

Oral Habits, Malocclusion, Orthodontic Treatment Need in Children with Mixed Dentition: A Systematic Review

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ABSTRACT

Oral habits can modify the functional balance of the lips, tongue, cheeks, and masticatory system during mixed dentition, creating conditions that may alter occlusal development and increase orthodontic treatment need. This systematic review synthesized contemporary evidence on oral habits, malocclusion, and objective treatment need in children with mixed dentition, while retaining malocclusion traits as clinically relevant secondary outcomes. A population-exposure-outcome framework guided eligibility. PubMed/MEDLINE and Scopus were used as the primary bibliographic databases, supported by targeted retrieval from PubMed Central, publisher platforms, and journal portals for articles published from January 2020 to July 2026. Methodological quality was appraised with design-appropriate JBI checklists, and narrative synthesis was used because habit definitions, dentition stages, treatment-need indices, and effect measures were heterogeneous. Forty-five unique records entered screening, 35 full texts were assessed, and 30 studies were included. Treatment-need evidence was most consistent for breathing-related dysfunction. Sleep-disordered breathing was associated with higher IOTN grades, mixed-dentition mouth breathing showed a strong relationship with IOTN-DHC need, and school-based ICON assessment identified a substantial treatment-needed group among children in whom oral habits were evaluated. Tongue thrust and dysfunctional swallowing were repeatedly related to open bite, increased overjet, crossbite, and sagittal discrepancies, while sucking, biting, and unilateral chewing showed more variable patterns. Eleven studies were judged at low risk of bias, and 19 raised some concerns. Oral habits were associated with clinically relevant malocclusion during mixed dentition, but the strength of evidence for a specific treatment-need grade differed by habit. Breathing dysfunction provided the clearest direct signal for elevated orthodontic treatment need, whereas other habits were more often linked to occlusal traits that may contribute to interceptive treatment decisions.

Keywords: oral habits; malocclusion; orthodontic treatment need; mixed dentition; children

INTRODUCTION

Oral habits act on a developing dentition through repeated functional pressure rather than through a single fixed pathway. Mouth breathing can reduce lip seal, change tongue posture, and modify mandibular positioning, while tongue thrust or dysfunctional swallowing can redirect force toward the incisors and dental arches. These functional changes may disturb the equilibrium that contributes to transverse, vertical, and sagittal occlusal development, producing features such as arch constriction, increased overjet, open bite, crossbite, or Class II and III relationships [4,6]. Mixed-dentition evidence also shows that past nonnutritive sucking is associated with anterior open bite and posterior crossbite, indicating that the type and persistence of a habit influence the pattern

of occlusal change rather than producing a uniform effect [23]. The clinical consequence becomes more relevant when those changes move beyond an isolated trait and contribute to an orthodontic treatment need that can be graded objectively.

Mixed dentition combines active eruption, exfoliation, arch remodeling, and craniofacial growth within the same developmental period. Available arch space and eruption sequence influence crowding and arch-length discrepancy, while dental and skeletal maturation do not always progress at the same pace. Prediction methods applied to Surabayan children have produced different estimates of arch-length discrepancy, showing that developmental assessment cannot be reduced to chronological age alone [17,18].

Cervical vertebral maturation and dental maturation may also provide different interpretations of mandibular growth timing [20]. Functional pressure from an oral habit can therefore interact with a dentition that is already changing rapidly, which makes mixed dentition a clinically meaningful stage for evaluating whether an observed occlusal alteration is transient, persistent, or likely to require interceptive treatment.

Habit-specific evidence shows distinct clinical patterns. Mouth-breathing children have been reported to show narrower dental arches, more frequent Class II characteristics, and altered craniofacial morphology, while mixed-dentition and pediatric studies have linked breathing dysfunction with crowding and increased overjet [6,11,32]. Tongue thrust and dysfunctional swallowing are repeatedly associated with open bite, increased overjet, crossbite, and malocclusion across more than one spatial plane [3,4]. Finger sucking, lip biting, nail or object biting, and unilateral chewing show fewer uniform findings, partly because frequency, duration, intensity, and age at cessation differ between children [1,15]. Nonnutritive sucking in a mixed-dentition sample increased the odds of anterior open bite and posterior crossbite, reinforcing the need to interpret each habit according to its own exposure pattern [23].

Orthodontic treatment needs provides a different level of information from the presence of malocclusion alone. IOTN-DHC data have shown a greater proportion of borderline or definite need among children with oral habits, and sleep-disordered breathing has been associated with higher IOTN grades [2,5]. Growing patients with atypical swallowing, oral breathing, sucking, and related behaviors have also presented substantial objective need in clinic-based IOTN assessment [12]. Recent mixed-dentition evidence from Indonesia found that moderate treatment need was the most frequent IOTN-DHC category in a mouth-breathing sample and that breathing pattern was strongly correlated with treatment need [26]. ICON assessment in another Indonesian school sample identified orthodontic treatment need in 46.3% of examined children while oral habits were recorded concurrently [27]. A large Italian pediatric series further incorporated finger sucking, mouth breathing, and tongue thrust among criteria used to identify interceptive orthodontic treatment need [34]. These findings support a review structure that separates objective treatment need from individual malocclusion traits instead of treating both outcomes as interchangeable.

This systematic review aimed to synthesize evidence published from 2020 to 2026 on oral habits, malocclusion, and orthodontic treatment need in children with mixed dentition. Objective treatment need assessed with IOTN, IOTN-DHC, ICON, ROMA, or interceptive treatment-need criteria was prioritized as the principal clinical outcome, while Angle classification, overjet, overbite, open bite, crossbite, crowding, arch constriction, and

related traits were retained to explain the occlusal pathway associated with each habit. Evidence from clearly defined mixed-dentition populations received greater interpretive weight than broader pediatric samples, although developmentally relevant studies were retained when the target age range was sufficiently represented. Habit-specific interpretation was used because breathing dysfunction, tongue-related dysfunction, sucking, biting, parafunction, and unilateral chewing differ in mechanism, persistence, and the strength of their relationship with treatment need [1,4].

MATERIALS AND METHODS

A systematic review design was used to evaluate observational evidence on oral habits, malocclusion, and orthodontic treatment need. Reporting followed the PRISMA 2020 sequence from identification to final inclusion [22]. The review question, eligibility framework, study selection, quality appraisal, and data extraction fields were defined before synthesis. No participant recruitment, intervention, identifiable patient information, or confidential clinical records were involved because all evidence came from published studies. Numerical values reported in the selection pathway were kept consistent across the abstract, methods, results, and PRISMA flow diagram.

Population, exposure, and outcome elements defined the review question. The population comprised children in mixed dentition or broader pediatric samples in which mixed-dentition participants were clearly represented and the findings remained applicable to that developmental stage. Exposure included mouth breathing, sleep-disordered breathing with mouth-breathing manifestations, tongue thrust, atypical or dysfunctional swallowing, thumb or digit sucking, pacifier use, lip biting, nail or object biting, bruxism, and unilateral chewing. The primary outcome was orthodontic treatment needed measured with IOTN, IOTN-DHC, ICON, ROMA, or clearly defined interceptive treatment-need criteria. Secondary outcomes included Angle classification, overjet, overbite, open bite, crossbite, crowding, arch constriction, midline deviation, and related craniofacial or occlusal features. Treatment-need results were interpreted separately from secondary malocclusion traits so that a morphological finding was not automatically equated with a treatment indication.

Primary database searches covered PubMed/MEDLINE and Scopus. Supplementary identification and full-text retrieval used PubMed Central, ScienceDirect/Elsevier, Springer/BMC, MDPI, SciELO, Wiley/Taylor & Francis, and targeted journal portals or handsearching when relevant records were available through those routes. The search period extended from 1 January 2020 to 31 July 2026 to prioritize recent pediatric evidence while retaining a six-year interval broad enough to capture recurring oral-habit and treatment-need patterns. Search expressions combined terms for oral habits, malocclusion or orthodontic treatment need, and pediatric populations.

The core structure was adapted to each database: (oral habit* OR mouth breathing OR tongue thrust* OR atypical swallowing OR thumb sucking OR lip biting OR nail biting OR bruxism OR unilateral chewing) AND (malocclusion OR orthodontic treatment need OR IOTN OR ICON OR ROMA OR dental aesthetic index OR crowding OR crossbite OR open bite) AND (child* OR pediatric OR paediatric OR schoolchild* OR mixed dentition). English- and Indonesian-language journal articles within the specified period were considered, and no automated eligibility tool was used.

Eligible studies were original observational reports that evaluated at least one oral habit and clinically assessed orthodontic treatment need or a relevant malocclusion outcome. Samples had to involve mixed dentition directly or provide a pediatric age range in which mixed dentition was sufficiently represented for developmental interpretation. Preschool-only samples, primary-dentition-only studies, reports dominated by permanent dentition without interpretable mixed-dentition data, editorials, case reports used as analytical evidence, and studies without a clinically relevant orthodontic outcome were excluded. Broader pediatric samples were retained only when their findings contributed to the functional pathway, objective treatment need, or occlusal characteristics relevant to mixed dentition. Supporting literature on dentition development, maturation, and index interpretation was used for contextual discussion but was not counted as an included analytical study.

Forty-five unique records entered title and abstract screening. Ten records were excluded because the population, developmental stage, oral-habit exposure, or orthodontic outcome did not match the eligibility framework. Thirty-five reports were sought and available for full-text assessment. Five full-text reports were excluded because two had populations or dentition stages outside or insufficiently aligned with the target group, two did not provide a relevant clinically assessed orthodontic outcome, and one represented a companion publication that did not contribute an independent analytical dataset. Thirty studies met the final eligibility criteria and entered narrative synthesis. Duplicate records, automated exclusions, and unavailable full texts did not alter the final pathway shown in the PRISMA 2020 flow diagram [22].

Methodological quality was appraised with design-appropriate JBI checklists. Twenty-seven analytical cross-sectional studies were assessed for clarity of inclusion criteria, description of participants and setting, validity of exposure and outcome measurement, recognition and handling of confounding, and appropriateness of statistical analysis. One descriptive prevalence study was considered primarily as narrative support, while two observational studies with cohort or prospective labels were interpreted cautiously when temporal sequence remained limited. Eleven studies were judged to have low risk of bias, and 19 raised some concerns. The most frequent concerns involved incomplete control of confounding, broad developmental ranges, self- or caregiver-reported habit exposure, referral-based sampling, and uncertainty about temporal direction. No study was excluded solely because of methodological quality; lower-quality evidence received less interpretive weight.

Data extraction covered authorship, publication year, country, study design, journal index or quartile when available, sample size, age and dentition stage, habit category, exposure assessment, treatment-need index, occlusal outcome, statistical method, effect estimate, principal finding, developmental applicability, and risk-of-bias judgment. Narrative synthesis was selected because the studies differed in oral-habit definitions, exposure duration, dentition-stage reporting, treatment-need instruments, sampling frames, and statistical presentation. IOTN, IOTN-DHC, ICON, ROMA, and interceptive-need findings were summarized before secondary malocclusion traits so that treatment need remained the main clinical outcome. Effect estimates, proportions, categorical grades, and descriptive findings could not be pooled on a common scale. Meta-analysis was not attempted because the available exposure definitions and outcome measures were too heterogeneous for a defensible, combined estimate.

RESULTS

The identification process yielded 45 unique records for title and abstract screening. Ten records were excluded at that stage, leaving 35 reports for full-text eligibility assessment. Five full-text reports were excluded: two because the population or dentition stage was outside or insufficiently aligned with the review criteria, two because the principal outcome did not provide an adequate clinically assessed orthodontic endpoint, and one because it did not contribute an independent analytical dataset. Thirty studies entered the final synthesis. The sequence of 45 screened records, 35 assessed reports, and 30 included studies is presented in Figure 1 [22].

PRISMA 2020 STUDY SELECTION FLOW

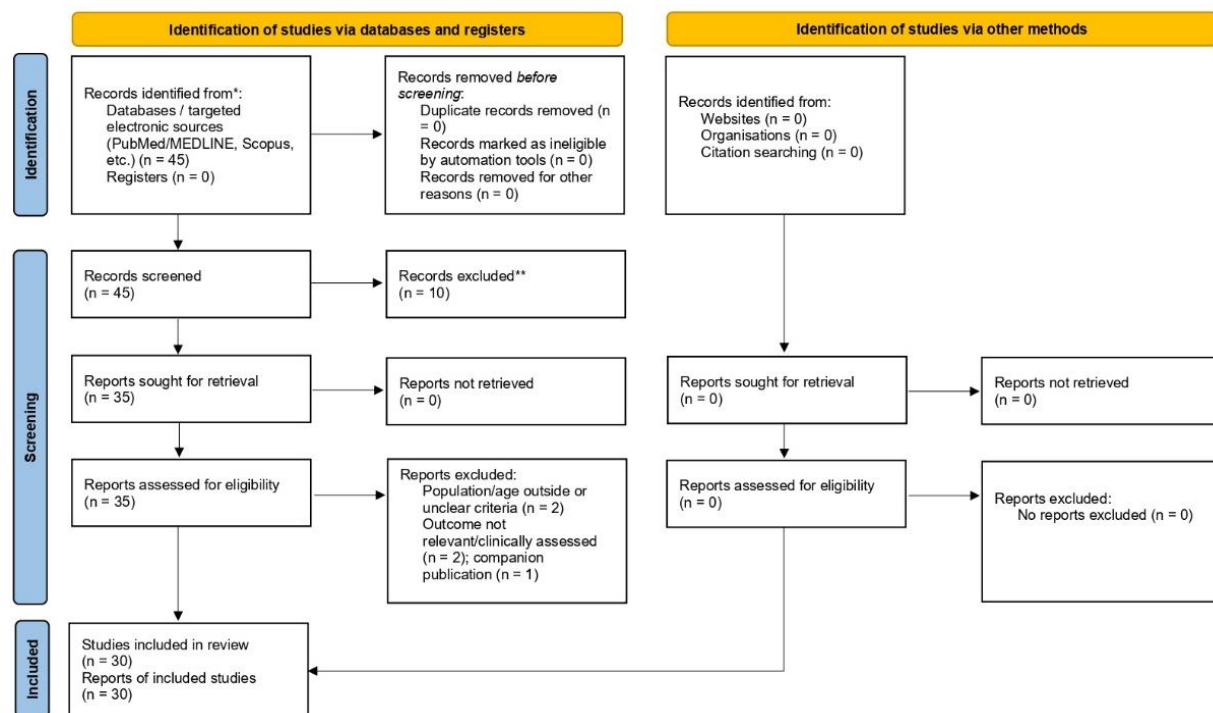


FIGURE 1: PRISMA 2020 Flow Diagram of The Study Selection Process.

The included studies represented Vietnam, India, Peru, Italy, Indonesia, Chile, Saudi Arabia, Yemen, Japan, Spain, China, Brazil, and Türkiye. Sample sizes ranged from 46 to 2,199 children. Several studies examined mixed dentition directly, including school-based samples focused on sucking habits, mouth breathing, crowding, malocclusion traits, and objective treatment need [1,11,23,26]. Broader pediatric populations were retained when mixed dentition was substantially represented or when the study contributed clinically relevant treatment-need or functional evidence [12,24,34]. Cross-sectional designs predominated, with smaller contributions from retrospective records, descriptive prevalence data, and observational cohorts. The evidence base also included studies published in Q1 and Q2 journals, while other included reports came from Scopus-indexed or local peer-reviewed journals, as detailed in Table 1.

Mouth breathing and sleep-disordered breathing produced the clearest combination of treatment-need and malocclusion findings. Sleep-disordered breathing was associated with higher IOTN grades and greater odds of Angle Class II or III relationships [5]. A mixed-dentition Indonesian study reported that moderate IOTN-DHC need was the most frequent category at 28.6%, with a strong positive association between mouth-breathing pattern and orthodontic treatment need ($r = 0.833$; $p < 0.001$). [26] Clinical and cephalometric studies described narrower maxillary dimensions, Class II tendencies, increased overjet, or altered facial and airway morphology among mouth breathers [6,28,35,36]. Japanese mixed-dentition data also showed approximately twofold greater odds of crowding with daytime or night-time mouth breathing [11].

ROMA-based assessment documented a high burden of dentofacial anomalies among mouth-breathing children, although the available report did not provide a habit-specific treatment-need grade that could be compared directly with IOTN or ICON [31].

Tongue thrust, atypical swallowing, and dysfunctional swallowing showed a reproducible relationship with malocclusion traits but less direct reporting of habit-specific treatment-need categories. Dysfunctional swallowing remained independently associated with several malocclusion traits, including Class II, Class III, increased overjet, and open bite [4]. Peruvian data connected atypical swallowing with vertical, sagittal, and transverse discrepancies [3], while Vietnamese mixed-dentition evidence linked tongue thrust with anterior open bite, posterior crossbite, and excessive overbite [1]. Spanish observations also identified relationships between atypical swallowing and vertical or horizontal occlusal pathology [13]. A recent orthodontic-care sample of children aged 6–16 years continued to document the coexistence of atypical swallowing and clinically relevant occlusal characteristics [29]. These studies support functional assessment of the tongue and swallowing pattern, but most did not assign a separate IOTN or ICON category to tongue-related exposure alone.

Sucking, biting, and other parafunctional behaviors showed more variable associations. Past nonnutritive sucking in 547 mixed-dentition children increased the odds of anterior open bite (OR 2.16; 95% CI 1.07–4.33) and posterior crossbite (OR 2.39; 95% CI 1.56–5.49). [23] A Brazilian mixed-dentition study also found pacifier use and early interruption of breastfeeding to be independently associated with selected malocclusions [30].

Vietnamese data linked finger sucking and lip biting with specific Angle classes [15], while nail or object biting was associated with midline deviation in another mixed-dentition sample.[1] A Turkish school survey found oral habits in 28.4% of children aged 10–12 years, with nail biting, mouth breathing, and tongue thrust among the most frequent behaviors [25]. Evidence for biting, bruxism, and unilateral chewing remained less consistent because duration and frequency were not measured uniformly and several studies combined multiple behaviors within one exposure category.

Objective treatment-need findings distinguished clinically actionable evidence from studies limited to morphology. Children with oral habits showed a substantially greater proportion of IOTN grades III–V in one pediatric sample, including 31.6% at grades IV–V compared with 2.4% in the comparison group [2]. The Vietnamese mixed-dentition study reported variation in IOTN distribution according to the number of oral habits [1], and sleep-disordered breathing was strongly associated with higher IOTN grades [5]. ICON assessment among Indonesian pupils identified a treatment-needed subgroup in the earlier school survey [7], while a newer school-based study reported a median ICON score of 41 and orthodontic treatment need in 46.3% of participants whose oral habits were assessed concurrently.[27]

Clinic-based IOTN-DHC data documented grades 4–5 in 27.55% of growing patients [12], and a large Italian prospective series incorporated finger sucking, mouth breathing, tongue thrust, crossbite, overjet, and eruption-space problems into interceptive orthodontic treatment-need assessment [34]. The available evidence therefore supports stronger conclusions about treatment need for breathing-related dysfunction and multiple persistent habits than for isolated biting or unilateral chewing.

Quality appraisal classified 11 studies as low risk of bias and 19 as raising some concerns. Low-risk studies generally used clear eligibility criteria, calibrated or standardized clinical outcomes, appropriate statistical analysis, and multivariable handling of relevant confounders. Mixed-dentition studies with direct clinical examination and adjusted models provided the most dependable habit-specific estimates [3,14,15,23,30,33]. Some-concern judgments most often reflected self-reported exposure, incomplete confounder control, clinic-based sampling, broad age ranges, or cross-sectional designs that could not establish whether the habit preceded the malocclusion. No included study was removed solely because of quality, but evidence from clearly defined mixed-dentition samples and objective treatment-need indices received greater interpretive weight.

TABLE 1: Characteristics, journal index, treatment-need measures, and principal findings of the included studies.

Study	Country; design; journal index	Sample/age	Oral habit exposure	Treatment need/outcome	Principal finding
Nguyen et al., 2024	Vietnam; cross-sectional; J Int Soc Prev Community Dent (Q2)	434; 8–12 y	Breathing, tongue thrust, biting, unilateral chewing	Malocclusion traits; IOTN	Habit-specific traits were accompanied by IOTN distributions that varied with the number of oral habits.
Satti et al., 2025	India; cross-sectional; Int J Clin Pediatr Dent (Scopus indexed)	Pediatric patients; age not fully reported	Tongue thrust, mouth breathing, thumb sucking	IOTN-DHC; malocclusion traits	IOTN grades III–V were more frequent with oral habits; grades IV–V were 31.6% versus 2.4% in the comparison group.
Rodríguez-Olivos et al., 2022	Peru; analytical cross-sectional; BMC Oral Health (Q1)	155; 6–12 y	Atypical swallowing, breathing, lip sucking	Vertical, transverse, sagittal malocclusion	Atypical swallowing was related to malocclusion in all three spatial planes.
Severino et al., 2025	Italy; retrospective cross-sectional; BMC Oral Health (Q1)	190; 6–12 y	Swallowing, breathing, sucking, biting	Angle, overjet, overbite	Dysfunctional swallowing independently predicted several malocclusion traits.
Shirke and Katre, 2023	India; cross-sectional; Cureus (Scopus indexed)	177; 6–12 y	Sleep-disordered breathing	Angle classification; IOTN	Sleep-disordered breathing increased the odds of Class II/III malocclusion and higher treatment-need grades.
Balakrishnan et al., 2025	India; cross-sectional; Int J Clin Pediatr Dent (Scopus indexed)	66; 6–12 y	Mouth breathing	Clinical and cephalometric traits	Mouth breathing was linked with narrower arches and Class II features; no formal treatment-need index was reported.
Aulia et al., 2023	Indonesia; descriptive cross-sectional; Dentin (local/SINTA)	46; 10–12 y	Oral habits	ICON	ICON identified a treatment-needed subgroup among children reporting oral habits.
Candia-Castillo et al., 2020	Chile; cross-sectional; Journal of Oral Research	327; 5–11 y	Tongue thrust, swallowing, breathing	Dentomaxillary anomalies	Tongue thrust was related to crossbite, overbite, and open bite.
Zakirulla et al., 2020	Saudi Arabia; cross-sectional; PBOCI (Scopus indexed)	750; 7–13 y	Multiple oral habits	Occlusal traits	Mouth breathing was associated with crowding.
Aldobai et al., 2025	Yemen; cross-sectional; Romanian Journal of Stomatology	1,079; 7–12 y	Tongue thrust, breathing, lip biting	Malocclusion classes	Oral habits showed a positive association with malocclusion.

Study	Country; design; journal index	Sample/age	Oral habit exposure	Treatment need/outcome	Principal finding
Sato et al., 2026	Japan; cross-sectional; Global Pediatrics (Q2)	10–12 y; N not fully reported	Day/night mouth breathing	Crowding	Mouth breathing approximately doubled the odds of crowded dentition.
Negri et al., 2021	Italy; retrospective observational; Eur J Paediatr Dent (Q1)	504; 4–16 y	Swallowing, sucking, breathing, bruxism	IOTN-DHC	IOTN-DHC grades 4–5 occurred in 27.55% of the clinic sample alongside multiple oral habits.
Santos Barrera et al., 2024	Spain; observational cohort; Clinics and Practice (Scopus indexed)	106; 5–12 y	Breathing, swallowing, sucking	Three spatial planes	Habit–outcome relationships differed by spatial plane; treatment need was not graded with IOTN or ICON.
Xu et al., 2023	China; cross-sectional; Oral Health & Preventive Dentistry (Scopus indexed)	2,162; 6–12 y	Multiple oral habits	Mixed-dentition malocclusion	Habit frequency and duration were related to mixed-dentition malocclusion.
Vu et al., 2024	Vietnam; cross-sectional; J Oral Biol Craniofac Res (Q1)	873; 9–10 y	Sucking, biting, tongue thrust, breathing	Angle Class I–III	Several oral habits independently increased the odds of specific Angle classes.
Belitz et al., 2022	Brazil; cross-sectional; Angle Orthodontist (Q1)	547; 7–13 y	Past finger/pacifier sucking	Malocclusion traits	Nonnutritive sucking increased odds of anterior open bite (OR 2.16) and posterior crossbite (OR 2.39).
Laganà et al., 2025	Italy; cross-sectional; Children (Q2)	1,033; 6–14 y	Multiple oral and functional habits	Occlusal relationships; prevention relevance	Oral habits were frequent and often multiple; Class I was the most common occlusal condition.
Atasever İşler et al., 2025	Türkiye; cross-sectional; BMC Oral Health (Q1)	1,144; 10–12 y	Mouth breathing, nail/pencil biting, tongue thrust, lip biting	Crossbite, overjet, overbite, crowding, Angle classes	Oral habits occurred in 28.4%; nail biting, mouth breathing, and tongue thrust were the most frequent.
Aisyah et al., 2026	Indonesia; analytical cross-sectional; Dentin (local/SINTA)	56; mixed dentition	Mouth breathing	IOTN-DHC	Moderate treatment need was most frequent (28.6%); mouth breathing correlated strongly with treatment need ($r=0.833$; $p<0.001$).
Sanjaya et al., 2026	Indonesia; cross-sectional; Kesmas (Scopus indexed)	67 child–parent pairs	Lip biting, tongue thrust, other reported habits	ICON	Median ICON was 41 and 46.3% required orthodontic treatment; oral habits were assessed with validated questionnaires.

Study	Country; design; journal index	Sample/age	Oral habit exposure	Treatment need/outcome	Principal finding
Cheng et al., 2023	China; cross-sectional clinical comparison; Int Dent J (Q1)	65; 10–12 y	Mouth breathing vs nasal breathing	3D facial morphology; skeletal Class II	Mouth- and nasal-breathing children with skeletal Class II showed different facial soft-tissue morphology.
Caruso et al., 2025	Italy; cross-sectional; Dentistry Journal (Scopus indexed)	60; 6–16 y	Atypical/dysfunctional swallowing	Occlusal characteristics	Atypical swallowing coexisted with clinically relevant malocclusion patterns in orthodontic-care patients.
Traebert et al., 2020	Brazil; cross-sectional; An Acad Bras Cienc (Q2)	664; 6 y; mixed dentition	Pacifier use and sucking practices	Overjet, posterior crossbite, other malocclusions	Pacifier use and early interruption of breastfeeding were independently associated with selected malocclusions.
Shetty et al., 2026	India; cross-sectional; J Oral Biol Craniofac Res (Q1)	109; 6–12 y	Mouth breathing	ROMA Index; dentofacial anomalies	Mouth breathers showed a high burden of dentofacial anomalies, including increased overjet in 83.5%.
Festa et al., 2021	Italy; cross-sectional clinical study; Acta Otorhinolaryngol Ital (Scopus indexed)	221; mean 6.2 ± 2.5 y	Mouth breathing / upper-airway obstruction	Malocclusion, Class II, overjet	Malocclusion was present in 81.4%; tonsillar hypertrophy was associated with malocclusion and increased overjet.
Freitas et al., 2021	Brazil; population-based cross-sectional; Cien Saude Colet (Scopus indexed)	332; 12 y	Breathing, chewing, swallowing, phonation alterations	DAI severity; Angle classes	Mouth breathing was associated with defined and disabling malocclusion and with Class III patterns.
Carli et al., 2023	Italy; prospective observational; Eur J Paediatr Dent (Q1)	2,199 pediatric patients	Finger sucking, mouth breathing, tongue thrust	Interceptive Orthodontic Treatment Need	Oral habits were included among criteria identifying interceptive treatment need together with crossbite, overjet, and eruption-space problems.
Habumugisha et al., 2022	China; cross-sectional; BMC Oral Health (Q1)	70; 10–12 y	Mouth breathing vs nasal breathing	Maxillary arch and pharyngeal airway	Mouth-breathing children had smaller airway and maxillary arch dimensions than nasal breathers across skeletal Classes I and II.
Li et al., 2022	China; cross-sectional; BMC Oral Health (Q1)	120; 7–15 y	Mouth breathing	Maxillofacial and airway development	Mouth breathing was associated with altered maxillofacial and airway measurements across maturation stages.
Ayu et al., 2023	Indonesia; cross-sectional; Interdental J Kedokt Gigi	50 mouth-breathing children	Mouth breathing	Modified Dewey Angle classification	Mouth breathing was related to malocclusion type; Class I Dewey type 2 was most frequent (50%).

TABLE 2: Methodological appraisal and role in synthesis.

Study group	Number	Risk judgment	Use in synthesis
Analytical cross-sectional studies	27	Low risk: 11; some concerns: 16	Main evidence; weight based on dentition-stage fit, confounding control, exposure validity, and objective orthodontic outcomes.
Descriptive prevalence study	1	Some concerns	Narrative support for habit prevalence and ICON-related clinical context; no causal interpretation.
Observational cohort/prospective studies	2	Some concerns: 2	Used for temporal or interceptive-treatment context with caution where follow-up or causal sequence was limited.
Total included	30	Low risk: 11; some concerns: 19; no high-risk study	All studies retained; mixed-dentition samples and objective treatment-need measures received greater interpretive weight.

TABLE 3: Thematic synthesis of oral habits, orthodontic treatment need, and malocclusion outcomes.

Habit category	Orthodontic treatment-need evidence	Related malocclusion traits	Key interpretation
Mouth breathing / SDB	Higher IOTN grades; mixed-dentition IOTN-DHC most often moderate; ROMA-based dentofacial risk	Class II, crowding, arch constriction, increased overjet	Strongest direct treatment-need signal. Breathing dysfunction repeatedly combined objective need with clinically relevant occlusal change.
Tongue thrust / dysfunctional swallowing	Direct habit-specific IOTN grades were rarely separated; interceptive criteria include tongue thrust	Open bite, overjet, crossbite, Angle II/III	Consistent malocclusion pattern supports functional assessment, but a universal treatment-need grade cannot be assigned from current evidence.
Sucking habits	Included in interceptive treatment-need criteria; direct IOTN/ICON grading remains limited	Anterior open bite, posterior crossbite, Class I/II, overjet/overbite changes	Treatment relevance depends strongly on persistence and cessation timing; mixed-dentition data show clear occlusal associations.
Biting / parafunction	Treatment-need indices seldom reported separately for these habits	Midline deviation, Class II/III, crowding	Evidence is positive but heterogeneous; treatment need should be graded from the resulting occlusal condition rather than inferred from the habit alone.
Unilateral chewing	No consistent habit-specific IOTN/ICON category	Posterior crossbite, posterior open bite	Evidence remains limited and should not be used to assign a treatment-need grade without objective occlusal assessment.
Multiple persistent habits	IOTN and ICON studies show greater or clinically relevant treatment need when several habits or functional problems coexist	General malocclusion burden across vertical, transverse, and sagittal planes	Objective indices are most useful when several persistent habits accompany measurable malocclusion, because habit count alone does not define severity.

DISCUSSION

Oral habits were associated with malocclusion across the included mixed-dentition and pediatric studies, but the clinical meaning of that association changed when objective treatment need was considered separately from morphology. Breathing dysfunction provided the most consistent direct link to higher orthodontic need, whereas tongue-related dysfunction and sucking habits were more consistently tied to specific occlusal traits that can become indications for interceptive care [5,23,26]. Evidence from IOTN, IOTN-DHC, ICON, ROMA, and interceptive-need assessments showed that the same broad label of an oral habit cannot be translated into one universal treatment category. Habit type, persistence, developmental stage, and the resulting occlusal feature all influenced how much clinical attention was required. A habit-specific interpretation therefore provides a more defensible basis for treatment planning than grouping all repetitive oral behaviors into a single exposure.

Mouth breathing showed the clearest treatment-need profile. Sleep-disordered breathing was associated with higher IOTN grades [5], and mixed-dentition children with mouth breathing showed a strong positive relationship between breathing category and IOTN-DHC need, with moderate need appearing most frequently in the Indonesian sample [26]. Clinic and imaging studies support a plausible functional pathway through reduced lip seal, altered tongue posture, narrower maxillary dimensions, increased overjet, and Class II-related morphology [6,28,35]. Upper-airway findings also showed that 81.4% of evaluated mouth-breathing children had malocclusion, with tonsillar hypertrophy associated with malocclusion and increased overjet [32]. ROMA-based assessment identified a high burden of dentofacial anomalies among mouth breathers [31], but ROMA findings cannot be converted directly into IOTN grades. These differences reinforce the need to report the index actually used rather than describing all objective orthodontic assessments as equivalent.

Tongue thrust and dysfunctional swallowing produced a strong and recurrent malocclusion pattern, particularly open bite, increased overjet, crossbite, and sagittal discrepancies [1,3,4]. A low or anterior tongue position can change the distribution of functional forces acting on incisors and palatal structures, while an existing open bite may itself alter tongue posture. This bidirectional possibility limits causal interpretation in cross-sectional studies even when associations are strong. Recent orthodontic-care data continue to show atypical swallowing alongside clinically relevant occlusal characteristics [29], and interceptive treatment-need criteria in a large pediatric series explicitly included tongue thrust [34]. Direct IOTN or ICON grades were seldom reported for tongue thrust as an isolated exposure, so the evidence supports functional and occlusal assessment rather than assigning a fixed treatment-need category to the habit itself.

Sucking habits showed a clearer relationship with selected occlusal traits than with a standardized treatment-need grade. Mixed-dentition children with previous nonnutritive sucking had higher odds of anterior open bite and posterior crossbite [23], while pacifier use was independently associated with selected malocclusions in another mixed-dentition population [30]. Finger sucking also appeared among the clinical findings used to identify interceptive orthodontic need in the large Italian pediatric series [34]. Lip biting and other biting behaviors were linked with selected Angle classes or midline deviation in Vietnamese samples [1,15], yet studies rarely reported IOTN or ICON categories separately for those behaviors. Treatment relevance for sucking and biting should therefore be derived from persistence, timing of cessation, and the occlusal consequence rather than from a yes-or-no history of the habit.

Mixed dentition provides a developmental setting in which the same habit may have different consequences depending on eruption sequence, available arch space, and skeletal maturation. Arch-length prediction methods applied to Surabayan children have shown that the estimated discrepancy can vary according to the analytical method [17,18], while dental and skeletal maturation may not progress in parallel [20]. Mouth-breathing effects also differed across cervical vertebral maturation stages in children and adolescents [36], supporting the view that developmental status modifies the expression of functional pressure. Evidence from clearly defined mixed-dentition samples deserves greater weight when the review question concerns early orthodontic need, because broad pediatric age ranges can combine children at substantially different stages of occlusal development.

Treatment-need indices added information that prevalence or morphology alone could not provide. IOTN-DHC distinguished moderate and greater need in mixed-dentition mouth breathers [26], while ICON identified orthodontic treatment need in 46.3% of a school sample in which oral habits were measured concurrently [27]. Earlier IOTN evidence showed higher grades among children with oral habits and a marked difference in grades IV–V between exposed and comparison groups [2]. Growing clinic patients also showed grade 4–5 IOTN-DHC in more than one quarter of the sample [12]. Interceptive treatment-need assessment extended the concept beyond a single index by identifying crossbite, excessive overjet, eruption-space problems, and selected oral habits as findings requiring early attention [34]. These data support describing treatment need with the original instrument and category reported by each study rather than reducing all outcomes to a general statement that treatment is needed.

A focused combination of oral-habit exposure, mixed-dentition applicability, malocclusion traits, and objective orthodontic treatment need represents a principal strength of this review. The synthesis separates direct treatment-need evidence

from secondary morphological outcomes, preventing open bite, crossbite, crowding, or Class II relationships from being treated automatically as equivalent levels of need. Habit categories were interpreted individually, and evidence from clearly defined mixed-dentition samples was given greater weight than broad clinic populations. The expanded evidence base also includes recent studies from Q1 and Q2 journals together with relevant Scopus-indexed and regional pediatric dental reports, allowing treatment-need findings to be compared across IOTN, IOTN-DHC, ICON, ROMA, and interceptive criteria without forcing those instruments on a single scale.

Methodological limitations restrict the certainty of several habit-specific conclusions. Meta-analysis was not performed because exposure definitions, duration and frequency measures, dentition-stage reporting, treatment-need instruments, and statistical effect measures were too heterogeneous for a defensible, pooled estimate. Most included studies were cross-sectional, so temporal direction could not be established, and reverse causation remains possible, particularly for tongue posture and open bite. Caregiver or child reports introduced potential exposure misclassification in some studies, while referral-based samples and broad age ranges reduced direct comparability with school-based mixed-dentition populations. Confounding was not handled uniformly, and several studies reported malocclusion traits without a standardized treatment-need index. Clinical assessment should therefore combine a detailed history with functional examination, occlusal findings, and an objective treatment-need measure whenever possible, especially before assigning an interceptive treatment priority.

CONCLUSIONS

Oral habits were associated with clinically relevant malocclusion during mixed dentition, but the level of orthodontic treatment need was not identical across habit categories. Breathing-related dysfunction showed the clearest direct treatment-need signal: sleep-disordered breathing was associated with higher IOTN grades, and mixed-dentition mouth breathing was strongly related to IOTN-DHC need, with moderate need reported most frequently in one Indonesian sample [5,26]. Objective ICON assessment also identified a substantial treatment-needed group in schoolchildren whose oral habits were evaluated [27], while interceptive treatment-need criteria included mouth breathing, finger sucking, and tongue thrust together with crossbite, excessive overjet, and eruption-space problems [34]. Tongue thrust and dysfunctional swallowing were consistently related to open bite, increased overjet, crossbite, and Class II or III patterns, but available studies did not support assigning a single IOTN grade to these habits. Nonnutritive sucking was associated with anterior open bite and posterior crossbite, whereas biting, parafunctional behavior, and unilateral chewing had more heterogeneous or limited evidence [23]. Treatment priority should therefore be based on the

combination of habit type, persistence, developmental stage, measured occlusal change, and an objective orthodontic treatment-need index rather than on the presence of an oral habit alone.

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