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ORAL PATHOLOGY

# Association between oral habits, mouth breathing and malocclusion

## *Associazione fra abitudini viziate, respirazione orale e malocclusione*

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SUMMARY

The ratio of bad habits, mouth breathing and malocclusion is an important issue in view of prevention and early treatment of disorders of the craniofacial growth. While bad habits can interfere with the position of the teeth and normal pattern of skeletal growth, on the other hand obstruction of the upper airway, resulting in mouth breathing, changes the pattern of craniofacial growth causing malocclusion. Our cross-sectional study, carried out on 3017 children using the ROMA index, was developed to verify if there was a significant correlation between bad habits/mouth breathing and malocclusion. The results showed that an increase in the degree of the index increases the prevalence of bad habits and mouth breathing, meaning that these factors are associated with more severe malocclusions. Moreover, we found a significant association of bad habits with increased overjet and openbite, while no association was found with crossbite. Additionally, we found that mouth breathing is closely related to increased overjet, reduced overjet, anterior or posterior crossbite, openbite and displacement of contact points. Therefore, it is necessary to intervene early on these aetiological factors of malocclusion to prevent its development or worsening and, if already developed, correct it by early orthodontic treatment to promote eugnatic skeletal growth.

KEY WORDS: Oral habits • Mouth breathing • Malocclusion • Occlusal index • ROMA index

RIASSUNTO

*Il rapporto fra abitudini viziate, respirazione orale e malocclusione è fondamentale in tema di prevenzione e trattamento precoce dei disturbi della crescita cranio-facciale. Infatti così come le abitudini viziate possono interferire negativamente con la posizione dei denti e con il normale pattern di crescita scheletrica cranio-facciale, così l'ostruzione delle vie aeree superiori, con conseguente respirazione orale, cambia il modello di crescita craniofacciale con sviluppo di malocclusioni da moderate a severe. Questo studio trasversale, effettuato su 3.017 bambini applicando il ROMA index, vuole verificare l'esistenza di una correlazione significativa tra abitudini viziate/respirazione orale e malocclusione. Dai risultati emerge che all'aumentare del grado dell'indice aumenta anche la prevalenza di abitudini viziate e respirazione orale, significando che questi fattori sono associati alle malocclusioni più gravi. Inoltre abbiamo riscontrato un'associazione statisticamente significativa fra abitudini viziate e overjet e openbite aumentati, ma non con il morso inverso. Dal lavoro è emerso che la respirazione orale è strettamente correlata ad overjet aumentato, overjet inverso, morso crociato, openbite e displacement. Riteniamo quindi che abitudini viziate e respirazione orale, rientrando fra i fattori di rischio di malocclusione, vadano intercettati e corretti precocemente per prevenire lo sviluppo di malocclusioni o il peggioramento di quelle preesistenti.*

PAROLE CHIAVE: *Abitudini viziate • Respirazione orale • Malocclusione • Indici occlusali • ROMA index*

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## Introduction

It is still debated whether bad habits and mouth breathing have a role in the aetiopathogenesis of malocclusions. Beyond this controversy, whenever these problems are found in association with malocclusion, it is of considerable importance for prognosis and they must be eliminated in order to ensure a functional environment adequate for physiological growth. If some neuromuscular activities are developed to compensate dentoalveolar or skeletal alterations, others have an aetiological role [1 2]. Improper oral habits can interfere not only with the position of the teeth, but especially with the normal skeletal growth pattern.

Some studies have shown that many environmental factors cause malocclusion [3 4], including eating habits, and especially the current trend in consuming foods of soft consistence with reduction of masticatory forces, non-nutritive sucking, pacifier sucking and finger sucking and early weaning [5]. Pacifier sucking, baby bottle sucking and especially finger sucking frequently causes protrusion of the upper incisors and the premaxilla, atypical swallowing [6 7], anterior open bite and posterior crossbite [8-10]. The posterior crossbite is due to a low position of the tongue due to sucking, with lack of thrust of the tongue on the palate and increased activity of the muscles of the cheeks that causes an alteration of muscle pressure on the upper arch [11-12].

Regarding the influence of breathing on craniofacial morphology, there are several publications in the literature. Although some authors believe that the change of the normal pattern of dento-skeletal growth is due to genetic and environmental factors [13], most think instead that the obstruction of upper airways, resulting in mouth breathing, changes the pattern of craniofacial growth [14] with typical facial features and dentition: long face, contraction of the upper dental arch, high arched palate, gummy smile, dental malocclusion both Class II and Class III [15]. In mouth breathing, compared to the general population, a higher prevalence of posterior cross bite, of anterior open bite and Class II malocclusion is seen [16].
Furthermore, there are frequent medical and social problems related to tiredness due to lack of sleep, which is interrupted for mouth breathing and frequent sleep apnoea, such as attention deficit disorder (ADD) and hyperactivity [17].
It is therefore appropriate to verify the existence of a significant association between bad habits, mouth breathing and malocclusion and if children with these habits have characteristics of malocclusion worse than those of the general population; when found bad habits and mouth breathing are risk factors for malocclusion that need to be corrected early.
In this study we evaluated the association between bad habits/mouth breathing and malocclusion by application of the ROMA index [18] on a sample of school children already participating in an epidemiological study [19] and on the timing of orthodontic treatment [20].

## ROMA index

The ROMA Index - Risk Of Malocclusion Assessment Index - is a tool to assess treatment need in young patients. It was specifically devised for use in examining young patients during the first visit, in an attempt to grade, beside malocclusions, skeletal and functional aspects, which in children are determinants of oro-facial development. It was developed reviewing and modifying the dental and occlusal parameters of DHC of the IOTN [21] with addition of items relative to skeletal and functional problems, which lack in the IOTN (maxillary hypodevelopment/mandibular hyperdevelopment or increased overjet; maxillary hyperdevelopment/ mandibular hypodevelopment or reduced overjet; mandibular hypo- or hyperdivergence; facial or mandibular asymmetries; functional asymmetries; bad habits; mouth breathing).
The ROMA Index (Table I) is intended as a guide to clinical signs of malocclusion in paediatric patients. Depending on how many signs are detected, there is a greater or lesser need for orthodontic intervention. The most severe characteristic is identified for any particular patient during examination, and the patient is then categorised on the index risk factor scale according to this most severe characteristic. As in the following list, categories are ranked in order of seriousness, thus also indicating the level of urgency with which orthodontic diagnosis/treatment is required:

*GRADE 5 → EXTREME RISK*
Diagnosis comprises congenital facial malformations and major systemic malformation syndromes. Treatment, to be performed in collaboration with paediatricians and other specialists (multidisciplinary care), is required as early as possible.

*GRADE 4 → GREAT RISK*
It includes major cranio-facial skeletal malformations and alterations of the occlusion. Alternatively, there can be systemic problems likely to worsen prognosis that justify immediate treatment, independent of the rhythm of growth of the different cranio-facial components. Both orthopaedic therapy and orthodontic interventions are required to correct the problems caused by the malocclusion and hindering harmonious maxillary growth.

*GRADE 3 → MODERATE RISK*
There are non-severe alterations in dental and/or skeletal relationships, but most tending to persist and sometimes worsen with growth. The timing of intervention is dependent on the patient's age, i.e., on the active growth phases of the affected areas, so as to achieve good treatment response. Orthodontic treatment is combined with orthopaedic-functional therapy to be performed after undertaking appropriate diagnostic investigations.

*GRADE 2 → MILD RISK*
This includes easily controlled factors having only limited effects on cranio-facial development. Diagnostic investigations and preventive interventions to promote correct cranio-facial development are planned, but they are delayed until there is a temporal correspondence between the aetiological agent and growth acceleration in the affected region.

*GRADE 1 → MINIMUM RISK*
No predisposing conditions to malocclusion are detected. In this case, treatment is unnecessary and it is sufficient to carry out periodic examinations, in order to monitor the normal course of development and to detect possible pathological factors promptly.
The index items, identified by a letter, are framed in four categories of problems (systemic, craniofacial, dental, functional) and each item is accompanied by a number which corresponds to the degree of risk. The degree of risk for each patient is given by the worst index item detected.

**Table I.** ROMA index,

| Problems | Items | | Grade |
|---|---|---|---|
| Systemic | Malformation syndromes | | 5a |
| | Congenital malformations | | 5b |
| | Postural or orthopaedic problems | | 4c |
| | Medical or auxological problems | | 4d |
| | Inheritance of malocclusion | | 4e |
| Cranio-facial | Facial or mandibular asymmetries | | 4f |
| | TMJ dysfunctions | | 4g |
| | Sequelae of trauma or surgery of the cranio-facial district | | 4j |
| | Maxillary hypodevelopment or mandibular hyperdevelopment | OVJ≤0 | 4k |
| | | OVJ>0 | 3k |
| | Maxillary hyperdevelopment or mandibular hypodevelopment | OVJ>6m | 4h |
| | | 3mm<OVJ<6mm | 3h |
| | | 0mm<OVJ<3mm | 2h |
| | Mandibular hypo- or hyperdivergence | | 4i |
| Dental | Caries and early loss of deciduous teeth | | 3l |
| | Scissor bite | | 4m |
| | Anterior or posterior crossbite* | >2mm | 4n |
| | | >1mm | 3n |
| | | <1mm | 2n |
| | Displacement** | >4mm | 4o |
| | | >2mm | 3o |
| | | >1mm | 2o |
| | Open bite | >4mm | 4p |
| | | >2mm | 3p |
| | | >1mm | 2p |
| | Hypodontia of permanent teeth | | 4q |
| | OVB>5mm | | 3r |
| | Anomalies of the tooth eruption sequence | | 2s |
| | Poor oral hygiene | | 2t |
| | Normal mesial or distal occlusion (up to a cuspid) | | 2u |
| Functional | Functional asymmetries | | 2v |
| | Bad habits | | 2w |
| | Mouth breathing | | 2x |

** one or more teeth.*
***displacement of contact points (the maximum distance of the contact points of the most misaligned contiguous teeth).*

## Materials and methods

The investigation was planned as a cross-sectional study and the ROMA index (Table I) was used to examine 3017 Italian children. The sample was balanced according to gender, age and geographical origin. It consists of 1375 males (45.6%) and 1642 females (54.4%) aged between 7 and 13 years (Table II). The survey was conducted between 2008 and 2011 and the children - 1529 (50.7%) from primary schools and 1488 (49.3%) from secondary schools–were examined in their schools, after official approval of the survey by each school principal. Schools belonged to the following Italian regions: Piemonte and Friuli (North), Abruzzo and Lazio (Centre), Puglia and Calabria (South).

The ROMA index was applied by operators who had previously undergone a training period of one month following the instructions of a special manual, in order to apply the index with the same standard of judgment and to minimise errors. In addition, the index has already been validated and was also verified its intra-examiner and inter-examiner reproducibility [18]. To evaluate the reproducibility, the intra-examiner error was calculated on the tables index made by the same operator who examined 20 children twice, one month apart. A second operator independently collected a third table index for each of the 20 children to assess the inter-examiner error. The Kappa values oscillate between 0.643 and 1.00 in relation to intra-operator concordance ($0.00 < p < 0.002$), and between

**Table II.** sample distribution.

| | Males | Females | Primary school | Secondary school |
|---|---|---|---|---|
| N | 1375 | 1642 | 1529 | 1488 |
| Prevalence (%) | 45.6 | 54.4 | 50.7 | 49.3 |

0.773 and 1.00 in relation to inter-operator concordance ($p = 0 < 0.001$): the index is therefore highly reproducible. After calculating the prevalence of malocclusion on the basis of the degrees of orthodontic risk determined by the index, we evaluated the prevalence with which bad habits (2w) and mouth breathing (2x) are found in association with sex, macroarea, grade of the index, index items (increased overjet, reduced overjet, anterior or posterior crossbite, open bite, displacement), verifying the statistical significance of this association.

Descriptive analyses were performed using frequencies and percentages and frequency tables for categorical variables. For the bivariate analysis chi-square tests were performed to evaluate differences for categorical variables. The level of significance was set at $p \leq 0.05$. Data were analysed with the software SPSS 19.0 for Windows.

## Results

Table III shows the results in the total sample and after stratification according to primary and secondary schools. Variables included in the analysis were "bad habits" (2w) and "mouth breathing" (2x) in relation to socio-demographic characteristics (sex and geographical area of origin) and index grades.

There was no statistically significant association between bad habits /mouth breathing and sex, although differences were present for both geographical area and grade of the index. The prevalence of bad habits and mouth breathing was higher in South Italy and with the increase of the degree of the index an increase in the prevalence of 2w and 2x was also seen, meaning that these factors were associated with more severe malocclusions. Grade 5 does not follow the trend for the small sample due to the low prevalence of syndromic diseases in the population.

In Table IV, "bad habits" (2w) and "mouth breathing "(2x) were related to increased overjet (h), reduced overjet (k), crossbite (n), openbite (o), displacement (p). The table shows that 2w and 2x are both closely related with increased overjet and displacement in all age groups. Reduced overjet, openbite and posterior crossbite was significantly associated only with mouth breathing in both the total sample and in the subgroups (primary and secondary schools), except in primary school children with reduced overjet.

## Discussion

*Bad habits*

Many authors have written about the relationship between bad habits and malocclusion. Oral habits are repetitive behaviour in the oral cavity that result in loss of tooth structure and include digit sucking, pacifier sucking, lip sucking and biting, nail-biting, bruxism, self-injurious habits and tongue thrusting [22]. Their effect is dependent on the nature, onset and duration of habits. Persistent nonnutritive sucking habits may result in long-term problems and can affect the stomatognathic system, leading to an imbalance between external and internal muscle. Tongue thrusting, an abnormal tongue position with deviation from the normal swallowing pattern, and mouth breathing may be associated with anterior open bite, abnormal speech and anterior protrusion of the maxillary incisors [23]. It appears that several factors account for the persistence of infantile swallowing patterns and that tongue thrust plays an important role in the aetiology of openbite as well as in the relapse of treated openbite patients [24 25]. A study conducted by Viggiano concluded that children with non-nutritive sucking activity and accustomed to using a bottle had more than double the risk of posterior crossbite right from the primary dentition [5]. Warren conducted a study to known about the extent to which nonnutritive sucking habits contribute to malocclusion in the mixed dentition. The authors have found that anterior openbite and posterior crossbite were associated with habits of 36 months or more. Sustained pacifier habits, including those of 24 to 47 months, were associated with anterior openbite and Class II molar relationships, while digit habits were associated with anterior openbite when sustained for 60 months or longer [26].

The negative influence of bad habits on occlusion originates in childhood. Bottle feeding and nonnutritive sucking habits have been associated with malocclusions starting from the primary dentition [4 10]. Several authors have pointed out that bottle-fed children have a strong tendency to develop a pacifier-sucking habit [27-29]. Nonnutritive sucking habits are associated with an atypical swallowing pattern, and with tongue thrusting, which may be related to the development of malocclusions such as posterior crossbite [4 12].

According reports by other authors, in our study we found a significant association of bad habits with increased overjet and openbite. Otherwise, no association was found with anterior or posterior crossbite. This may be due to the fact that the biological damages caused by bad habits depend on many factors [30]: age of initiation, duration, intensity and type, and, above all, individual biological and genetic features [31-33]. The early cessation of bad habits leads spontaneously to structural and functional normalisation, especially if the patient has a eugnatic growth direction [34].

**Table III.** 2w and 2x in relation to socio-demographic characteristics. P < 0.005 is statistically significant.

| Variables | | Total Sample | | | | | | Only Primary School | | | | | | Only Secondary School | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2W | OR | P | 2X | OR | P | 2W | OR | P | 2X | OR | P | 2W | OR | P | 2X | OR | P |
| | | n. (%) | | | n. (%) | | | n. (%) | | | n. (%) | | | n. (%) | | | n. (%) | | |
| **SEX** | **Males** | 211 (7) | 1,021 (0,838-1,245) | 0,84 | 178 (5,9) | 0,0847 (0,679-1,055) | 0,076 | 126 (8,3) | 1,172 (0,904-1,519) | 0,128 | 117 (7,7) | 0,0847 (0,679-1,055) | 0,121 | 85 (5,7) | 0,882 (0,648-1,202) | 0,429 | 61 (4,1) | 0,917 (0,643-1,309) | 0,348 |
| | **Females** | 257 (8,5) | | | 184 (6,1) | | | 157 (10,3) | | | 110 (7,2) | | | 100 (6,7) | | | 74 (5) | | |
| **tot** | | 468 (15,5) | | | 362 (12) | | | 283 (18,5) | | | 227 (14,9) | | | 185 (12,4) | | | 135 (9,1) | | |
| **MACROAREA** | North | 158 (5,2) | - | <0,05* | 91 (3) | - | <0,05* | 89 (5,8) | - | 0,077 | 58 (3,8) | - | <0,05* | 69 (4,6) | - | <0,05* | 33 (2,2) | - | <0,003* |
| | Centre | 114 (3,8) | | | 128 (4,2) | | | 87 (5,7) | | | 80 (5,2) | | | 27 (1,8) | | | 48 (3,2) | | |
| | South | 196 (6,5) | | | 143 (4,7) | | | 107 (7) | | | 89 (5,8) | | | 89 (6) | | | 54 (3,6) | | |
| **tot** | | 468 (15,5) | | | 362 (12) | | | 283 (18,5) | | | 227 (14,8) | | | 185 (12,4) | | | 135 (9,1) | | |
| **DEGREE INDEX** | 1 | 0 | - | <0,05* | 3 (0,1) | - | <0,05* | 0 | - | <0,05* | 3 (0,2) | - | <0,05* | 0 | - | <0,05* | 0 | - | <0,05* |
| | 2 | 74 (2,5) | | | 44 (1,5) | | | 37 (2,5) | | | 29 (1,9) | | | 37 (2,5) | | | 15 (1) | | |
| | 3 | 170 (5,6) | | | 130 (4,3) | | | 112 (5,6) | | | 77 (5) | | | 58 (3,9) | | | 53 (3,6) | | |
| | 4 | 223 (7,4) | | | 183 (6,1) | | | 133 (7,4) | | | 116 (7,6) | | | 90 (6) | | | 67 (4,5) | | |
| | 5 | 1 (0) | | | 2 (0,1) | | | 1 (0) | | | 2 (0,1) | | | 0 (0) | | | 0 | | |
| **tot** | | 468 (15,5) | | | 362 (12) | | | 283 (18.5) | | | 227 (14,8) | | | 185 (12,4) | | | 135 (9,1) | | |
| **TOT** | | 3014 (100) | | | 3014 (100) | | | 1527 (100) | | | 1527 (100) | | | 1487 (100) | | | 1487 (100) | | |

In this regard, Cozza et al. has linked the pattern of vertical growth and non-nutritive sucking habits with transverse maxillary deficit [35]. The authors concluded that if the habit of sucking in mixed dentition is associated with increased vertical dimension it is significantly associated with a transversal maxillary deficit, with narrow diameters of the upper jaw and increased prevalence of posterior crossbite.
Probably, thus, the risk for children with bad habits to develop a crossbite depends on the genetic pattern of growth, so not all individuals who have bad habits have crossbite or will develop crossbite in the future. Is therefore very important to assess the direction of skeletal growth of the patient with bad habits to determine the degree of risk of developing a malocclusion.

*Mouth breathing*

The presence of obstruction of the airways, especially at the level of the nose and pharynx, forces the patient to breathe through the mouth [36]. Allergic rhinitis and adenotonsillar hypertrophy are the main cause of airway obstruction. They are usually associated with various symptoms: lack of nasal airflow, sneezing, itching, runny nose clear, but also snoring, possible obstructive sleep apnoea syndrome (OSAS) and increased respiratory infections such as ear infections, sinusitis and tonsillitis [37 38]. Mouth breathing due to airway obstruction leads postural changes such as lip incompetence, low position of the tongue in the mouth floor and increased vertical facial height for clockwise rotation of the jaw [39].
The association between insufficient nasal breathing and dentofacial morphology has been studied extensively and many authors believe that the pattern of craniofacial growth can be affected by unbalanced muscle function typical of mouth breathing [14 40 41]. Children with mouth breathing have typical facial features: long face, dark circles, narrow nostrils, transverse contraction of the upper jaw, high arched palate and gummy smile associated with malocclusion of class II or, sometimes, class III, with a high prevalence of posterior crossbite and anterior openbite [15 16 42 43]. Children who mouth breath and who rotate the mandible in a posterior and inferior direction develop a Class II malocclusion and a skeletal Class II profile with increased overjet. In fact, the muscles which depress the jaw to open the mouth exert a backward pressure upon it which displaces the mandible distally and retard its growth. The buccinator muscles are made tense by opening the mouth and tend to exert lingual pressure on the maxillary bicuspids and molars, which do not receive sufficient support from the tongue, so that the palate and the upper dental arch becomes quite narrow. Lip function is abnormal, the lower lip being large and bulbous and the upper lip short and functionless, with often lower lip forced up under the upper incisor, that are further protruded with increased overjet. Bresolin et al. found that mouth breathers had longer faces with a narrower maxilla and retrognathic jaws [44 45] and Trask found that allergic children who were mouth breathers had longer and more retrusive faces than nasal breather children [46].
In the opinion of Rakosi and Schilli, mouth breathing may have a role in the aetiopathogenesis of some forms of Class III malocclusion. Oral breathing children have constantly open jaw and a low posture of the tongue with excessive mandibular growth, with constant distraction of the mandibular condyle from the fossa which may be a growth stimulus [47]. In addition, the lack of thrust of the tongue on the palate and on the upper jaw may cause a sagittal and transverse maxillary skeletal deficit, a Class III malocclusion with reduced or reverse overjet.
Many authors also found that mouth breathers have a high prevalence of narrow dental arches and dental crowding [15 48], especially considering the upper arch [49].
The results of our study agree fully with literature reports: we found that mouth breathing is closely related to increased overjet, reduced overjet, anterior or posterior crossbite, openbite and displacement. Therefore, it is necessary to intervene early on aetiological factors of mouth breathing to prevent the development or worsening of malocclusion and, if already developed, to correct it by early orthodontic treatment to promote eugnatic skeletal growth. Early orthodontic treatments in these young patients are needed to modify skeletal malocclusions: more stable results are achievable, less extractions of permanent teeth are needed with increased parental satisfaction and the length of orthodontic treatments in permanent dentition is sensibly reduced with lower risks of enamel decalcifications and gum diseases after treatment [50-52].

## Conclusions

The scientific community acknowledges that bad habits and oral breathing have a role in the aetiopathogenesis of malocclusions, and their association is confirmed herein. Mouth breathing and bad habits can be considered as risk factors of malocclusion because they change the physiological balance of growth. However, while mouth breathing is always significantly associated with all occlusal problems examined, bad habits have a significant role only in some, probably because of their lower relevance than other factors implicated in the aetipathogenesis of malocclusions. Thus, we can assume that the "risk of developing malocclusion" related to bad habits would be expressed in individuals more susceptible to genetic causes and unfavourable growth pattern.
Nonetheless, we believe that for these type of problems close collaboration is needed between different specialists (paediatrician, allergist, ENT specialist, orthodontist, speech therapist) and that early orthodontic visits and treatment, when needed in children with bad habits or with allergic rhinitis and/or adeno-tonsillar hypertrophy

**Table IV.** 2w and 2x in relation to increased overjet (h), reduced overjet (k), cross bite (n), displacement (o), openbite (p).

| Variables | | Total sample | | | | | | Only Primary School | | | | | | Only Secondary School | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2W | OR | P | 2X | OR | P | 2W | OR | P | 2X | OR | P | 2W | OR | P | 2X | OR | P |
| | | n. (%) | | | n. (%) | | | n. (%) | | | n. (%) | | | n. (%) | | | n. (%) | | |
| H | 2<br>3<br>4 | 197 (6.5) | 1.589 (1.299-1.944) | <0.001* | 168 (5.6) | 1.907 (1.527-2.382) | <0.001* | 127 (8.3) | 1.382 (1.064-1.793) | 0.009* | 117 (7.7) | 1.870 (1.408-2.484) | < 0.001* | 70 (4.7) | 1.738 (1.260-2.398) | < 0.001* | 51 (3.4) | 1.694 (1.172-2.448) | 0.004* |
| Tot | | 468 (15.5) | | | 362 (12) | | | 283 (18.5) | | | 227 (14.8) | | | 185 (12.4) | | | 135 (9.1) | | |
| k | 3<br>4 | 48 (1.6) | 1.186 (.854-1.648) | 0.175 | 42 (1.4) | 1.384 (.976-1.962) | 0.045* | 30 (2) | 1.212 (0.792-1.856) | 0.217 | 24 (1.6) | 1.197 (0.753-1.904) | 0.257 | 18 (1.2) | 1.135 (.673-1.915) | 0.359 | 18 (1.2) | 1.688 (.991-2.875) | 0.042* |
| tot | | 468 (15.5) | | | 362 (12) | | | 283 (18.5) | | | 227 (14.8) | | | 185 (12.4) | | | 135 (9.1) | | |
| n | 2<br>3<br>4 | 85 (2.8) | 1.008 (.780-1.302) | 0.498 | 103 (3.4) | 1.991 (1.551-2.557) | <0.001* | 52 (3.4) | .920 (.660-1.281) | 0.344 | 73 (4.8) | 2.281 (1.667-3.121) | < 0.001* | 33 (2.2) | 1.099 (0.734-1.645) | 0.357 | 30 (2) | 1.488 (.967-2.289) | 0.048* |
| tot | | 468 (15.5) | | | 362 (12) | | | 283 (18.5) | | | 227 (14.8) | | | 185 (12.4) | | | 135 (9.1) | | |
| O | 2<br>3<br>4 | 249 (8.3) | 1.117 (.917-1.360) | 0.148 | 214 (7.1) | 1.460 (1.168-1.825) | <0.001* | 157 (10.3) | 1.169 (.902-1.515) | 0.133 | 141 (9.2) | 1.600 (1.198-2.137) | 0.001* | 92 (6.2) | 1.015 (.746-1.382) | 0.492 | 73 (4.9) | 1.229 (.862-1.753) | 0.147 |
| tot | | 468 (15.5) | | | 362 (12) | 1.460 (1.168-1.825) | <0.001* | 283 (18.5) | | | 227 (14.8) | | | 185 (12.4) | | | 135 (9.1) | | |
| p | 2<br>3<br>4 | 70 (2.3) | 3.299 (2.421-4.497) | <0.001* | 49 (1.6) | 2.614 (1.855-3.685) | <0.001* | 38 (2.5) | 3.120 (2.029-4.798) | <0.001* | 24 (1.6) | 1.990 (1.226-3.231) | 0.006* | 32 (2.2) | 3.684 (2.347-5.782) | < 0.001* | 25 (1.7) | 3.76 6(2.304-6.156) | < 0.001* |
| tot | | 468 (15.5) | | | 362 (12) | | | 283( 18.5) | | | 227 (14.8) | | | 185 (12.4) | | | 135 (9.1) | | |

will allow early detection and timely treatment of dysfunctions and avoid worsening of already established malocclusions.

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