years with complete primary dentition whose parents agreed to participate in the study. Children with special health care needs, mixed and complete permanent dentition, missing primary teeth, and uncooperative behavior were excluded. Before proceeding informed oral and written consent was taken. Primate space was recorded in presence of at least two visible spaces between primary lateral incisor and canine in the maxillary arch and primary canine and first primary molar in the mandibular arch. Interdental space was recorded in the presence of at least two spaces between primary incisors. Intermolar space was recorded in presence of at least two spaces between primary molars. Generalized space was recorded in presence of primate space, interdental space and intermolar space. The mean of decayed, missing and filled teeth (deft) score and decayed, missing and filled surface(defs) score was recorded as given by Gruebbel AO [7]. All the data was recorded by a single investigator.

The data was entered and analysed using IBM Statistical Package of Social Sciences (SPSS) Statistics for Windows, version 24 (IBM, Inc., Chicago, IL, USA). The mean of deft and defs score was calculated. The prevalence of primate space, interdental space, intermolar space and generalized space was calculated. Kolmogorov Smirnov test was used to check the distribution of data. Due to the skewed nature of the data, non-parametric tests were used for further analysis. Mann-Whitney U test was used to analyse the relationship of spacing and dental caries in primary dentition. Spearman correlation was done to determine the relationship between the number of spacing with dmft and dmfs. The significance level was set at $p < 0.05$.

## RESULTS

The mean age of the study participants was 4.58±1.03 years with majority of five years (155, 34.1%). Among 455 study participants examined, most of them (238, 52.3%) were females. More than half of the caregivers had received school level of education (289, 63.5%) and had monthly income between 24351-36550 Nepali rupees (182, 40.0%). **(Table 1)**

The mean deft score of the study participants was 5.96 ±

**Table 1: Demographic characteristics of study participants (N=455)**

| Type of space | Category | No. of study population N (%) |
|---|---|---|
| Age in years | 3 | 85 (18.6) |
| | 4 | 117 (25.7) |
| | 5 | 155 (34.1) |
| | 6 | 98 (21.5) |
| Sex | Male | 217 (47.7) |
| | Female | 238 (52.3) |
| Caregiver's education | Illiterate | 5 (1.1) |
| | School level | 289 (63.5) |
| | Intermediate level | 44 (9.7) |
| | Bachelor level and above | 117 (25.7) |
| Monthly income in Nepali rupees | ≥ 97451 | 55 (12.1) |
| | 48751-97450 | 63 (13.8) |
| | 36551-48750 | 82 (18.0) |
| | 24351-36550 | 182 (40.0) |
| | 14551-24350 | 56 (12.3) |
| | 4851- 14550 | 14 (3.1) |
| | ≤ 4850 | 3 (0.7) |

4.47, with a median of 5. Similarly, the mean dmfs score was 8.72 ± 7.97, with a median of 7. Table 2 presents distribution of spacing in study participants. The primate space was observed among 288 (63.3%) children, interdental spacing among 171 (37.6%) and intermolar spacing among 75 (16.5%) of the study participants.

However, there was no spacing at all in 147 (32.3%) children **(Table 2)**.

**Table 2: Distribution of spacing in study participants (n=455)**

| Type of spacae | Category | Males (217) N (%) | Females (238) N (%) | Total no. of study population n (%) |
|---|---|---|---|---|
| Primate space | Present | 141 (65.0) | 147 (61.8) | 288 (63.3) |
| | Absent | 76 (35.0) | 91 (38.2) | 167 (36.7) |
| Interdental space | Present | 87 (40.1) | 84 (35.3) | 171 (37.6) |
| | Absent | 130 (59.9) | 154 (64.7) | 284 (62.4) |
| Intermolar space | Present | 37 (17.1) | 38 (16.0) | 75 (16.5) |
| | Absent | 180 (82.9) | 200 (84.0) | 380 (83.5) |
| Primate + interdental space | Present | 81 (37.3) | 74 (31.1) | 155 (34.1) |
| | Absent | 136 (62.7) | 164 (68.9) | 300 (65.9) |
| (Primate + interdental + intermolar) generalized space | Present | 30 (13.8) | 34 (14.3) | 64 (14.1) |
| | Absent | 187 (86.2) | 204 (85.7) | 391 (85.9) |
| No spacing | Yes | 65 (30.0) | 82 (34.5) | 147 (32.3) |
| | No | 152 (70.0) | 156 (65.5) | 308 (67.7) |

A significant difference in deft scores was found between those with and without primate space (p = 0.014) and interdental space (p < 0.001). Children without primate space showed significantly higher dmft scores (median 6, IQR 3-9) than those with the presence of this space (median 5, IQR 2-8). Similarly, those without interdental space showed significantly higher deft scores (median 6, IQR 3-9) than those with the presence of this space (median 4, IQR 1-8). Moreover, children without any form of spacing presented with significantly higher deft scores than those with any form of spacing in between teeth (p < 0.001) **(Table 3)**.

**Table 3: Relationship between types of spacing and caries experience (deft) in study participants (n=455)**

| Type of space | Category | Deft | | | P value* |
|---|---|---|---|---|---|
| | | Mean±SD | Median (IQR) | Mean rank | |
| Primate space | Present (N=288) | 5.65±4.46 | 5 (2-8) | 216.54 | 0.014 |
| | Absent (N=167) | 6.49±4.44 | 6 (3-9) | 247.76 | |
| Interdental space | Present (N=171) | 4.86±4.37 | 4 (1-8) | 194.08 | <0.001 |
| | Absent (N=284) | 6.62±4.40 | 6 (3-9) | 248.43 | |
| Intermolar space | Present (N=75) | 5.55±5.43 | 3 (1-10) | 206.60 | 0.122 |
| | Absent (N=380) | 6.04±4.26 | 6 (2.25-8.75) | 232.22 | |
| Primate + interdental space | Present (N=155) | 5.78±4.46 | 5 (2-8) | 221.77 | 0.466 |
| | Absent (N=300) | 6.05±4.48 | 6 (2-9) | 231.22 | |
| (Primate + interdental +Intermolar) generalized space | Present (N=64) | 6.66±5.12 | 6 (3-9) | 243.30 | 0.314 |
| | Absent (N=391) | 5.84±4.35 | 5 (2-9) | 225.50 | |
| No spacing | Yes (N=147) | 6.73±4.21 | 6 (4-9) | 258.38 | <0.001 |
| | No (N=308) | 5.58±4.54 | 5 (2-8) | 213.50 | |

*Mann-Whitney U test

There was a significant difference in defs scores between participants with and without primate space (p = 0.024), indicating that the absence of primate space is related to a higher degree of caries. Similarly, significant difference in dmfs scores was observed between participants with and without interdental space (p < 0.001), suggesting that the absence of interdental space is linked to higher defs scores, indicating more extensive dental damage. A significant difference in defs scores was found between participants with and without spacing (p < 0.001), suggesting that the absence of spacing is related to more severe dental surface

caries **(Table 4)**.

**Table 4: Relationship between types of spacing and defs in study participants (n=455)**

| Type of space | Category | Defs | | | P value* |
|---|---|---|---|---|---|
| | | Mean±SD | Median (IQR) | Mean rank | |
| Primate space | Present (N=288) | 8.23±8.02 | 6 (2-12) | 216.54 | 0.024 |
| | Absent (N=167) | 9.56±7.84 | 8 (4-13) | 247.76 | |
| Interdental space | Present (N=171) | 7.34±8.12 | 4 (1-12) | 192.70 | <0.001 |
| | Absent (N=284) | 9.55±7.78 | 8 (4-12) | 249.26 | |
| Generalized space | Present (N=75) | 9.08±10.41 | 4 (1-13) | 202.87 | 0.069 |
| | Absent (N=380) | 8.65±7.41 | 7 (4-12) | 232.96 | |
| Primate + interdental space | Present (N=155) | 7.88±6.74 | 6 (3-12) | 220.70 | 0.394 |
| | Absent (N=300) | 9.16±8.52 | 7 (2-13) | 231.77 | |
| Primate + interdental + generalized space | Present (N=64) | 8.19±7.02 | 7 (4-11.50) | 226.77 | 0.936 |
| | Absent (N=391) | 8.81±8.12 | 7 (2-12) | 228.20 | |
| No spacing | Yes (N=147) | 9.98±7.71 | 9 (4-13) | 256.52 | <0.001 |
| | No (N=308) | 8.12±8.04 | 6 (2-12) | 214.39 | |

*Mann-Whitney U test

A very weak but statistically significant negative correlation was found between the number of spacing types with dmft (p=0.002) and dmfs (p=0.025, **Table 5**).

**Table 5: Correlation between number of spacing types with dmft and dmfs (N=455)**

| Variables | r value | P value* |
|---|---|---|
| dmft | -0.147 | 0.002 |
| dmfs | -0.105 | 0.025 |

*Spearman correlation

## DISCUSSION

The present study was conducted to assess the prevalence of various types of dental spacing and its relation with dental caries in primary dentition among the children aged three to six years. The study with 455 children observed the primate space, interdental space and intermolar space to be 63.3%, 37.6% and 16.5% respectively. However, no spacing at all was observed in 147 (32.3%) of children. The mean dmft and dmfs score of the study participants was 5.96 ± 4.47 and 8.72 ± 7.97 respectively. The finding of this study supports the significant relation of dental caries and spacing specially primate space and interdental space. Hence this study is in favor of the hypothesis that spacing contributes as a protective factor against dental caries. No statistically significant difference in deft and defs scores was found between participants with and without intermolar space, suggesting that intermolar space may not have a major impact on dmft and dmfs scores in this age group.

The previous literature suggests that primate spaces are a physiological characteristic of the developing dentition and help to accommodate the eruption of permanent teeth, resulting in a decrease in the likelihood of crowding [8]. Primate spaces are the spaces present mesial to the primary maxillary canine and distal to the primary mandibular canine. A study by V. Y. Cho et.al. [9] and Kaufman A et.al. [10] reported primate space in 41% and 86.5% of children which is in contrast to the present study (63.3%). There is a huge difference in the prevalence of the primate spaces in the literatures that may be explained by variation in study population, genetic constitution, use of diagnostic criteria and the method of recording primate space. Likewise, in the present study interdental space was found in 37.6% of the studied population which is similar to prior studies by Pradhan et. al. [11] (44%) and V. Y. Cho [9] (39% ). While intermolar space was relatively uncommon, observed only in 16.5%. These findings suggest primate space to be most commonly observed and intermolar space to be least in our study population.The prevalence of intermolar space could not be directly compared because, upto the author's knowledge this is the first study to record the presence of intermolar spaces and no study had recorded spaces between molars in primary dentition.

The mean deft and defs score of the study participants was 5.96 ± 4.47 and 8.72 ± 7.97 respectively. This value is higher than most of other studies that were conducted in the Nepalease population [12-14]. Nevertheless, its finding aligns with an earlier study [15]. This explains that the incidence of caries is very high in this study population. Similarly, this study is hospital based study which could be another reason for the high incidence of caries and the most common reason for dental visit is dental caries.

In this study, children with the absence of primate spaces and interdental spaces showed significantly higher dmft and dmfs scores than those with the presence of these spaces. It suggests a greater chance for dental caries in the absence of primate spaces and interdental spaces. Similar finding of higher dmfs score was seen in the absences of primate spaces in study done by V.Y. Cho et.al. [9] suggesting that the spacing facilitates the self-cleansing

action of saliva, less plaque retention and easy mechanical removal of plaques in children resulting in less bacterial colonization. On the contrary, in teeth with close contact areas, food particles and plaque may remain undisturbed for long period of time, increasing the likelihood of enamel decalcification and dental caries. In the same way, the finding of our study aligns with the previous finding[16] that concluded children without interdental spacing in the primary dentition are at higher risk for dental caries. On the contrary, the presence of interdental spacing did not reveal a statistically significant difference on dmft and dmfs scores in a study done by V.Y. Cho. et al. [9]. But, the study by Warren et al. [6] demonstrated that the lack of interdental spaces in the primary dentition is weakly related with a higher risk for dental caries which is similar to our study. This may be due to low incidence of caries (27%) in the studied population. Similarly, no significant difference in dmfs score was found between the participants with and without intermolar spacing, suggesting that intermolar spacing may not have a major impact on dmfs scores. This may be attributed to the late eruption of primary molars in the oral cavity in comparison to anteriors. Late eruption allows less exposure in the oral cavity. They are comparatively more susceptible to caries in the late mixed dentition period after the eruption of permanent molars when the intermolars spaces decrease.

Notably, in this study, one-third of the participants (32.3%) lacked all kind of spacing which is similar to a study that was conducted in the Nepalese population [11]. A significant difference in dmft and dmfs scores was found between participants with and without spacing ($p < 0.001$), suggesting that the absence of spacing is related to more severe dental caries. This may be also one of the important reasons behind high incidence of caries in this study population. This is similar to the finding of a study by V. Y. Cho et al. [9] who observed that the absence of spaces in primary dentition are at an increased risk of developing carious lesions, which was statistically significant at the tooth surface level (dmfs). This finding also aligns with previous literature, which demonstrated a significant correlation between the number of decayed surfaces and the total number of interdental spaces [6]. A similar finding was suggested by a study[17] which concluded the odds for caries were significantly increased when contact points were closed, especially in posterior primary teeth. In addition, a study [9] concluded that children with generalised spacing had approximately five surfaces lower dmfs compared to those with no generalised spacing. The present study showes 14.3% children with generalised spacing.

A strength of our study is the inclusion of a well-defined age group with clinical examination carried out by a single pediatric dentist with a sufficient sample size. To minimize the confounding factors family income and caregiver's education was also recorded. But there was no statistically significant relation of caries with family income and caregiver's education. However, there are some limitations to consider. The cross-sectional nature of the study does not allow for determination of the cause of the disease. Additionally, confounding factors such as oral hygiene practices, fluoride exposure and diet were not controlled, which may have influenced caries development independently or together. Similarly, radiographic investigation was not done so some interproximal caries was likely to have been undiagnosed. In addition to that, as the study was conducted among the children visiting the hospital it might not represent the general population. Despite these limitations, the present findings have important clinical implications. Early assessment of dental spacing patterns during routine pediatric dental check-ups may help in the prediction of caries risk. Children with closed contacts may require active surveillance, exclusive use of preventive measures, and oral hygiene education to reduce the risk of caries development. Therefore, the presence or absence of spacing can be used as valuable clinical indicator for early prediction of caries and should be incorporated in the caries risk assessment tools.

## CONCLUSION

This study demonstrates that spacing in the primary dentition is significantly related with a lower dental caries experience, suggesting its role as a protective developmental feature against dental caries. Further longitudinal studies and consideration of all the possible confounding factors such as oral hygiene practices, fluoride exposure, family income, caregiver's education and diet are required to confirm these observations and enhance our understanding of the relationship between spacing between primary dentition and dental caries.

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