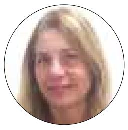
Orthodontic treatment need and timing: Assessment of evolutive malocclusion conditions and associated risk factors



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Abstract

Aim Orthodontic treatment need indexes are indispensable tools for collecting aepidemiological information, to define the need for clinical intervention on a graduated risk scale and to monitor the evolution of clinical conditions over time. The purpose of this research is to evaluate the prevalence of malocclusion and associated risk factors, and to compare the prevalence of malocclusion related to children's growth. Investigating the correlation between malocclusion and dental occlusion development is crucial to define orthodontic timing and the most suitable treatment modalities.

Materials and methods A cross-sectional, multi-center, observational study was carried out throughout Italy: 4,422 patients aged between 2 and 13 years were visited. The patients were divided into two age groups: one composed of patients aged 2 -7 years, and one of children between 8 and 13 years of age. The prevalence data were classified according to the items of the Baby ROMA (first group, deciduous/early mixed dentition) and ROMA Index (second group, late mixed/permanent dentition). Pearson's Chi-square test was applied for the calculation of statistical significance in the comparison of prevalence data between the two age groups ($P < 0.05$).

Results The need for orthodontic treatment among Italian children is high. In the sample aged between 2 and 7 years, the most frequent malocclusions are the moderate and severe open bite (23%), moderate and severe Class II (21.2%), deep bite (18.8%), cross bite (16.5%), Class III (7.7%), and crowding (5.1%). In the sample aged between 8 and 13 years the most frequent malocclusions are crowding (50.8 %), Class II (33.1%), deep bite (19.2%) crossbite (18.1%), Class III (9.1%), open bite (6.6%), facial or mandibular asymmetries (3.3%), and functional asymmetries (3.2%). It was found a statistically significant variation of the different malocclusion conditions according to age.

Conclusions The study confirms that some risk factors occur during growth, and worsen the malocclusion. Therefore, it is important to reduce this risk of worsening by counteracting those factors with an early orthodontic intervention. Some malocclusions are less affected by environmental risk factors. In these case it would be better defer treatment until adolescence.

KEYWORDS Malocclusions; Orthodontic treatment need indices; Risk factors

Introduction

The use of orthodontic treatment need indices is currently universally accepted and spread worldwide. Interest about the topic has increased, since indices supply one of the major determinants for a well-reasoned allocation of financial funds. In fact it is a major concern to correctly allocate funds for nations with oral care national system or for the third part financing, in order to provide efficacy for both research purposes and provision of medical care [Grippaudo et al., 2008].

The authors believe that the primary purpose of orthodontic treatment need indices should be to guide clinicians to select the proper treatment for the single cluster of priority treatment [Quinzi et al., 2018]. That is to say, also patients with a low priority treatment should be treated the best possible way according to their conditions [Ferro et al., 2016]. It is important to identify not only the groups of patients needing to be treated, but, above all, to classify the evolutive behaviour of signs and symptoms of malocclusions. A tool enabling to apply the proper treatment to all clusters of patients, in order to maximise the efforts when necessary and to minimise future interventions, is invaluable for clinicians. Periodic orthodontic visits should start early to motivate the patient to eliminate modifiable risk factors and reduce the risk of developing occlusal problems [Moimaz et al., 2014]. In fact, malocclusions in children are often overlooked or underestimated despite their high prevalence.

The authors previously created and reported two indices of malocclusion assessment: ROMA Index (Risk Of Malocclusion Assessment Index) [Grippaudo et al., 2007] and Baby ROMA Index [Grippaudo et al., 2014]. ROMA Index can be applied to children in the late mixed dentition phase or in permanent dentition, and it is also useful to evaluate the need for interventions and the risk of malocclusions worsening if they remain untreated. The Baby-ROMA Index was designed to be applied in primary dentition or in the early mixed dentition phase. It was devised by observing that some of the malocclusion signs can worsen with growth, while others remain unchanged over time and others can even improve. Therefore, it would be desirable to have superimposable information from the two indices, with the aim to classify the malocclusions observed at an early stage on a risk-based scale and monitoring condition over time. Based on these premises, the purposes of the present research are the following.

- To assess the prevalence of malocclusion and associated risk factors using specific indices for the various age groups (descriptive or qualitative investigation).

- To assess the severity of malocclusion and the need for orthodontic treatment among Italian children using specific indices for the various age groups (descriptive or qualitative investigation).
- To compare prevalence between the two subgroups of the sample and to compare the two indices for orthodontic treatment need (quantitative investigation). The null hypothesis is that there are no statistically significant differences between the scores and the items of the ROMA Index and Baby ROMA Index between two age groups (between 2 and 7 year-olds, and between 8 and 13 year-olds).

Materials and methods

Characteristics of the sample and study design

A cross-sectional and multicenter study was carried out in a population of 4,422 patients aged between 2 and 13 years (2,078 males and 2,341 females). The sample was divided into two subgroups. The first group consisted of 1,405 children aged between 2 and 7 years (average age 4.87 years; 699 females and 706 males) and the second group of 3,017 children aged between 8 and 13 years (average age 10.69; 1,642 females and 1,372 males). The patients were visited at the Dental Clinic of the "A. Gemelli Polyclinic Foundation IRCSS" in Rome, in schools and kindergartens, and in paediatric clinics. The visits took place throughout Italy (North, Central and Southern Italy).

Clinical assessment

The research was conducted in accordance with the ethical standards of the Declaration of Helsinki. A specific protocol was used to make the clinical observation reproducible and standardised: an artificial light was used to illuminate the oral cavity, a tongue depressor to inspect the lower arch and widen the cheeks, and a gauge to measure overbite and overjet. The authorisation of the school principal was requested, and the written informed consent of the parents was collected before the screening was performed, informing them in detail about the research protocol and the method of visit. For younger children, more information was provided by parents about the medical history: relevant medical or auxological conditions, orthopaedic or postural problems, familial tendency for malocclusion, trauma to the facial and oral regions, bad oral habits, bruxism, bad oral hygiene, and previous dental therapies for caries or orthodontic treatments. The operators involved in the study were dentists from the School of Orthodontics of the Catholic University of Rome who had been calibrated by instructors (CG and EGP) to perform observation and data collection with the use of the orthodontic treatment indices.

Data collection

For each patient visited, data were recording including the date of birth, age, gender, risk of malocclusion, items of the ROMA Index and Baby ROMA Index. For the first group (children between 2 and 7 years) it was used the Baby ROMA Index [Grippaudo et al., 2014]. For the second group (children between 8 and 13 years) it was used the ROMA Index [Grippaudo et al., 2007]. Systemic, craniofacial, dental, and functional problems associated with malocclusion were recorded. The clinical data were associated with a unique progressive number for identification. The data collected indicate the prevalence of the index Grades and the distribution of the items (systemic, craniofacial, dental, and functional problems). All data were inserted in a database.

Statistical analysis and indices comparison

The statistical analysis was carried out in collaboration with the Epidemiology Center of the Department of Public Health and Infectious Diseases, Faculty of Medicine and Surgery, La Sapienza University of Rome. For the statistical analysis, the Statistical Package for Social Science (SPSS, Chicago, IL) was used. Descriptive statistics was used to compute prevalence of data collected by the two indices, independently. After descriptive statistics, indices comparison was performed. The prevalence of the single item in one index was coupled with the homologous item of the other index. For items that needed to be merged for superimposition (e.g. Roma Index 5a – 5b), the prevalence was arranged. Therefore, similar items of the two indices were rendered superimposable to make them statistically comparable. When homologous items did not exist between the two indices, the coupling was not performed (Table 1). The Pearson Chi-square test was applied to detect statistically significant differences in prevalence data of grades and items (emerged from the indices' coupling), between the two groups. The level of significance was set at 5% ($P < 0.05$).

Results

Prevalence of the risk of malocclusion

In 2 and 7 year-olds, the level of risk associated with malocclusion most frequently found in the population is Grade 2 (49.3% of subjects, 692 children) followed by Grade 4 (21.6%, 303 children), which added together represent about 71% of the total population (almost three-quarters). Grades 3 (9.3%, 130 children) and 5 (2.1%, 30 children) are both less represented. 17% of the subjects (239 children) do not have malocclusion (risk level 1 or "no risk" for malocclusion). In 8 and 13 year-olds, Grade 4 and 3 are respectively 37.8% (1,141 subjects) and 37.7% (1,136 subjects), representing overall about 75% of the population. Grade 2 is well represented (13.5%; 407 subjects), while Grade 5 is poorly represented with only 0.3% (10 subjects). The prevalence of level of risk of malocclusion and results from Pearson Chi-square test are listed in Table 2. Grade 1, 2, 5 showed a higher prevalence in younger children with respect to older children, with significant differences. Grade 3 and 4 showed a higher prevalence in older children with respect to younger children, with significant differences.

Prevalence of craniofacial, skeletal, dental and functional problems between 2 and 7 years

The prevalence of problems in the group aged between 2 and 7 years is described in Table 3. The conditions are arranged by Grade and listed in order of frequency. In this group the most frequent malocclusions are cross bite (16.5%) with or without lateral deviation (in 10.2% and 6.5% respectively), moderate and severe open bite (23%), moderate and severe Class II malocclusion (21.2%), Class III malocclusion (7.7%) with positive (4.9%) or negative (2.8%) overjet, deep bite (18,8%), and crowding (5.1%).

Prevalence of craniofacial, skeletal, dental and functional problems between 8 and 13 years

The prevalence of the problems in the sample aged between 8 and 13 years is described in Table 4. In this group the most

Item description (Baby ROMA Index/ROMA Index*)	Item code in Baby ROMA Index	Item code in ROMA Index
Congenital syndromes, malformations/ Congenital malformations - Malformation syndromes	5b	5a – 5b
Maxillofacial trauma with condylar fracture	5a	-
Postural or orthopedic problems	2c	4c
Medical or auxological conditions	2d	4d
Inheritance Malocclusion / Familial tendency for malocclusion	2e	4e
Facial or mandibular asymmetries	4f	4f
TMJ disfunctions/ Articular disfunctions	4g	4g
Outcomes of trauma or surgery of the cranio-facial district/ Sequelae of traumas or surgery of the cranio-facial district	5j	4j
Maxillary hypoplasia, Mandibular hyperplasia OVJ <0/ Maxillary hypodevelopment or mandibular hyperdevelopment (OVJ <0)	4k	4k
Maxillary hyperplasia/mandibular hypoplasia OVJ> 6mm/ Maxillary hyperdevelopment or mandibular hypodevalopment (OVJ> 6 mm)	3h	4h
-/ Mandibular hypodivergence, hyperdivergence	-	4i
Scissor bite	4m	4m
Crossbite> 2 mm or lateral shift/ Anterior or posterior crossbite> 2 mm	4n	4n
Displacement> 2 mm/ Displacement> 4mm	3o	4o
Open bite> 4 mm	3p	4p
Hypodontia up to 2 teeth - Hypodontia more than 2 teeth/ Hypodontia of permanent dentition	3q – 4q	4q
Maxillary hypoplasia/mandibular hyperplasia OVJ> 0/ Maxillary hypodevelopment or mandibular hyperdevelopment (OVJ> 0)	2k	3k
Maxillary hyperplasia/mandibular hypoplasia 3<OVJ< 6mm/ Maxillary hyperdevelopment or mandibular hypodevelopment (3<OVJ<6 mm) - Maxillary hyperdevelopment or mandibular hypodevelopment (0<OVJ<3 mm)	2h	3h – 2h
Caries and early loss of deciduous teeth	4l	3l
Cross bite <2 mm or no lateral shift/ Anterior or posterior crossbite> 1 mm - Anterior or posterior crossbite up to 1 mm	2n	3n – 2n
Displacement >1 mm – absence of diastema/ Displacement> 2 mm - Displacement> 1 mm	2o	3o – 2o
Open bite> 2mm/ Open bite> 2mm - Open bite> 1 mm	2p	3p – 2p
OVB> 5mm/ OVB> 5 mm	2r	3r
- / Permutation anomalies	-	2s
Poor oral hygiene	2t	2t
- / Normal, mesial, or distal occlusion (up to a cuspid)	-	2u
- / Functional asymmetries	-	2v
Thumb/finger sucking habit/ Bad habits	2w	2w
Oral breathing-OSAS/ Mouth breathing	2x	2x
None of the problems listed above	N	N

(*) only one description if the two descriptions have the same name in the two indices; (-) no homologous item available for superimposition

TABLE 1 Superimposition of items of Baby ROMA Index and ROMA Index.

Baby ROMA and ROMA index grades	Prevalence 2-7 y	Prevalence 8-13 y	Significance (P)
Grade 1	17.0 %	8.6 %	0,000*
Grade 2	49.3 %	13.5 %	0,000*
Grade 3	9.3 %	37.7 %	0,000*
Grade 4	21.6 %	37.8 %	0,000*
Grade 5	2.1 %	0.3 %	0,000*

TABLE 2 Prevalence of risk of malocclusion of ROMA and Baby ROMA index grades in children between 2-7 years (1405 children) and between 8-13 years (3017 children) and Pearson Chi-square test statistical significance. **significant*

Baby ROMA Index (grades, items)	Prevalence
Grade 5	
Congenital syndromes/malformations (5b)	1.5%
Outcomes of trauma or surgery of the cranio-facial district (5j)	1%
Maxillofacial trauma with condylar fracture (5a)	0%
Grade 4	
Caries and early loss of deciduous teeth (4l)	12.7%
Crossbite> 2 mm or lateral shift (4n)	10.2%
Maxillary hypoplasia/Mandibular hyperplasia OVJ <0 (4k)	2.8%
Facial or mandibular asymmetries (4f)	0.7%
Hypodontia more than 2 teeth (4q)	0.6%
Scissor bite (4m)	0.4%
TMJ disfunctions (4g)	0.1%
Grade 3	
Displacement > 2 mm (3o)	5.1%
Open bite > 4 mm (3p)	4.3%
Maxillary hyperplasia/mandibular hypoplasia OVJ > 6mm (3h)	3.9%
Hypodontia up to 2 teeth (3q)	1.1%
Grade 2	
Oral breathing/OSAS (2x)	22.8%
Thumb/finger sucking habit (2w)	21.8%
Poor oral hygiene (2t)	19.4%
OVB > 5mm/Open bite> 2mm (2r and 2p, respectively)	18.8% each
Maxillary hyperplasia/mandibular hypoplasia 3< OVJ < 6mm (2h)	17.3%
Parafunctions (bruxism, clenching) (2v)	15.3%
Displacement >1 mm – absence of diastema (2o)	14,8%
Familial tendency for Malocclusion (2e)	8.3%
Cross bite <2 mm or no lateral shift (2n)	6.5%
Maxillary hypoplasia/mandibular hyperplasia OVJ > 0 (2k)	4.9%
Medical or auxological conditions, Postural/orthopaedic problems, Maxillofacial trauma without condylar fracture (2d, 2c, 2a, respectively)	2.6% each
Grade 1	
None of the problems listed above (N)	17.2%

TABLE 3 Prevalence of craniofacial, skeletal, dental and functional problems in the group aged between 2 and 7 years via Baby ROMA Index (1405 children). Items within the grades are listed in decreasing prevalence.

frequent malocclusions are crossbite (18.1%), deep bite (19.2%), open bite (6.6%), Class II (33.1%), Class III (9.1%), crowding (50.8%), facial or mandibular asymmetries (3.3%), and functional asymmetries (3.2%). The most frequent risk factors among the subjects aged between 8 and 13 years are caries (14.6%), poor oral hygiene (32.1%), bad habits such as non-nutritive sucking habit (NNSH) (15.5%), oral breathing and obstructive sleep apnoea (OSA) (12%), alterations in the exfoliation sequence (4.9%), medical or auxological conditions (3%), and postural or orthopaedic problems (2.4%).

Prevalence comparison between age groups, indices comparison, and statistical significance

For the different items of the indices, there is an increase or

ROMA Index (grades, items)	Prevalence
Grade 5	
Congenital malformations (5b)	0.2%
Malformation syndromes (5a)	0.1%
Grade 4	
Displacement > 4mm (4o)	12.1%
Mandibular hypodivergence/hyperdivergence (4i)	8.9%
Maxillary hyperdevelopment or mandibular hypodevalopment (OVJ > 6 mm) (4h)	6.6%
Anterior or posterior crossbite > 2 mm (4n)	6.3%
Facial or mandibular asymmetries (4f)	3.3%
Medical/auxological conditions (4d)	3%
Postural/orthopaedic problems (4c)	2.4%
Articular disfunctions/Scissor bite (4g and 4m, respectively)	2.2% each
Maxillary hypodevelopment or mandibular hyperdevelopment (OVJ <0) (4k)	2,1%
Familial tendency for malocclusion (4e)	1.5%
Sequelae of traumas or surgery of the cranio-facial district (4j)	1.4%
Hypodontia of permanent dentition (4q)	1.3%
Open bite > 4 mm (4p)	0.8%
Grade 3	
Displacement > 2 mm (3o)	25.5%
OVB > 5 mm (3r)	19.2%
Caries and early loss of deciduous dentition (3l)	14.6%
Maxillary hyperdevelopment or mandibular hypodevelopment (3 < OVJ <6 mm) (3h)	13%
Anterior or posterior crossbite > 1 mm (3n)	9.2%
Maxillary hypodevelopment or mandibular hyperdevelopment (OVJ > 0) (3k)	7.0%
Open bite > 2mm (3p)	3.4%
Grade 2	
Poor oral hygiene (2t)	32.1%
Normal, mesial, or distal occlusion (up to a cuspid) (2u)	20.8%
Displacement > 1 mm (2o)	13.2%
Bad habits (2w)	15.5%
Maxillary hyperdevelopment or mandibular hypodevelopment (0< OVJ <3 mm) (2h)	13.5%
Mouth breathing (2x)	12%
Permutation anomalies (2s)	4.9%
Functional asymmetries (2v)	3.2%
Anterior or posterior crossbite up to 1 mm (2n)	2.6%
Open bite > 1 mm (2p)	2.4%
Grade 1	
None of the problems listed above (N)	10.4%

TABLE 4 Prevalence of craniofacial, skeletal, dental and functional problems of children between 8 and 13 years via ROMA Index (3017 children). Items within the grades are listed in decreasing prevalence.

a decrease in prevalence in the population as the age changes. Results of items arrangement, Pearson Chi-square test and their relative significance are shown in Table 5.

Syndromes and congenital malformations, familial tendency for malocclusion, crossbite >2 mm, open bites of different severity, bad habits, oral breathing and OSAS and no signs of risk of malocclusion showed a higher prevalence in younger children with respect to older children, with significant differences. Facial or mandibular asymmetries, TMJ disfunctions, Class II of varying severity, scissor bite, Class III with OVJ>0, anterior/posterior crossbites and displacements of varying severity and poor oral hygiene showed, on the contrary, a higher prevalence in older children. The other items did not show any statistically significant differences of prevalence between the two groups.

Baby ROMA Index		ROMA Index		Significance (P)
Item	Prevalence	Item	Prevalence	
5b	1.5%	5a – 5b	0.3%	0.000*
2c	2.6%	4c	2.4%	0.622
2d	2.6%	4d	3%	0.444
2e	8.3%	4e	1.5%	0.000*
4f	0.7%	4f	3.3%	0.000*
4g	0.1%	4g	2.2%	0.000*
5j	1%	4j	1.4%	0.273
4k	2.8%	4k	2.1%	0.138
3h	3.9%	4h	6.6%	0.000*
4m	0.4%	4m	2.2%	0.000*
4n	10.2%	4n	6.3%	0.000*
3o	5.1%	4o	12.1%	0.000*
3p	4.3%	4p	0.8%	0.000*
3q – 4q	1.7%	4q	1.3%	0.174
2k	4.9%	3k	7%	0.009*
2h	17.3%	3h – 2h	26.5%	0.000*
4l	12.7%	3l	14.6%	0.106
2n	6.5	3n – 2n	11.8%	0.003*
2o	14.8%	3o – 2o	38.7%	0.000*
2p	18.8%	3p – 2p	5.8%	0.000*
2r	18.8%	3r	19.2%	0.732
2t	19.4%	2t	32.1%	0.000*
2w	21.8%	2w	15.5%	0.000*
2x	22.8%	2x	12%	0.000*
N	17.2%	N	10.2%	0.000*

(*) significant

TABLE 5 Prevalence of craniofacial, skeletal, dental and functional problems in children between 2-7 years (1,405 children) and between 8-13 years (3,017 children); items prevalence arrangement and Pearson Chi-square test statistical significance

Discussion

Results of the Pearson's Chi-square test show a difference for all the grades and for the majority of the items of the Baby ROMA Index and ROMA Index between the two groups, children aged 2–7 years and children aged 8–13 years. Therefore, the null hypothesis was partially rejected.

Changes in Grade and orthodontic treatment need by age

The survey showed that in the Italian paediatric population there is a high need for orthodontic treatment. Between 2 and 7 years of age, only 17.2% of children do not have malocclusion or associated risk factors, and between 8 and 13 years of age, only 10.2% of subjects do not require orthodontic therapy. Between 2 and 7 years of age, in the early deciduous or mixed dentition phase, about 50% of the population already presents a mild malocclusion (Grade 2) that could persist in late mixed or permanent dentition [Grippaudo et al., 2014]. In fact, according to the literature, a child presenting malocclusion in the deciduous dentition has an increased risk of malocclusion in mixed and permanent dentition [Shen et al., 2018]. The 9.3% of the population between 2 and 7 year of age has a moderate malocclusion (Grade 3) and the 23.7% has a severe malocclusion (Grade 4 and Grade 5). Overall, 1/3 of the examined population requires treatment for moderate or severe malocclusion, for these cases early interception is required. The treatment timing, the duration of intervention, the phases of therapy as well as the type of devices may vary according to the malocclusion and its severity, depending on the patient's compliance and the presence of comorbidities (such as caries, TMJ disorders, oral breathing, OSA, postural alterations, developmental problems or auxological conditions). Between 8 and 13 years of age, only 13.5% of subjects have a mild malocclusion, most have moderate or severe orthodontic problems, respectively in 37.7% and 37.8% of cases, that require immediate orthodontic interventions.

Referring patients to periodic controls or to interceptive treatment, when needed, is a reliable strategy to intercept malocclusion soon [Grippaudo et al., 2019]. The early elimination of risk factors prevents the worsening of malocclusions by reducing the environmental aetiological component [Grippaudo et al., 2013]. From 2–7 years to 8–13 years there is a decrease in mild malocclusions, and an increase in moderate to severe malocclusions. This suggests that while mild malocclusions can remain unchanged over time when risk factors are removed, some of them can evolve towards more severe malocclusions and tend to worsen with growth if not properly intercepted [Grippaudo et al., 2007]. In fact, there is a statistically significant decrease in Grade 2 for minor problems from 2–7 years (49.3%) to 8–13 years (13.5%); there is an increase in Grade 3 for moderate problems from 2–7 years (9.3%) to 8–13 years (37.7%), and an increase in Grade 4 for severe problems from 2–7 years (21.6%) to 8–13 years (37.8%) ($P<0.05$).

Descriptive assessment of malocclusion between 2 and 7 years

In the sample aged between 2 and 7 years there is a high incidence of cross bite (16.7%) with or without lateral shift of the jaw (in 10.2% and 6.5% respectively), moderate and severe open bite (23.1%), moderate and severe Class II malocclusion (21.2%), Class III malocclusion (7.7%) with positive (4.9%) or negative (2.8%) overjet, deep bite (18.8%) and crowding (5.1%). Therefore, the most frequent sagittal problem is Class II malocclusion compared to Class III, with a ratio of 3:1. Although less represented, Class III malocclusion requires an early therapeutic approach [Satravaha, 2017]. Specifically, early treatment for Class III malocclusions with an orthopaedic or functional approach seems to reduce the need for orthodontic treatment in permanent dentition and control the growth of the subject [Mucedero et al., 2010]. The early treatment of Class III malocclusion with maxillary hypoplasia and positive familial history has shown better clinical results in deciduous dentition or early mixed dentition [Ferro et al., 2003], allowing to obtain skeletal changes and long-term stability [Masucci et al., 2011], as well as reducing the need for surgical treatment [Mandall et al., 2016].

The most frequent vertical problem in the sample is open bite, about 5% more common than deep bite. Open bite is often associated with functional alterations such as labial or lingual interposition between the arches, non-nutritive sucking habits (NNSH) and oral breathing [Paolantonio et al., 2019]. Oral breathing and paediatric OSA (22.8%) are the most frequently encountered risk factors, followed by NNSH and lip interposition (21.8%), poor oral hygiene (19.4%) and caries (12.7%). Oral breathing and paediatric OSA are problems of purely paediatric and ENT interest, however it is the orthodontist who has to deal with the occlusal aspects [Luzzi et al., 2019]. With orthodontic devices, it is possible to intervene on the mandibular and lingual retrusion by interrupting the pathogenetic mechanism of OSA [Luzzi et al., 2019]. Especially in children, functional orthodontic and rapid maxillary expansion devices can be used to increase the amplitude of the nasal airways and of the retrolingual pharyngeal space. In childhood, from an orthopaedic standpoint, when the transverse contraction of the maxilla is successfully treated, is it often followed by an improvement of the respiratory condition as well as the malocclusion [Pirelli et al., 2010]. Whenever possible, management of children suffering from oral breathing and other breathing problems, NNSH and OSA should always be considered. Functional alterations worsen the malocclusion and the orthodontic treatment seems to improve the breathing framework [Occasi et al., 2018].

TMJ disorders (DTM) are infrequent among children (0.1%), and are mostly represented by conditions of congenital hypermobility associated with ligamentous laxity with or without condylar subluxation or dislocation. Facial traumas and chin injuries (around 1%) increase the risk of intracapsular fracture of the condyle or extracapsular head of the condyle neck in children, as well as causing fracture of the upper incisors or intrusive trauma. Class II malocclusion with overjet represents a risk factor for trauma and fractures of the upper incisors [Glendor, 2000].

Upper transverse deficits can occur with (10.2%) or without (6.5%) mandibular laterodeviation, although laterodeviation is more often found in cases of severe crossbite and severe upper transverse deficit, whereby unilateral mandibular displacement occurs as a mechanism of compensation during chewing. The greater the transverse deficit, the greater is the risk of lateral deviation of the mandible, both functional and structural. This takes place not only due to deflecting dental contacts but also due to a deficit of unilateral vertical dimension, alterations of the chewing cycle, functional asymmetry of the masticatory muscles [Cutroneo et al., 2016], and asymmetry of the mandibular rami. The latter condition is present in 0.7% of subjects and is often associated with facial and cranial asymmetry as well as postural alterations. Posterior crossbite requires early interceptive therapy because the functional shift of the mandible can lead to the asymmetric development of the mandibular ramus and facial asymmetry. Early treatment for correction of the posterior crossbite with mandibular shift is advisable to prevent facial asymmetry and to normalise growth pattern [Bell and Kiebach, 2014; Bukhari et al., 2018].

Descriptive assessment of malocclusion between 8 and 13 years

Among the sagittal malocclusions, in the 2–7 year-olds group, Class II (33.1%) is more represented than the Class III (9.1%) with a ratio of approximately 3:1. Class II malocclusions of varying severity were found: overjet greater than 6 mm in 6.6% of subjects, between 3 and 6 mm in 13% of subjects, and overjet up to 3 mm in 13.5% of subjects. For Class II malocclusions intervention before the pubertal growth peak is generally recommended. The treatment of Class II malocclusion is carried out as one-phase therapy (one step in late mixed dentition or in permanent dentition) or two-phase therapy (first phase of treatment in early mixed dentition, and second phase of treatment in permanent dentition) according to the need and the therapeutic response [Maspero et al., 2018; Quinzi et al., 2018].

Open bite is present in 6.6% of subjects in this group. It is severe in 0.8% of subjects with anterior space greater than 4 mm. The subjects with open bite present NNSH, atypical swallowing and oral breathing, confirming the close correlation between functional alterations and this type of malocclusion

[Giugliano et al., 2014; Rohit, 2018; Rosa et al., 2019]. In particular, subjects with oral breathing may have facial deformities and malocclusion, as it is an alteration of the orofacial development of both the face and the dentition and of the muscle tone. The typical extraoral features in patients with mouth breathing are generally defined as "adenoid facies", characterised by long face due to an increase in facial height and increased skeletal divergence, asthenic habitus, and incompetent lips. The most frequent intraoral features are low and protruded tongue, insufficient transverse diameter of the maxilla (high and narrow palate with possible crossbite), and tendency to open bite and increased overjet [Valcheva et al., 2018]. From the observed results, when age increases, the open bite seems to improve. That is probably due to the fact that often children give up some bad habits during growth. A statistically significant decrease in the number of subjects with open bite is observed with increasing age, in particular with a reduction in prevalence from 23.1% in the 2–7 year-olds group to 6.6% in the 8–13 year-olds group. There is also a statistically significant reduction in bad habits and mouth breathing as age increases. This suggests that functional improvement can lead to improvement of this malocclusion, helping the elimination of the environmental aetiological factors. It is not possible to exclude the genetic substrate favouring the development of open bite and characterised by increased divergence of the bone bases, in fact the correction of function and breathing is crucial for treating this malocclusion [Piancino et al., 2019].

Subgroups comparison analysis

If the risk of malocclusion seems to worsen with increasing age, most of the items of the indices show a statistically significant decrease in prevalence when age increases. This could be due to the use of different indices in the two groups which have slightly different but still comparable items. Therefore, the variations in the distribution of prevalence in the items may appear lower in the ROMA Index because they are distributed on a greater number of items than in the Baby ROMA Index.

A clinical explanation for the decrease of prevalence of some items is that there is actually a spontaneous improvement of some conditions that appear less frequent with increasing age. Mild crossbite could take advantage form the buccal eruption of the permanent teeth in the second exfoliation phase. Oral breathing and OSAS also seems to improve with age, probably due to the spontaneous growth of the skeletal base that allows nasal airways to gain space for the air flux. Bad habits are less represented in older children probably because of the neurological development and the parent's help.

The limitation of the study was to compare different populations using similar indices. In fact, the study is cross-sectional and describes a condition at a given moment, excluding the time factor. Results validated the procedure, but for a further corroboration, future longitudinal studies should be carried out to monitor malocclusion conditions in the same sample as time goes by.

Conclusion

In the light of the results of this research, it is possible to state that orthodontic treatment need indices are fundamental tools to guide the clinician on the real need for intervention, according to the risk factors and type of malocclusion. The latter, coupled with patient compliance orient the clinician towards the most suitable orthodontic treatment timing to maximize the response to the devices. The multidisciplinary treatment for the management of children suffering from oral breathing and other breathing problems, such as NNSH and OSA, should always be considered.

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