Research Article

Early Orthodontic and Orofacial Screening at Ages 1, 3 And 6–7: An Organizational Model

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Abstract

Malocclusion in children is usually treated as an orthodontic problem to be addressed in the mixed or permanent dentition. Accumulating evidence indicates that a substantial share of malocclusions develops against a background of functional factors, chiefly chronic mouth breathing, low tongue posture, incompetent lip seal and prolonged non-nutritive sucking, which can be detected long before orthodontic treatment begins. This review examines the evidence linking nasal breathing, jaw growth, sleep-disordered breathing and postural control, with an explicit appraisal of the strength of each link. Three critical windows for functional screening are proposed: 1 year, 3 years and 6–7 years. Each window is defined by the developmental stage, the interventions available at that stage and the presence of an existing scheduled contact with the health system. Analysis of the Russian procedure for preventive examinations of minors shows that a pediatrician, a pediatric dentist and an otorhinolaryngologist already examine the child at these ages, yet the examination record contains no item on breathing, lip seal or occlusion. Implementation barriers are grouped into three levels: organizational fragmentation of care, the absence of a brief tool validated for primary care, and insufficient interprofessional training. We propose a model in which the pediatrician acts as the entry filter, the dentist assesses orofacial function, and referral to an otorhinolaryngologist, orthodontist or myofunctional therapist follows predefined signs. The model requires no additional visits; it changes the content of existing ones. Limitations of the evidence, including the predominance of cross-sectional studies and the risk of overdiagnosis, are discussed.

Keywords: malocclusion; mouth breathing; early screening; preventive pediatric examination; interprofessional care; organizational innovation

1. Introduction

At the scheduled 12-month examination, a pediatrician assesses weight, length, psychomotor development and immunization status. Whether the child breathes through the mouth during sleep or keeps the lips apart at rest is not part of the standard assessment, although these signs largely determine how the maxilla will grow over the following years. Malocclusion is among the most common oral conditions of childhood: its pooled worldwide prevalence is about 56% and remains virtually unchanged from the primary to the permanent dentition [1]. In the mixed dentition, Class II molar relationship affects about 23% of children, posterior crossbite 11.7% and anterior open bite 5.3% [2]. The consequences extend beyond esthetics: a meta-analysis confirmed a consistent, though moderate, association between malocclusion and lower oral health-related quality of life in adolescents [3].

The conventional strategy postpones correction until orthodontic treatment becomes technically feasible. This logic suits malocclusions with a strong hereditary component but is poorly suited to those that develop under functional influences. Chronic mouth breathing, prolonged sucking habits and low tongue posture are associated with altered vertical and sagittal jaw growth, posterior crossbite and anterior open bite [4–6]. These factors are common: a meta-analysis of 54 studies found mouth breathing in 21.1% of children aged 3–18 years [7], and in samples screened specifically for it the proportion reached 44% [8]. A nationwide Japanese survey recorded incompetent lip seal in 30.7% of children aged 3–12 years, with prevalence increasing with age [9].

The problem is largely systemic. Calls to integrate oral health into primary care reflect long-standing criticism of the isolation of dentistry from the rest of medicine [10]. In pediatric practice, the divide takes the form of separate financing, unshared records and minimal oral health training for pediatricians [11]. A child with mouth breathing and developing maxillary constriction may be followed for years by several specialists, each of whom sees only part of the picture.

This review aims to justify functional screening of dentofacial development, embedded in existing preventive examinations at ages 1, 3 and 6–7 years, as an organizational innovation, and to analyze the conditions for its implementation. The innovation lies not in a new appliance or treatment but in redefining when and by whom the dentofacial system is assessed. PubMed, the Cochrane Library, Scopus and eLIBRARY were searched with priority given to publications from 2021–2026; systematic reviews and meta-analyses were preferred and,

where unavailable, the largest primary studies. Regulatory documents and guidelines were analyzed from the original sources.

2. The functional chain: nasal breathing, jaw growth and postural control

The central link in the chain is the shift from nasal to mouth breathing, caused by adenoid hypertrophy, allergic inflammation of the nasal mucosa or a habitual pattern without organic obstruction. During mouth breathing, the tongue drops from its palatal position and the maxilla loses the functional load that normally supports its transverse growth. A meta-analysis of cephalometric studies showed that, compared with nasal breathers, children with mouth breathing had SNB and SNA angles smaller by 1.96° and 1.63°, respectively, an SN-GoGn angle larger by 4.10°, and narrower upper airways; the authors rated the certainty of this evidence as low because all included studies were observational [4]. In a population sample of 12-year-olds, cephalometric adenoid hypertrophy was found in 13.9–19.0% and was independently associated with mandibular retrusion and a larger ANB angle [12]. Adolescents who breathe through the mouth have lower lip-closing force, tongue pressure and masticatory efficiency, with tongue pressure being the only independent predictor of breathing mode [13]. Both studies are cross-sectional: they agree with the meta-analysis but do not resolve the direction of the association. The consistency of findings across designs supports the plausibility of the association, although it does not raise the certainty of the pooled evidence. Together, these observations are described as a vicious cycle in which obstruction sustains mouth breathing and altered facial growth in turn perpetuates obstruction [14].

Detecting mouth breathing is less straightforward than it seems. An international Delphi consensus of speech-language pathologists identified the proportion of time with the mouth open at rest and tongue posture as the most informative signs, whereas noisy breathing and isolated habits did not reach consensus [15]. A protocol built on this consensus showed excellent reproducibility but only fair sensitivity, and its authors recommend starting with parental questionnaires before clinical assessment [16]. This sequence, from question to examination, underpins the proposed model.

Direct evidence of causality is scarce, and the most convincing data come from studies in which obstruction was removed. A systematic review of 16 controlled prospective cohorts reported that adenotonsillectomy was followed by wider maxillary arches, fewer lateral crossbites and a more horizontal mandibular growth pattern, while vertical and sagittal maxillary growth did not change; the authors stressed the high risk of bias and heterogeneity [17]. For allergic rhinitis, an association with malocclusion remains unconfirmed, as the six studies in a systematic review gave conflicting results [18]. Atypical swallowing presents a similar picture: tongue posture affects muscular balance and may contribute to malocclusion, but the evidence on interventions rests on a small number of heterogeneous studies [19].

Evidence on sucking habits is considerably more robust. In a meta-analysis of 13 studies including 10,272 children, a history of non-nutritive sucking was associated with anterior open bite (odds ratio [OR] 8.78) [6]. In another meta-analysis, the OR for open bite was 5.0 for digit sucking and 7.39 for pacifier use, whereas only pacifier use was significantly associated with posterior crossbite (OR 2.80) [20]. Breastfeeding, by contrast, is associated with lower odds of mouth breathing (OR 0.62) [8] and with fewer posterior crossbites and Class II malocclusions, with a duration-dependent effect [21]. In preschoolers aged 3–6 years, incompetent lip seal increased the age-adjusted odds of malocclusion 1.84-fold [22]. The link between orofacial dysfunction and occlusion is also evident in children with speech sound disorders, 87% of whom had orofacial dysfunction on the Nordic Orofacial Test-Screening (NOT-S), and 61% malocclusion compared with 29% of controls [23].

The relationship between the dentofacial system and posture requires the most cautious interpretation. A systematic review of 24 cross-sectional studies (6,199 participants) described associations of malocclusion with body and head posture, foot parameters and gait, but heterogeneity in definitions and methods precluded meta-analysis [24]. A review of sagittal skeletal malocclusions found that Class II is more often accompanied by increased cervical lordosis and forward head posture, and Class III by a straighter cervical spine, while explicitly noting that causality has not been established [25]. For children with mouth breathing, the evidence of postural disorders is of low quality [26], and gait studies remain small and heterogeneous [27]. Posture can therefore serve as an accompanying marker during screening, not as a target for occlusal treatment.

The extension of the chain most relevant to general health concerns sleep-disordered breathing (SDB). Obstructive sleep apnea (OSA) affects about 2–5% of children in the general pediatric population, and habitual snoring about 7.45% [28]; untreated OSA is associated with cardiovascular, cardiometabolic and neurocognitive complications [29]. In dental samples, 12–13% of children screen positive on the Pediatric Sleep Questionnaire (PSQ), and a positive result is associated with tonsillar hypertrophy, Class II molar relationship and posterior crossbite [30, 31]. In a multicenter study of orthodontic patients, mouth breathing was reported in 61.8%, and a positive SDB screen was associated with symptoms of attention-deficit/hyperactivity disorder (adjusted OR 6.22) [31]. Figure 1 summarizes the functional chain and the strength of evidence for each link.

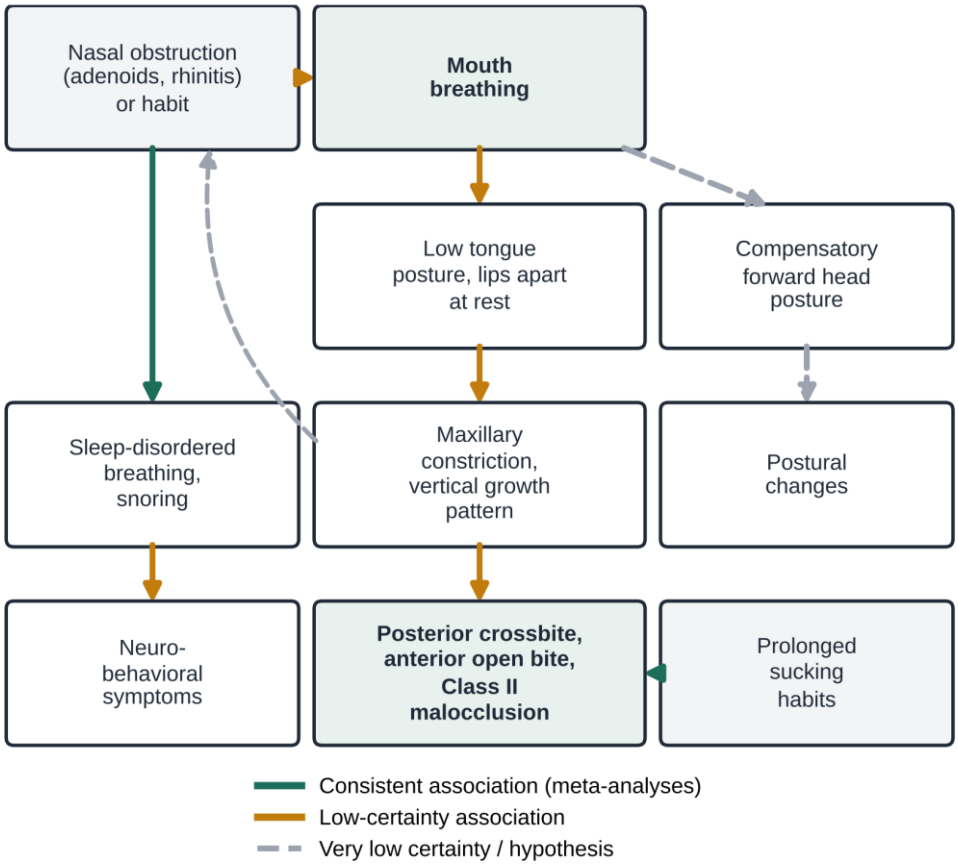

Figure 1. Functional chain linking nasal obstruction, mouth breathing, jaw growth, sleep-disordered breathing and postural changes. Arrow color and style indicate the strength of evidence from the systematic reviews included in the analysis. Original diagram by the authors.

3. Critical windows: rationale for ages 1, 3 and 6–7 years

The choice of screening ages rests on three conditions: the developmental stage of the dentofacial system, the availability of an intervention capable of changing the trajectory at that stage, and an existing scheduled contact with the health system. An age that meets only the first condition is of little use to an organizational model because it would require a new visit. Table 1 summarizes the three windows.

Table 1. Critical windows for functional dentofacial screening

Window	Developmental stage	What to assess	Who already examines the child (Order No. 211n)	Available actions and strength of evidence
12 months	Eruption of first teeth, onset of chewing	Snoring and breathing during sleep (parental report); lip seal at rest; pacifier or digit sucking; breastfeeding duration	Pediatrician, pediatric dentist, otorhinolaryngologist [32]	Counseling on feeding and habits [8, 21]; ENT assessment if snoring [33]; point of counseling and observation, as the prognostic value of signs is unknown
3 years	Complete primary dentition	Open bite, crossbite, mandibular shift; terminal plane; habits after age 3; awake breathing mode; NOT-S items	Pediatrician, pediatric dentist, otorhinolaryngologist	Habit cessation [6, 20]; removal of nasal obstruction [17]; observation of crossbite, up to 45% self-correct [34]; OMT: low certainty [35]
6–7 years	Eruption of first permanent	Crossbite with functional shift; Class II and Class III	6 years: pediatrician, dentist,	Expansion plate or quad-helix at 7–11 years: high certainty

	molars and incisors, early mixed dentition	relationship; overjet; head posture	otorhinolaryngologist, orthopedic surgeon; 7 years: pediatrician, dentist	[36]; early functional appliances reduce incisal trauma [37]; early Class III correction [38]

The first window falls at about one year of age, when the first teeth erupt and chewing develops; the American Academy of Pediatric Dentistry recommends the first dental examination no later than 12 months [39]. No orthodontic interventions apply at this stage, but three instrument-free observations are possible: breathing during sleep as described by parents, lip seal at rest and sucking habits. The value of this window lies in counseling on breastfeeding duration and pacifier use [8, 21] and in early identification of snoring children for otorhinolaryngological assessment. Because the prognostic value of functional signs at this age is the least studied, the window should be regarded as a point of counseling and observation rather than diagnosis.

The second window corresponds to age three, when the primary dentition is complete. Non-nutritive sucking beyond age three is associated with a higher frequency of malocclusion [39], and open bite, crossbite and mandibular shift become visible. The dentist can also assess the sagittal relationship from the terminal plane of the primary second molars. In 396 children aged 3–6 years, a flush terminal plane was found in 52.7%, a mesial step in 26.1% and a distal step in 21.2%; according to the longitudinal data cited by the authors, a distal step usually develops into a Class II relationship of the first permanent molars, whereas a flush plane more often leads to Class I [40]. A distal step in a mouth-breathing child therefore warrants targeted follow-up at subsequent annual examinations. Standardized tools become applicable from this age: NOT-S is designed for children aged three and older [41], and a protocol for assessing awake breathing has been validated in preschoolers from 2 years 11 months [16]. The common claim that orofacial myofunctional therapy (OMT) is most effective at this age is not supported: in a scoping review of 58 studies, no intervention achieved high-level confirmation of effectiveness, as only 11 studies were randomized trials and nearly half had no control group [35], and a systematic review in children with SDB included only non-randomized studies [42]. According to primary studies summarized in a narrative review, up to 45% of crossbites in the primary dentition self-correct, so treatment at this stage is justified only when lasting harm is likely [34]. The value of the three-year window thus lies mainly in removing causes: stopping sucking habits and referring children with nasal obstruction to an otorhinolaryngologist before the altered growth pattern becomes established.

The third window spans 6–7 years, when the first permanent molars and incisors erupt. The early mixed dentition is considered the preferred period for correcting functional posterior crossbite because maxillary expansion then produces a predominantly skeletal rather than dentoalveolar effect [34]. In children aged 7–11 years, high-certainty evidence supports removable expansion plates and quad-helix appliances over observation [36]. In Class II malocclusion, early functional appliance treatment reduces incisal trauma (OR 0.56), although no other clear advantage over adolescent treatment has been shown [37]. Trauma risk is directly related to overjet: in a prospective study of 1,413 children aged 6–13 years, an overjet of 6 mm or more carried a relative risk of dental injury within one year of 3.37 [43]. Early approaches to Class III correction likewise target the primary and early mixed dentition [38]. Chronological age reflects midpalatal suture maturation only approximately, so the decision to expand requires individual assessment [44]. A structured tool exists for the dental part of the examination at this age: the Index for Preventive and Interceptive Orthodontic Needs (IPION), in versions for ages 6 and 9, scores caries, premature loss of primary teeth, first permanent molar relationship, overjet, overbite, crossbite and incompetent lip seal [45]. In mixed-dentition samples, the index identified a definite need for early intervention in 51–59% of children, with a considerable share of points attributable to caries and premature tooth loss [45, 46]. The reliability and validity of modified versions remain insufficiently studied, and the index does not indicate the type of intervention required [47].

The key fact for the organizational framework is that all three windows already coincide with scheduled contacts. Under the Russian procedure for preventive examinations of minors in force since 1 September 2025, a pediatric dentist examines the child at 12 months and then annually from 2 to 17 years, an otorhinolaryngologist at 12 months, 3 and 6 years, and an orthopedic surgeon at 6 years, while the pediatrician takes part in every examination [32]. Thus, at 12 months, 3 years and 6 years, the pediatrician, dentist and otorhinolaryngologist assess the same child at the same stage, and at 6 years they are joined by the orthopedic surgeon (Figure 2). However, the examination record contains no item on breathing mode, lip seal, occlusion or head posture [32]. International recommendations show a similar gap: the periodicity schedule of the American Academy of Pediatric Dentistry includes assessment of occlusion and habits but does not mention the airway at any age [39], whereas the pediatric OSA guideline recommends asking about snoring at every routine visit [33] without linking this question to dental assessment.

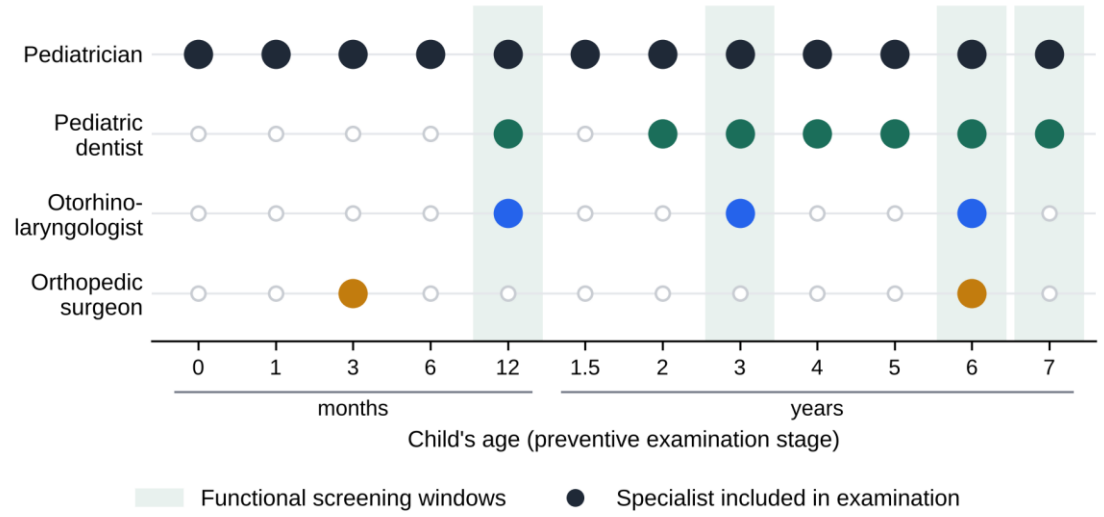

Figure 2. Participation of the pediatrician, pediatric dentist, otorhinolaryngologist and orthopedic surgeon in preventive examinations of children from birth to 7 years under Order No. 211n of the Ministry of Health of the Russian Federation; the proposed functional screening windows are shaded. Constructed by the authors from the examination procedure.

4. Barriers to implementation

The first barrier is organizational. Each specialist who sees the child during the critical windows is responsible for one subsystem, and none has either the mandate or the tool to assess the functional chain as a whole. In a convenience sample of 110 surveyed pediatricians, 64.5% referred children with mouth breathing mainly to an otorhinolaryngologist, only 0.9% exclusively to an orthodontist, and 18.2% never referred to an orthodontist [48]. Separate financing and unshared records entrench this divide at the system level [11]. Proposed integrated pathways for pediatric oral health have not yet been evaluated for clinical effectiveness [49]. The opposite risk also exists: several authors warn that expanding the orthodontist's role in SDB has outpaced the evidence and stress that OSA must be diagnosed by a physician on the basis of polysomnography [50–52]. An organizational model must address both underdetection and overdiagnosis.

The second barrier is methodological. The claim that no screening tools exist is inaccurate. In its original validation, the PSQ showed a sensitivity of 0.81–0.85 and a specificity of 0.87 for SDB [53]. In a population sample of children aged 4–9 years, however, a parental questionnaire detected only 33% of cases identified by home sleep testing, with a specificity of 65% [29]. A scoping review of 34 studies of SDB screening in dental settings found no tool validated in those settings [54], and the proportion of positive screens in orthodontic samples ranges from 1.2% to 69% depending on the instrument and population [55]. NOT-S takes 5–7 minutes and is intended for various professionals, but its psychometric properties have not been examined in detail for most language versions [41]. Even among speech-language pathologists, expert agreement on classifying breathing mode was only fair [15]. The barrier, therefore, is the lack of a brief tool validated for a 2–3-minute segment of a pediatric visit, not the lack of tools altogether.

The third barrier is educational. A scoping review of 25 studies from the past decade described pediatricians' oral health knowledge as unsatisfactory, citing inadequate training, low confidence and lack of time [56]. In a survey of Turkish pediatricians, 73.6% recognized the link between mouth breathing and maxillary constriction, yet only 14.5% were aware of maxillary expansion, while 70.9% wanted relevant training [48]. Gaps exist on the dental side as well: SDB training in North American orthodontic residency programs remains largely didactic and unstandardized [57]. A systematic review of oral health curricula for primary care clinicians found them too heterogeneous to determine their effect on practice [58]. Experience with integrating oral health into well-child visits shows that results depend on process support: a program that redesigned the workflow raised the share of visits with oral health assessment from nearly zero to about 50% and sustained it for two years [11]. Table 2 summarizes the barriers and possible solutions.

Table 2. Barriers to implementing integrated screening and possible solutions

Level	Manifestation	Evidence	Possible solution
Organizational	Each specialist assesses one	64.5% of pediatricians refer mouth-breathing children mainly to ENT, 0.9%	Functional tasks assigned to participants of the existing

	subsystem; referrals mainly to ENT; separate records	exclusively to an orthodontist [48]; separate financing and records [11]; proposed pathways not yet evaluated [49]	examination stage; shared functional block in form No. 030-PO/u
Methodological	No brief tool validated for primary care	Parental questionnaire sensitivity 33% in a population sample [29]; no tool validated in dental settings [54]; NOT-S requires 5–7 minutes [41]	Prospective validation of a checklist of 4 questions and 6 clinical signs
Educational	Limited knowledge at the interface of pediatrics, dentistry and otorhinolaryngology	Pediatricians' knowledge rated unsatisfactory [56]; 14.5% aware of maxillary expansion, 70.9% want training [48]; orthodontic SDB training unstandardized [57]	Brief module on recognizing signs and following the pathway; evaluation by change in practice rather than self-report [58]

5. The integrated dentofacial screening model

The proposed model rests on three principles. It creates no new visits and uses the examination stages at which the pediatrician, dentist and otorhinolaryngologist already see the child. It redistributes the content of examinations by assigning each specialist a specific functional task. Finally, it separates screening from diagnosis: neither the pediatrician nor the dentist diagnoses OSA; both only identify indications for referral [51, 52]. The pathway is shown in Figure 3.

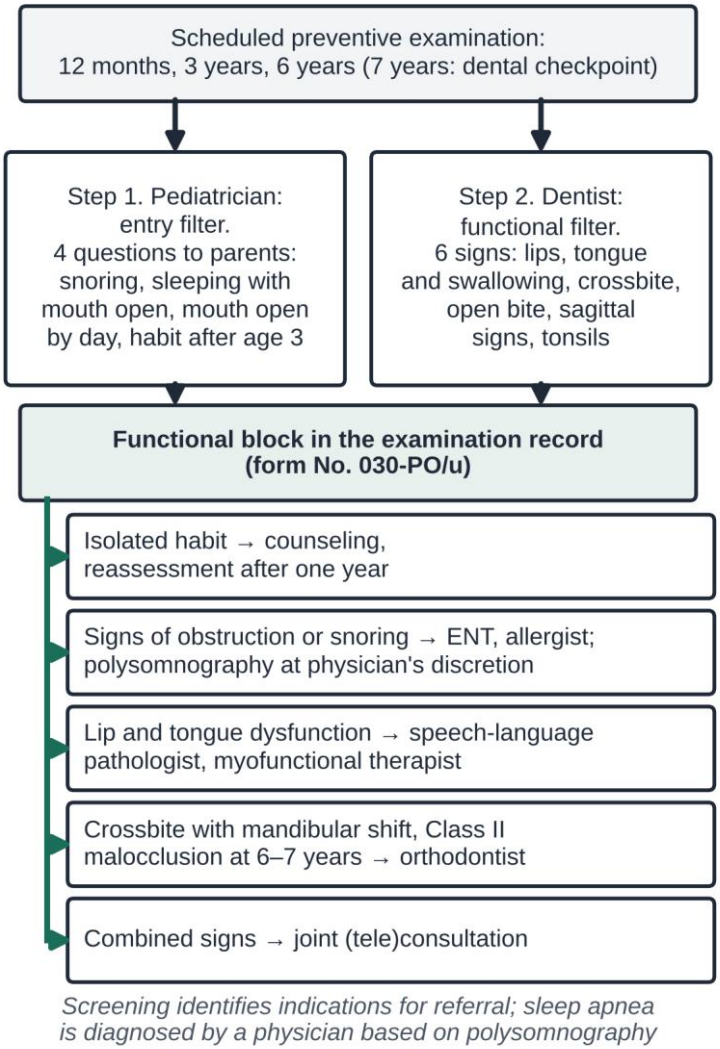

Figure 3. Integrated dentofacial screening model: roles of the pediatrician and dentist, the functional block in the examination record and referral options. Original diagram by the authors.

In the first step, the pediatrician acts as the entry filter. At 12 months, 3 years and 6 years, parents are asked four questions: whether the child snores habitually, on most nights, sleeps with the mouth open, keeps the

mouth open at rest during the day, and has a sucking habit after age three. The snoring question follows the 2012 clinical practice guideline of the American Academy of Pediatrics [33]; the Russian procedure for preventive examinations contains no such question [32]. Frequent snoring is of greater concern than occasional snoring [33], but the threshold for a positive answer has not been validated for this purpose and must be established when the checklist is validated. Incompetent lip seal was chosen as a common and easily observed sign [9, 22]. A positive answer to any question is recorded and passed to the dentist and otorhinolaryngologist at the same stage.

In the second step, the dentist acts as a functional filter rather than solely as a provider of dental care. In addition to examining the teeth, the dentist records six signs with operational criteria (Table 3). The first is lips apart at rest during several minutes of unobtrusive observation, the key criterion of the breathing assessment consensus [15]. The second is low tongue posture at rest or tongue interposition between the incisors during swallowing [19, 41]. The third is posterior crossbite with a mandibular shift on closure, manifested as midline deviation and lower facial asymmetry [34]. The fourth is anterior open bite, defined as the absence of vertical incisor overlap [6]. The fifth combines sagittal signs: a distal step of the terminal plane in the primary dentition [40] and, in the mixed dentition, a Class II first permanent molar relationship and an overjet of 6 mm or more [43]. The sixth is visible enlargement of the palatine tonsils, which in dental samples is associated with a positive SDB screen [30]; tonsil size assessment by the dentist, using a standardized grading of tonsil size together with the Mallampati score, is considered an acceptable screening element followed by referral [52, 54]. This is a clinical sign, not a diagnostic step: it justifies referral to an otorhinolaryngologist but not a conclusion about SDB. All signs are assessed without equipment and largely overlap with NOT-S items [41]; at age six, the dental component can build on the IPION structure supplemented with functional items [45]. The otorhinolaryngologist at the same stage is informed of positive screens and assesses nasal obstruction and adenoid and tonsil size in a targeted way. At age six, head posture is assessed by the orthopedic surgeon and treated as an accompanying marker, not as an indication for occlusal treatment [24, 25].

Table 3. Minimum set of signs for integrated screening and actions when present

Sign	Assessed by	Age	Basis	Action when present
A. Questions to parents				
Habitual snoring (on most nights)	Pediatrician	1, 3, 6 years	[28, 33]	Otorhinolaryngologist; polysomnography at physician's discretion
Sleeping with the mouth open	Pediatrician	1, 3, 6 years	[4, 8]	Otorhinolaryngologist; allergist if needed
Mouth open at rest during the day	Pediatrician	1, 3, 6 years	[9, 22]	Functional assessment by the dentist
Sucking habit after age 3	Pediatrician	3, 6 years	[6, 39]	Counseling; reassessment after one year
B. Clinical signs				
Lips apart at rest during 2–3 minutes of observation	Dentist	3, 6–7 years	[15, 22]	Speech-language pathologist or myofunctional therapist; ENT if combined with snoring
Low tongue posture at rest; tongue interposition between incisors during swallowing	Dentist	3, 6–7 years	[19, 41]	Speech-language pathologist or myofunctional therapist
Posterior crossbite with mandibular shift on closure (midline deviation, lower facial asymmetry)	Dentist	3, 6–7 years	[34, 36]	3 years: observation and removal of cause; 6–7 years: orthodontist
Anterior open bite (no vertical incisor overlap)	Dentist	3, 6–7 years	[6, 20]	Habit cessation; orthodontist if persisting at 6–7 years
Sagittal signs: distal step of the terminal plane (3 years); Class II first molar relationship, overjet ≥6 mm (6–7 years)	Dentist	3, 6–7 years	[37, 40, 43]	3 years: follow-up at annual examinations; 6–7 years: orthodontist; ENT if signs of obstruction

Visible enlargement of the palatine tonsils	Dentist, otorhinolaryngologist	3, 6 years	[30, 52]	Otorhinolaryngologist; polysomnography at physician's discretion

Documentation requires specific attention. As long as the examination record has no fields for functional signs [32], information on positive screens remains in the clinician's memory or in free text and does not reach the next specialist. The minimal solution is a functional block of four parental answers and six clinical signs, visible to all participants at a given stage. Experience with integrating oral health assessment into pediatric visits shows that sustainability is achieved when new actions are built into the visit form and the electronic record rather than left to clinician discretion [11]. In the Russian system, the natural carrier for such a block is examination record form No. 030-PO/u itself.

In the third step, referral depends on the combination of signs. An isolated habit calls for counseling and reassessment after one year. Signs of nasal obstruction lead to referral to an otorhinolaryngologist and, if necessary, an allergist; when OSA is suspected, the decision on polysomnography is made by a physician. Functional crossbite or marked Class II malocclusion at 6–7 years warrants orthodontic consultation, and persistent lip and tongue dysfunction warrants referral to a speech-language pathologist or myofunctional therapist. Complex cases combining obstruction, malocclusion and postural changes are reviewed at a joint consultation, which may be held by telemedicine. Other proposed models follow similar logic: an Italian pediatric oral health pathway uses three tiers with telemedicine and automated triage for high-risk children [49], and orthodontic authors recommend maxillary expansion only for documented maxillary constriction [51]. The proposed model differs in that it is embedded in the mandatory examination schedule and assigns the dentist an assessment role, not only a treatment role.

6. Conditions for implementation

Implementation planning can draw on the updated Consolidated Framework for Implementation Research (CFIR), with its five domains: innovation, outer setting, inner setting, individuals and implementation process [59]. For the proposed model, these correspond to a simple tool, changes to the record form and examination procedure, agreed roles within the outpatient clinic, training of pediatricians and dentists, and stepwise piloting. Outcomes can be evaluated with the RE-AIM framework [60]. Reach can be measured as the proportion of children of the target age with a fully completed functional block; adoption as the proportion of pediatric sites and dental offices using it; implementation fidelity as the agreement between pediatrician and dentist assessments of the same child; and maintenance as completion rates 12 months after support ends. Effectiveness at the child level is reflected in the proportion of children referred for correction within the window in which it is simplest and in the time from the first positive screen to specialist consultation.

The first condition is validation of the checklist. Consolidated screening principles require known test characteristics and system capacity to manage children who screen positive [61]. The checklist of four questions and six clinical signs should be tested in a prospective study estimating sensitivity and specificity against the conclusion of an interprofessional panel and, for the subgroup with snoring, sleep study data. Without validation, screening remains clinical opinion, and results from different institutions cannot be compared.

The second condition is training. A module on functional dentofacial development for pediatricians and dentists should be brief and focused on recognizing signs and following the pathway, not on orthodontics. Given the heterogeneity of existing curricula [58], its effect should be judged by changes in practice, such as the proportion of examinations with a completed functional block, rather than by self-reported knowledge.

The third condition concerns digital tools, which can extend reach but cannot yet replace clinical examination. Deep learning models analyzing smartphone photographs of the dentition taken by parents detected deep bite with an area under the ROC curve of 0.92, but only 0.73–0.74 for crowding and maxillary incisor protrusion [62]. Automated cephalometry achieves a mean landmark error of 1.39 mm [63], and convolutional neural networks classify the sagittal skeletal pattern on cephalograms with an accuracy of 0.96 [64]. An algorithm detecting mouth-breathing events in polysomnography lost accuracy considerably when tested on new recordings [65]. Reviews point to limited diversity of training data, consent issues with children's data and infrastructure constraints [66]. For referral decisions, teledentistry shows a sensitivity of 80–88% and a specificity of 73–95% [67], and mobile applications improve parental knowledge, although their effect on clinical outcomes is poorly studied [68]. Within the model, digital tools are best suited to remote follow-up of children who screen positive.

The fourth condition is economic. Screening within an existing examination adds little cost but generates a stream of referrals that must be planned for. A model-based comparison in the Swedish public dental service estimated the expected cost of interceptive treatment with a removable plate or quad-helix at about €1,500, compared with €2,500 for fixed appliances, with the quad-helix being the most cost-effective option; the model, however, assumed full success of fixed appliances and relied on expert opinion for long-term stability [69]. For

other interventions, the picture is less clear. Rapid maxillary expansion in children with OSA reduced the apnea–hypopnea index by 4–6 events per hour with very high heterogeneity [70], and a systematic review of functional appliances and expansion reported conflicting results [71]. OMT reduced the apnea–hypopnea index by a mean of 1.54 events per hour and is regarded as an adjunct in mild to moderate OSA [72]. The effect of prefabricated myofunctional appliances on vertical parameters is supported by very low-certainty evidence [73]. An expert consensus on early orthodontic intervention covers the period from fetal development to the early permanent dentition [74], but economic models of functional screening in primary care are still lacking.

Discussion

The proposed model rests on evidence of uneven quality. Most data linking mouth breathing to jaw growth and posture come from cross-sectional studies in which the direction of the association cannot be established [4, 24], and the reverse sequence, in which facial morphology predisposes to obstruction, remains a plausible alternative hypothesis [5]. For the rationale of screening, this distinction matters less than it may seem: even if the relationship is bidirectional, early detection allows modifiable factors, primarily sucking habits and nasal obstruction, to be addressed before the altered growth pattern becomes established [6, 17]. The interventions most often discussed in the context of early detection, particularly OMT and prefabricated appliances, have a limited evidence base [35, 73]. The weakest element of the model is the one-year window, because functional signs at this age may reflect transient conditions and their prognostic value is unknown.

Anchoring the third window at six rather than seven years requires explanation. In the Russian schedule, it is the six-year examination that brings together the dentist, otorhinolaryngologist and orthopedic surgeon, whereas at seven years only the dentist among these three specialists sees the child (the pediatrician participates at both stages) [32]. Because the evidence for interceptive crossbite treatment was obtained in children aged 7–11 years [36], detection at six leaves time for reassessment and treatment planning before this period begins. The seven-year examination is retained in the model as a dental checkpoint.

The second limitation is the risk of overdiagnosis. A screen with low specificity would increase the workload of otorhinolaryngologists and orthodontists and could lead to unnecessary interventions, including maxillary expansion without transverse deficiency [51, 52]. The model therefore uses stepwise referral, in which most children with isolated signs remain under observation rather than being referred for treatment; for primary-dentition crossbite, this approach follows directly from the high rate of spontaneous correction [34].

The third limitation concerns transferability. The model is built on the Russian preventive examination procedure, in which the coincidence of dental and otorhinolaryngological examinations at 12 months, 3 and 6 years provides a convenient basis [32]. Systems in which dental examination is not part of the mandatory pediatric schedule would require adaptation, for example delegating part of the assessment to nurses or using teledentistry [67]. Finally, the effect of functional screening on clinically meaningful outcomes, such as time to diagnosis or the proportion of children requiring complex orthodontic treatment, has not been assessed in any randomized trial.

Conclusion

The dentofacial system develops in early childhood under the influence of functional factors that can be detected by simple means long before orthodontic treatment begins. The existing schedule of preventive examinations already brings the child into contact with a pediatrician, dentist and otorhinolaryngologist at the critical ages but does not use these contacts for functional assessment. Implementing the proposed model requires no new visits but depends on three conditions that cannot be replaced by an administrative decision: a revised record form, a validated tool and trained pediatricians and dentists. The budget impact of the model therefore lies less in the screening itself than in the capacity of downstream services, which should be planned and evaluated during piloting.

Four research directions are needed to move from concept to practice: prospective validation of the checklist for pediatricians and dentists, with sensitivity and specificity estimated at each of the three ages; a cluster pilot in one or two regions measuring time to diagnosis, the proportion of children referred for early correction and the workload of related specialists; a prospective cohort testing the direction of the association between functional disorders, jaw growth and postural control; and an economic evaluation of early functional screening versus late orthodontic treatment that includes referral costs.

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