The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
21(2): S.I (2), 21199-21215, 2026 www.thebioscan.com

# Assessment of Prevalence of Crossbite Among Schoolchildren Aged 6–12 Years in Mumbai: A Cross-Sectional Study

**Authors' Information:**

**Dr. Pranjal Chavan[1], Dr. Dimple Padawe[2], Dr. Vilas Takate[3], Dr. Vandana Tripathi[4], Dr. Kishor Dighe[5], Dr. Medha Tanna[6]**

[1,2,3,4,5,6]Academic Qualification: M.D. S

[1]Affiliation: Post graduate student, [2]Professor and Head, [3,4]Associate Professor, [5]Assistant Professor, [6]Dental surgeon

[1,2,3,4,5,6]Institute: Department of Pediatric and Preventive Dentistry, Government Dental College and Hospital, Mumbai, Maharashtra

Email: pranjalc1114@gmail.com, Email: dimplepadawe@gmail.com, Email: vilastakate@gmail.com, Email: 12vinnipandey@gmail.com, Email: kd2467@gmail.com, Email: medha.tanna@gmail.com

**Corresponding Authors' Details:**

**Dr. Pranjal Chavan**

**Phone: 8380901114,9112070781**

**Email:** pranjalc1114@gmail.com

**Mailing address: pranjalc1114@gmail.com**

DOI:https://doi.org/10.63001/tbs.2026.v21.i02.S.I(2).pp21199-21215

**Keywords:**

*Crossbite;*
*Dental occlusion;*
*Interceptive orthodontics;*
*Malocclusion;*
*Mixed dentition.*

**Received on:**
**27-05-2026**
**Accepted on:**
**16-06-2026**
**Published on:**
**26-06-2026**

**Abstract**

**Background:** Crossbite is an important occlusal finding during the mixed dentition period and may contribute to functional disturbances, occlusal trauma, and developing dentofacial asymmetry if not identified early. Local prevalence data are useful for planning school-based screening and timely orthodontic referral.
**Aim:** To assess the prevalence and pattern of crossbite among schoolchildren aged 6–12 years in Mumbai, India.
**Materials and Methods:** This descriptive, school-based cross-sectional study was conducted among children aged 6–12 years in selected schools of Mumbai. A total of 797 children were included in the final analysis. Clinical examination was performed under adequate illumination, and crossbite was recorded in maximum intercuspation. Crossbite was classified as anterior, posterior, single-tooth, segmental, unilateral, bilateral, dental, or skeletal wherever documented. Data were analysed using descriptive statistics. Chi-square test was used to assess association with age and sex, and $p < 0.05$ was considered statistically significant.
**Results:** Crossbite was observed in 55 of 797 children, giving an overall prevalence of 6.90% (95% CI: 5.34–8.88). Anterior crossbite was recorded in 26 children (3.26%), while posterior crossbite was recorded in 4 children (0.50%). The highest age-wise prevalence was observed among 7-year-old children (12.90%). Crossbite prevalence was 7.49% in males and 6.22% in females. No statistically significant association was found between crossbite and age group ($p = 0.061$) or sex ($p = 0.462$).
**Conclusion:** Crossbite was present in a measurable proportion of schoolchildren aged 6–12 years in Mumbai, with anterior crossbite being the most commonly recorded subtype. The findings support routine school-based dental screening and timely orthodontic referral during mixed dentition.

## Introduction

Malocclusion is one of the common developmental problems observed during childhood and may affect dental alignment, occlusal function, facial appearance, and overall oral health-related quality of life. The mixed dentition period, usually between 6 and 12 years of age, is especially important because permanent incisors and first molars erupt during this phase, and several developing occlusal problems first become clinically evident [1]. Crossbite is an important form of malocclusion in which one or more maxillary teeth occlude lingual or palatal to the opposing mandibular teeth. It may present in the anterior or posterior region and may involve a single tooth, a segment, or an entire side of the arch [2].

The clinical importance of crossbite lies in the fact that it is not always a self-correcting condition. Anterior crossbite may be associated with altered eruption path, retained primary teeth, local crowding, or occlusal interference, while posterior crossbite is often related to transverse maxillary deficiency, abnormal oral habits, or functional mandibular shift [2,3]. If left untreated during growth, crossbite can contribute to traumatic occlusion, abnormal tooth wear, gingival recession, mandibular deviation, facial asymmetry, and more complex orthodontic needs in later stages [4]. Therefore, early identification during the mixed dentition period is important, as interceptive treatment is usually simpler, shorter, and more effective when growth potential is still present [1,5].

The reported prevalence of crossbite among children varies widely across different populations. This variation may be due to differences in age group, dentition stage, diagnostic criteria, ethnicity, oral habits, feeding practices, and whether the sample is school-based or clinic-based. Da Silva Filho et al. reported that unilateral posterior

crossbite was a common transverse malocclusion in preschool children and was frequently associated with functional mandibular deviation [2]. Macena et al. found a significant association between posterior crossbite and non-nutritive sucking habits in young children [3], while Kobayashi et al. observed a lower prevalence of posterior crossbite among children with longer duration of exclusive breastfeeding [6]. In mixed dentition children, Hosseini et al. reported anterior crossbite in 11% and posterior crossbite in 3.5% of schoolchildren, with higher occurrence among mouth-breathing children [5].

Indian studies have also shown variable estimates of crossbite and malocclusion in children. Reddy et al. reported anterior and posterior crossbite among schoolchildren in Nalgonda district [7], while Narayanan et al. observed crossbite in 7.2% of 10–12-year-old schoolchildren in Kerala [8]. More recently, Pruthvi et al. reported a crossbite prevalence of 7.5% among 8–12-year-old schoolchildren in Tamil Nadu [9]. However, data from Mumbai schoolchildren remain limited, despite the city's large and socioeconomically diverse child population. Local prevalence data are useful for planning school-based oral health screening, early orthodontic referral, and preventive counselling.

Hence, the present study was conducted to assess the prevalence and pattern of crossbite among schoolchildren aged 6–12 years in Mumbai, India. The study also aimed to evaluate the distribution of crossbite according to age and sex, thereby providing baseline information relevant to early diagnosis and interceptive orthodontic care in this population.

## Materials and Methods

### Study Design and Setting

This study was conducted as a descriptive, school-based cross-sectional survey to

assess the prevalence of crossbite among schoolchildren aged 6–12 years in Mumbai, Maharashtra, India. The study was carried out in selected schools within Mumbai city from May 2024 to December 2025. All clinical examinations were performed on the school premises in a designated area provided by the school authorities, under adequate natural or artificial illumination.

**Ethical Considerations**

The study was initiated after obtaining approval from the Institutional Ethics Committee. Written permission was obtained from the concerned school authorities before conducting the survey. Parents or guardians were provided with information regarding the purpose and procedure of the study, and children were examined only after obtaining written parental consent. Child assent was also obtained wherever applicable. The examination was non-invasive, and no radiographs, impressions, or treatment procedures were carried out as part of the study.

**Study Population**

The study population included school-going children aged 6–12 years, corresponding to the mixed dentition age group. Each child was considered as one unit of analysis. Children were included if they were enrolled in selected schools in Mumbai, were present on the day of examination, belonged to the required age group, and had valid parental consent. Children were excluded if they were absent on the day of screening, did not have parental consent or assent where applicable, or had special health care needs that could interfere with cooperation or standardized occlusal assessment.

**Sample Size and Sampling Procedure**

The sample size was calculated using the formula for prevalence estimation: $n = Z^2 \times P \times (1 - P) / d^2$, where Z was 1.96 for a 95% confidence level, P was the anticipated

prevalence of crossbite, and d was the absolute precision. It was estimated that a sample of 644 children would suffice to complete the study. To account for 20% non-response and field-related exclusions and improve the scientific credibility of the study results, a larger sample was targeted. A total of 800 children were screened, and after data cleaning, 797 eligible children were included in the final analysis.

A multistage probability-based sampling method was followed for school selection. Mumbai city was divided into administrative zones, and one ward was selected from each zone by the lottery method. From each selected ward, one school was chosen randomly, giving a total of seven schools. After obtaining school permission, class registers were used to prepare a list of eligible children aged 6–12 years. Each eligible child was assigned a serial number, and participants were selected using the lottery method until the required sample was achieved. If a selected child was absent or did not fulfil the eligibility criteria, another child was selected randomly from the remaining eligible list.

**Clinical Examination Procedure**

All examinations were carried out by a single trained examiner to reduce inter-examiner variation. Before the main survey, the examiner was trained and standardized in the Department of Pediatric and Preventive Dentistry for uniform identification and recording of crossbite. A pilot assessment was conducted before the main data collection to check the feasibility of the examination procedure, clarity of the recording form, participant flow, and consistency of clinical recording.

The children were examined while seated comfortably. Each child was asked to swallow and then close the teeth normally in maximum intercuspation. The anterior segment was examined first, followed by the right and left posterior segments. A sterile mouth mirror was used for intraoral

inspection. Disposable gloves, masks, hand sanitizer, sterile gauze or cotton, and sterile kidney trays were used during fieldwork. Standard infection control precautions were followed throughout the examination sessions.

**Definition and Classification of Crossbite**

Crossbite was defined as a transverse occlusal discrepancy in which one or more maxillary teeth occlude lingually or palatally to the corresponding mandibular teeth in maximum intercuspation. Anterior crossbite was recorded when one or more maxillary incisors or canines were positioned lingual to the mandibular anterior teeth. Posterior crossbite was recorded when one or more maxillary posterior teeth occluded lingually to the opposing mandibular posterior teeth. When a posterior crossbite was present, it was further recorded as unilateral right, unilateral left, or bilateral, depending on the side involved. If both anterior and posterior crossbites were seen in the same child, it was recorded as a combined pattern. Crossbite was also documented as single-tooth or segmental, wherever applicable.

**Data Collection and Outcome Measures**

A structured case recording form was used to record demographic and clinical data. The recorded variables included serial number, date of examination, age, sex, presence or absence of crossbite, type of crossbite, extent of involvement, and laterality where applicable. The primary outcome was the prevalence of crossbite among the examined children. Secondary outcomes included the distribution of anterior and posterior crossbite, single-tooth and segmental crossbite, unilateral and bilateral crossbite, and age-wise and sex-wise distribution of crossbite.

**Data Management and Statistical Analysis**

The completed forms were checked at the end of each examination session for missing or inconsistent entries. Data were

entered into a digital spreadsheet using serial numbers without personal identifiers. Data cleaning included verification of age range, crossbite status, and consistency of subtype entries.

Statistical analysis was performed using SPSS software version 21. Descriptive statistics were used to summarize the data. Categorical variables were expressed as frequencies and percentages. The prevalence of crossbite was calculated as the proportion of children with crossbite among the total number of children examined and was presented with 95% confidence intervals. The association of crossbite with age and sex was assessed using the chi-square test. Fisher's exact test was applied where expected cell counts were small. Odds ratio with 95% confidence interval was calculated for sex-wise comparison. A p value of less than 0.05 was considered statistically significant.

## Results

### Study Sample

A total of 797 schoolchildren aged 6–12 years were included in the final analysis after data cleaning. The mean age of the participants was 9.08 ± 1.73 years, with a median age of 9 years. Males constituted 53.6% of the sample and females constituted 46.4%. The demographic distribution of the study sample is presented in Table 1.

**Table 1. Demographic characteristics of the study sample**

| Variable | n (%) / Value |
|---|---|
| Total children analysed | 797 |
| Age, mean ± SD | 9.08 ± 1.73 years |
| Age, median (range) | 9 (6–12) years |
| Male | 427 (53.6) |
| Female | 370 (46.4) |

| | |
|---|---|
| Age 6 years | 79 (9.9) |
| Age 7 years | 155 (19.4) |
| Age 8 years | 262 (32.9) |
| Age 9 years | 145 (18.2) |
| Age 10 years | 90 (11.3) |
| Age 11 years | 64 (8.0) |
| Age 12 years | 2 (0.3) |

**Prevalence and Recorded Pattern of Crossbite**

Crossbite was identified in 55 of the 797 examined children, giving an overall prevalence of 6.90% (95% CI: 5.34–8.88). Among the recorded location subtypes, anterior crossbite was more frequent than posterior crossbite. However, crossbite subtype documentation was incomplete in some cases; therefore, subtype findings are presented as recorded frequencies rather than mutually exclusive categories. The prevalence and recorded pattern of crossbite are shown in Table 2.

**Table 2. Prevalence and recorded pattern of crossbite**

| Crossbite variable | n | % of total sample | 95% CI |
|---|---|---|---|
| Any crossbite | 55 | 6.90 | 5.34–8.88 |
| Anterior crossbite | 26 | 3.26 | 2.24–4.73 |
| Posterior crossbite | 4 | 0.50 | 0.19–1.29 |
| Single-tooth crossbite | 12 | 1.51 | 0.87–2.61 |
| Segmental crossbite | 6 | 0.75 | 0.35–1.63 |
| Unilateral crossbite | 5 | 0.63 | 0.27–1.45 |
| Bilateral crossbite | 0 | 0.00 | 0.00–0.48 |

| | | | |
|---|---|---|---|
| Dental crossbite | 6 | 0.75 | 0.35–1.63 |
| Skeletal crossbite | 5 | 0.63 | 0.27–1.45 |

Among the 55 children with crossbite, anterior crossbite was recorded in 26 children and posterior crossbite in 4 children. Location was not documented in 25 crossbite-positive children. Extent of involvement was recorded in 18 children, with single-tooth crossbite documented more frequently than segmental crossbite. Completeness of subtype documentation among crossbite-positive children is summarized in Table 3.

**Table 3. Completeness of crossbite subtype documentation among crossbite-positive children**

| Subtype domain | Recorded, n (%) | Not recorded, n (%) |
|---|---|---|
| Location: anterior/posterior | 30 (54.5) | 25 (45.5) |
| Extent: single-tooth/segmental | 18 (32.7) | 37 (67.3) |
| Laterality: unilateral/bilateral | 5 (9.1) | 50 (90.9) |
| Nature: dental/skeletal | 11 (20.0) | 44 (80.0) |

**Age-wise Distribution of Crossbite**

Age-wise prevalence ranged from 0.00% to 12.90%. The highest observed prevalence was recorded among 7-year-old children, followed by 6-year-old and 9-year-old children. The association between age group and crossbite presence was not statistically significant. Age-wise distribution is presented in Table 4.

**Table 4. Age-wise prevalence of crossbite**

| Age group | Total examined, n | Crossbite present, n | Prevalence (%) | 95% CI |
|---|---|---|---|---|
| 6 years | 79 | 8 | 10.13 | 5.22–18.85 |
| 7 years | 155 | 20 | 12.90 | 8.46–19.25 |
| 8 years | 262 | 9 | 3.44 | 1.82–6.42 |
| 9 years | 145 | 12 | 8.28 | 4.78–13.97 |
| 10 years | 90 | 4 | 4.44 | 1.74–10.92 |
| 11 years | 64 | 2 | 3.12 | 0.87–10.71 |
| 12 years | 2 | 0 | 0.00 | 0.00–65.76 |

Chi-square test: $\chi^2 = 11.148$, df = 6, p = 0.061; Cramer's V = 0.118.

**Sex-wise Distribution of Crossbite**

Crossbite was observed in 32 males and 23 females. The prevalence was slightly higher among males; however, the difference was not statistically significant. The sex-wise association analysis is shown in Table 5.

**Table 5. Sex-wise prevalence and association with crossbite**

| Sex | Total examined, n | Crossbite present, n | Prevalence (%) | 95% CI |
|---|---|---|---|---|
| Male | 427 | 32 | 7.49 | 5.35–10.40 |
| Female | 370 | 23 | 6.22 | 4.16–9.21 |

Chi-square test: $\chi^2 = 0.543$, df = 1, p = 0.462; Cramer's V = 0.026. Odds ratio for males compared with females: OR = 1.22; 95% CI: 0.70–2.13.

Overall, crossbite was recorded in 6.90% of the examined children. Anterior crossbite was the most frequently recorded location subtype. No statistically significant association was observed between crossbite presence and either age group or sex.

**Discussion**

The present study found an overall crossbite prevalence of 6.90% among schoolchildren aged 6–12 years in Mumbai. This indicates that crossbite represents a measurable occlusal finding during the mixed dentition period, when early orthodontic evaluation remains clinically useful. The prevalence was close to the 7.2% reported by Narayanan et al. among 10–12-year-old schoolchildren in Kerala [8] and the 7.5% reported by Pruthvi et al. among 8–12-year-old schoolchildren in Tamil Nadu [9]. However, it was lower than the 13.0% reported by Tabassum et al. in a school-based sample from Lahore [10] and higher than the 3.7% reported by Ferro et al. among Italian preschool children [11]. These differences may be explained by variation in age range, dentition stage, ethnicity, diagnostic criteria, and whether the study was conducted in school-based or clinic-based settings.

Anterior crossbite was the most frequently recorded subtype in the present study. This finding is in agreement with Pruthvi et al., who reported anterior crossbite more commonly than posterior crossbite among schoolchildren in Tamil Nadu [9]. Similar anterior predominance was also reported by Ajwa et al. in Jeddah schoolchildren and by Alharbi among Saudi schoolchildren [12,13]. In mixed dentition, anterior crossbite may commonly arise from altered eruption path, retained primary teeth, localized crowding, or premature occlusal

contacts. The presence of single-tooth crossbite in a proportion of affected children in the present study further suggests that many cases may have been localized dental crossbites rather than broad skeletal discrepancies. Lira and Fonseca also observed that anterior crossbite detected during school screening was commonly dental in nature and could be managed with simple interceptive treatment when diagnosed early [14]. Genji et al. similarly emphasized the importance of early identification of anterior crossbite in children attending a university dental hospital in Chennai [15].

Posterior crossbite was less frequently recorded in the present sample. This was lower than the prevalence reported in several studies focusing on posterior crossbite or transverse malocclusion [2,3,6]. However, low posterior crossbite prevalence has also been reported in Indian clinical data, such as the Chennai hospital-based study by Marimuthu et al. [16]. In contrast, posterior crossbite was more frequent in orthodontic or clinic-based samples reported by Chowdhury et al. and Anistoroaei et al., which is expected because patients attending orthodontic departments usually have a higher burden of malocclusion than general schoolchildren [17,18]. Posterior crossbite may also be under-recorded in simple school screening if functional shift, centric relation–centric occlusion discrepancy, or transverse arch width is not evaluated in detail.

Age-wise, the highest crossbite prevalence was observed at 7 years, followed by 6 and 9 years, although the association with age was not statistically significant. This pattern may reflect occlusal changes during early mixed dentition, particularly eruption of permanent incisors and first permanent molars. Vudata et al. reported higher frequencies of several malocclusion traits, including anterior and posterior crossbite tendency, among 9-year-old children

compared with 6-year-old children in Visakhapatnam [19]. Mai et al. also reported anterior crossbite tendency as one of the common malocclusion traits among 7–8-year-old children in China [20]. These findings support the need for screening throughout the mixed dentition period rather than limiting evaluation to a single age.

Sex-wise, crossbite prevalence was slightly higher among males than females, but the difference was not statistically significant. This is consistent with Indian school-based reports where gender differences in malocclusion traits were generally not significant [7,8]. Other studies have shown inconsistent patterns, with some reporting higher prevalence in females [10,18], while others observed higher proportions among males [9,21]. Therefore, sex alone should not be considered a reliable predictor for crossbite screening, and both boys and girls should be examined equally.

The findings support the inclusion of crossbite assessment in routine school dental screening programs. In a large urban population such as Mumbai, even a single-digit prevalence represents a substantial number of children who may benefit from early referral and interceptive care. The main limitations of the study include its cross-sectional design, absence of radiographs or study casts, lack of assessment of oral habits, breathing pattern, breastfeeding history, and socioeconomic variables, and incomplete documentation of some crossbite subtypes. Future studies should include standardized subtype recording, functional shift assessment, and habit-related data to better identify children who require early orthodontic intervention.

## Conclusion

Crossbite was observed in 6.90% of schoolchildren aged 6–12 years in Mumbai, with anterior crossbite being the most commonly recorded subtype. No

significant association was found between crossbite prevalence and age or sex in the present sample. These findings support routine school-based dental screening and timely orthodontic referral during the mixed dentition period.

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