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## Orthodontic Treatment Need of Austrian Schoolchildren in the Mixed Dentition Stage

#### KEYWORDS

Community Dentistry  
Index of Orthodontic Treatment Need  
Malocclusion  
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#### SUMMARY

Malocclusal traits can impair dental health and aesthetical appearance. The index of orthodontic treatment need (IOTN) identifies the patients who benefit the most from orthodontic treatment. The aim of this study was to assess the malocclusion frequencies and the orthodontic treatment need among Austrian children in the mixed dentition stage, since there is no pre-existing data from Austria.

In the present study, 157 children aged between 8 and 10 years were examined. Following an anamnesis questionnaire, which included a question about the parents' perceived treatment need, the children were examined clinically and dental impressions were taken. The sagittal molar relationship, overjet, overbite and the presence of cross- or scissor bite were registered. The treatment need was assessed using the dental health component (DHC) of the index of orthodontic treatment need (IOTN).

64.3% (95% CI [56.8, 71.8]) of the children showed Angle class I molar relation, 33.1% (95% CI [25.8, 40.5]) class II and 2.5% (95% CI [0.1, 5.0]) Angle class III relation. Crossbite was found in 36.3% (95% CI [28.8, 43.8]) of the participants. A treatment need for medical reasons (IOTN 4 or 5) was found in 30.6% (95% CI [23.4, 37.8]). There was no statistically significant relationship between objective treatment need and the parents' perception.

The malocclusion frequencies and the treatment need assessed in the present study appeared to be comparable to those assessed in other countries. The data supports the opinion that orthodontic screening is important and necessary at this stage of dental development, also due to the discordance between objective and perceived treatment need.

## Introduction

Malocclusion can have an impact on dental health and aesthetic appearance. Patients with certain malocclusal traits in childhood appear to have more problems related to teeth in their life (NGUYEN ET AL. 1999; STENVIK ET AL. 2011). If a malocclusal trait needs to be treated, depends on its impact on dental health and aesthetics. One of the most frequently used indices for identifying those patients who benefit mostly of an orthodontic treatment (SHAW ET AL. 1995) is the index of orthodontic treatment need (IOTN) (BROOK & SHAW 1989). It consists of two separate parts, the dental health component (DHC) and the aesthetic component (AC) (EVANS & SHAW 1987; BROOK & SHAW 1989). The AC is determined by using a “10 point rating scale (SCAN) illustrated by representative dental photographs” (EVANS & SHAW 1987) and therefore seems to be more susceptible to subjective influences. The dental health component (DHC) is based on recommendations of the Swedish medicinal authorities (BJOERK ET AL. 1964; LINDER-ARONSON 1974) and relates to the malocclusal findings with the greatest dental health impact: missing teeth, increased or inverted overjet, crossbite, displacement of teeth and increased overbite (TAUSCHE ET AL. 2004). The patient’s severest malocclusal trait determines the DHC grade (SHAW ET AL. 1995), the DHC values of the individual traits cannot be added (SHAW ET AL. 1995). Numerous studies have proven the IOTN, and particularly the DHC component, to be simple and fast to apply, and to be a reliable parameter for assessing the orthodontic treatment need (SHAW ET AL. 1995; COOPER ET AL. 2000; SOUAMES ET AL. 2006; MANZANERA ET AL. 2009). The Austrian health insurance has only recently decided to cover the costs for orthodontic treatment in children, with the IOTN serving as triage parameter: for children suffering from malocclusions grade IOTN 4 or 5, the costs for the orthodontic treatment are covered by the public health insurance. Although reports about malocclusion prevalence and orthodontic treatment need have been published by other countries, there is currently no data from Austria. The aim of this study was to assess the malocclusion frequencies and the prevalence of orthodontic treatment need among Austrian schoolchildren. This data would be useful for dental healthcare planning and would also enable the comparison with other countries.

## Materials and Methods

The design of the present study was prospective. The principles of the Declaration of Helsinki have been followed and informed consent was gained from the patients and one parent each. After approval by the local ethics committee (Ethikkommission der Medizinischen Universität Innsbruck, UM 3830, session 283/4.10), a representative randomised stratified sample of 558 children from 20 Tyrolean primary schools was generated by the Department of Statistics, Informatics and Health Economics of the Medical University of Innsbruck using WINPEPI statistical program (PEPI-for-Windows). Inclusion criteria were children going to school in Tyrol (Austria), age between eight and ten years and written informed consent of child and one parent. The exclusion criteria were children from outside Tyrol (Austria), missing written consent from child or parent and present or passed orthodontic treatment. After answering an anamnesis questionnaire assessing if the parents perceived any treatment need in their children (“Do you think your child is in need of orthodontic treatment?”, yes/no), a clinical orthodontic examination was performed by two trained examiners using a head light, two mouth mirrors and a plastic ruler with millimetre gradua-

tion. The two examiners showed a satisfactory inter-observer agreement (Cohen’s Kappa  $\kappa = .848$ ,  $p < .001$ , assessed by evaluating dental casts). The sagittal molar relationship was registered according to Angle, both for the left and for the right side in habitual intercuspitation position. Deviations from Angle class I relation of  $1/2$  cusp widths or more were registered as class II or III relation. Overjet and overbite were registered between the first incisors at the site with the greatest pronunciation, also in habitual intercuspitation position. The presence of infraocclusion, cross- or scissor bite was registered, and the region of the transversal anomalies was documented. Deviations in the anterior and canine region were defined as anterior localisation, deviations in the milk molar/premolar or molar region as posterior localisation. The laterality of the transversal anomaly was described as left, right or bilateral. In addition, alginate impressions of the upper and the lower jaw were taken and the bite was registered using bite wax (habitual bite position).

For the evaluation of the orthodontic treatment need (DHC component of the IOTN), the clinically assessed number of missing teeth, the overbite, overjet and crossbite dimension were used in synopsis with the extent of contact point displacement measured in the dental casts. In those cases, in which alginate impressions could not be taken because of in-compliance, the determination of the DHC treatment need was performed intraorally.

The data was analysed using SPSS Statistics 22 (IBM, Armonk NY, USA). Continuous measures were described as mean values and standard deviations, categorical data as absolute and relative frequencies. In addition, the 95% confidence intervals (95% CI) were calculated. Associations between continuous measures were determined with Pearson correlation coefficients. Frequency differences were assessed with contingency tables together with the chi-square test. An alpha level of .05 was used for all statistical tests. The assumption of an approximately normal distribution of the data has been confirmed by visual inspection of histograms, Q-Q plots and box plots and by evaluation of the data skewness and kurtosis. The assumption of homogeneity of variance was verified by visual inspection of scatter plots.

## Results

A total of 157 children were included in the study. No applicant had to be excluded because of past or present orthodontic treatment. From the included children, 51.0% were male and 49.0% were female. The participants’ mean age was 8.77 years (SD = 0.67).

### Questionnaire

An orthodontic treatment need in their child was perceived by 54.8% (95% CI [47.0, 62.6]) of the parents, 32.5% (95% CI [25.2, 39.8]) of the parents thought their child did not need any orthodontic treatment, and 12.7% (95% CI [7.5, 18.0]) of the parents were not able to decide if their child was in need of orthodontic treatment.

### Clinical Examination

The clinical examination showed that 64.3% (95% CI [56.8, 71.8]) of the children had Angle class I molar relation, 33.1% (95% CI [25.8, 40.5]) had Angle class II, and 2.5% (95% CI [0.1, 5.0]) Angle class III relation. In one participant, the sagittal molar relation had to be registered in the canine region due to a great number of missing teeth. The frequencies of the detailed

sagittal molar relations are presented in Table I. The overjet range lay between  $-4.0$  mm and  $10.0$  mm (Fig. 1), the mean value of the overjet was  $3.4$  mm,  $SD=1.8$  (95% CI [3.2, 3.7]). The range of the overbite lay between  $0.0$  mm and  $7.0$  mm (Fig. 2). An inverse overbite was not found within the examined group. The mean value of the overbite was  $3.6$  mm,  $SD=1.5$  (95% CI [3.3, 3.8]). There was a moderately positive correlation between overjet and overbite, which was statistically highly significant: children with increased overbite also tended to have an increased overjet,  $r(155) = .36$ ,  $p < .001$ .

Crossbite was found in  $36.3\%$  (95% CI [28.8, 43.8]) of the participants:  $14.6\%$  (95% CI [9.1, 20.2]) had anterior crossbite,  $15.3\%$  (95% CI [9.7, 20.9]) had posterior crossbite, and  $6.4\%$  (95% CI [2.5, 10.2]) had combined anterior and posterior crossbite. The precise localisations are broken down in Figure 3.

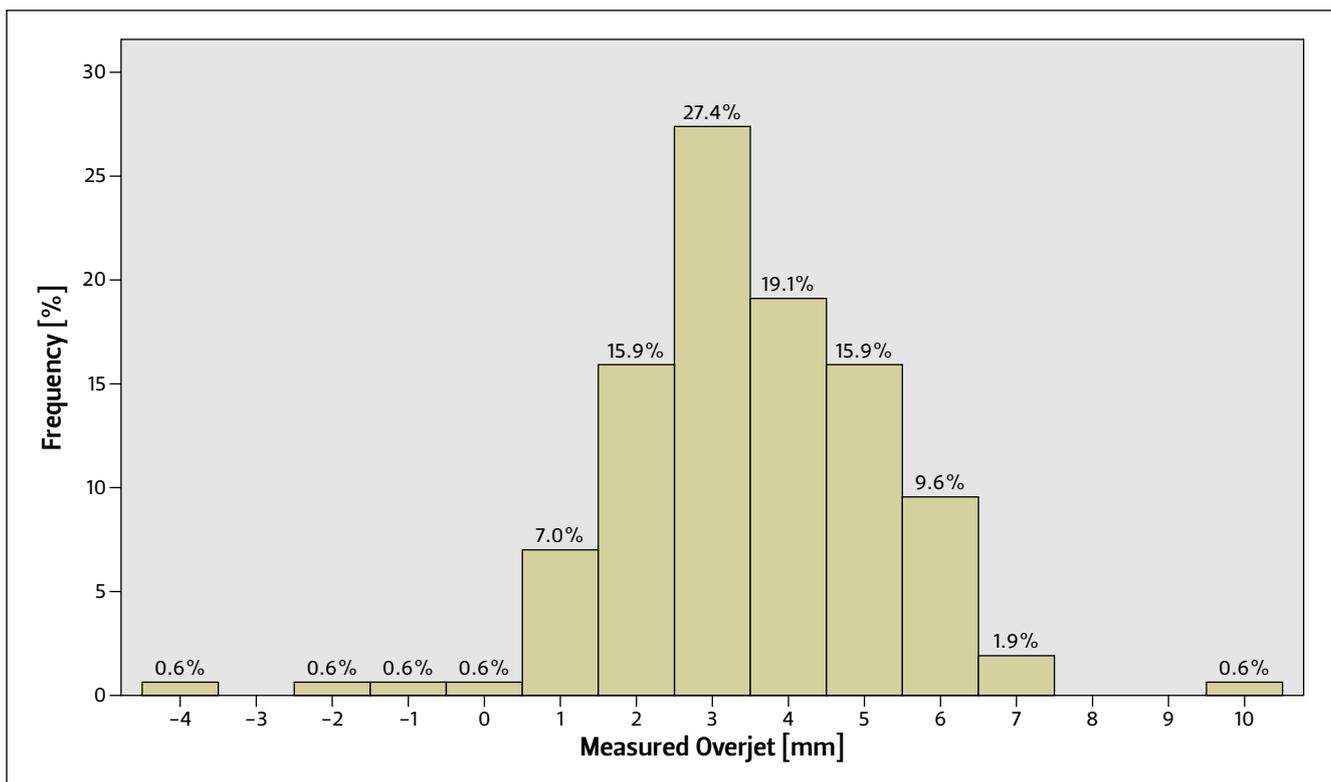
Posterior scissor bite was found in three participants,  $1.9\%$  (95% CI [0.0, 4.1]), always located in the premolar region.  $61.8\%$  (95% CI [54.2, 69.4]) of the examined children had regular transversal occlusal relations.

In the upper jaw,  $22.3\%$  (95% CI [15.8, 28.8]) of the children showed anterior crowding, and  $38.9\%$  (95% CI [31.2, 46.5]) had anterior diastemata. In the lower jaw,  $31.8\%$  (95% CI [24.6, 39.1]) of the examined children showed anterior crowding, and only  $17.2\%$  (95% CI [11.3, 23.1]) had anterior gaps.

A treatment need for medical reasons (DHC/IOTN 4 and 5 combined) was found in  $30.6\%$  (95% CI [23.4, 37.8]). The distribution of the treatment need is shown in Table II. There was no statistically significant relationship between objective treatment need and the parents' perception,  $\chi^2(1, N = 95) = 2.603$ ,  $p = .11$ .

**Tab. I** Detailed listing of sagittal molar relations

Feature	Frequency [%]	95% CI [%]	registered as
I	42.7	[34.9, 50.4]	Angle Class I
II ¼ cusp width	19.7	[13.5, 26.0]	Angle Class I
II ½ cusp width	24.8	[18.1, 31.6]	Angle Class II
II ¾ cusp width	2.5	[0.1, 5.0]	Angle Class II
II 1 cusp width	5.7	[2.1, 9.4]	Angle Class II
III ¼ cusp width	1.9	[0.0, 4.1]	Angle Class I
III ½ cusp width	1.9	[0.0, 4.1]	Angle Class III
III 1 cusp width	0.6	[0.0, 1.9]	Angle Class III
Total	100.0		



**Fig. 1** Overjet distribution

DHC/IOTN	Frequency [%]	95% CI [%]	Orthodontic treatment need	Frequency [%]	95% CI [%]
Grade 1	5.7	[2.1, 9.4]	No treatment need for medical reasons	36.9	[29.4, 44.5]
Grade 2	31.2	[24.0, 38.5]			
Grade 3	32.5	[25.2, 39.8]	Possible treatment need for medical reasons	32.5	[25.2, 39.8]
Grade 4	7.6	[3.5, 11.8]	Definite treatment need for medical reasons	30.6	[23.4, 37.8]
Grade 5	22.9	[16.4, 29.5]			

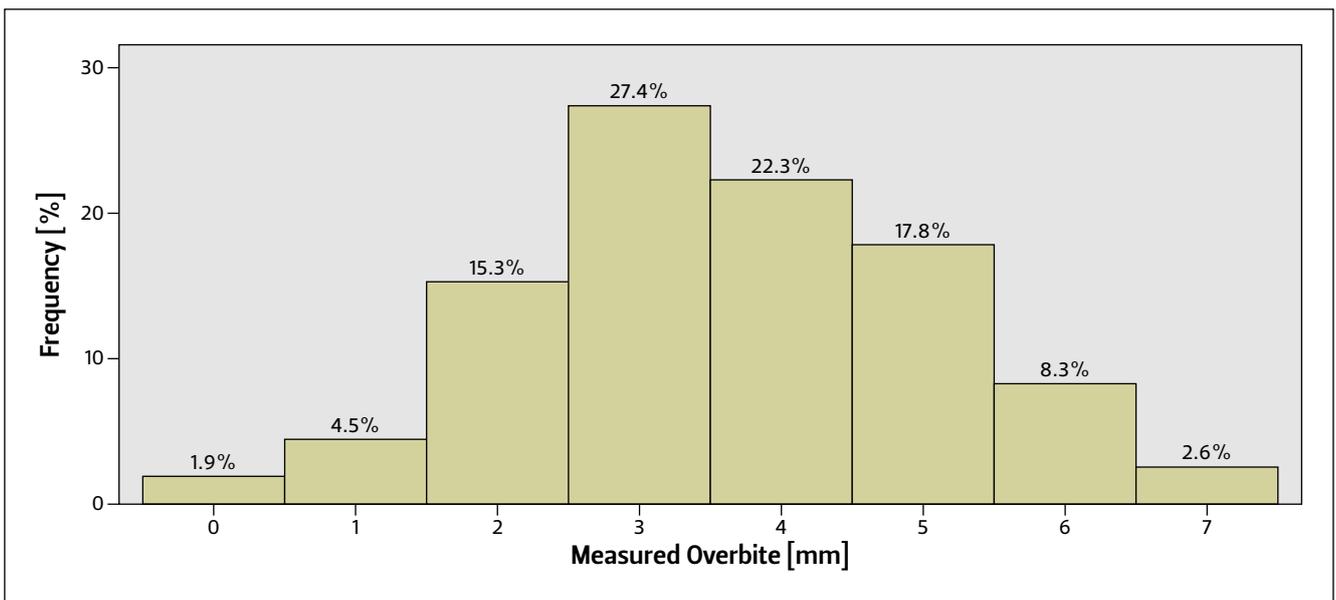


Fig. 2 Overbite distribution

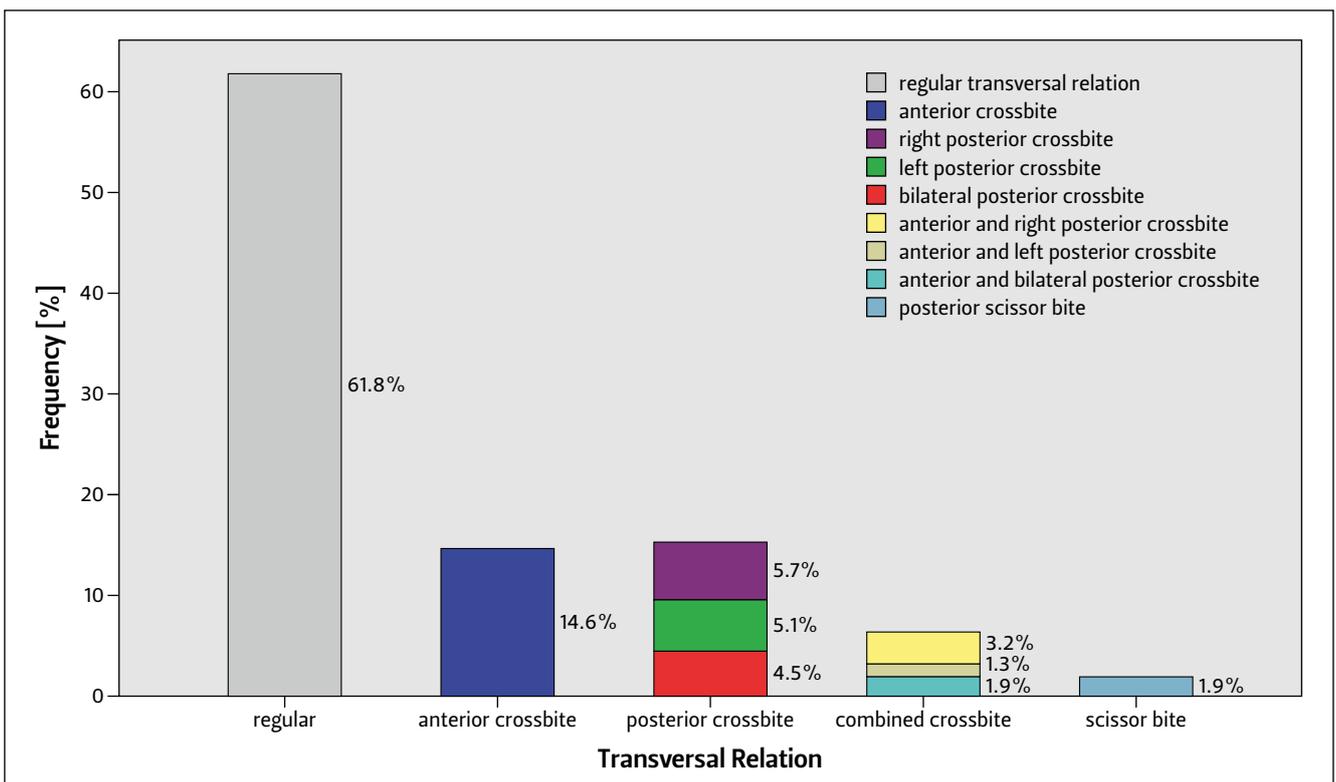


Fig. 3 Transversal relations

## Discussion

In the present study, a representative stratified sample of children was examined at a relevant point of dento-maxillofacial development. The age range within the study sample was small. At the age of eight to ten years, the early permanent dentition is usually not established yet. Interceptive orthodontic treatment may therefore be able to reduce the extent of (PRIMOZIC ET AL. 2013) and perhaps also the need for subsequent treatment (AL NIMRI & RICHARDSON 2000). Earlier timing may also enforce the long-term stability of orthodontic treatment results (KEROSUO ET AL. 2013). In Austria, the decision on health-system coverage of orthodontic treatment is based solely on the DHC component of the IOTN. The DHC/IOTN assesses the health impact of malocclusal traits according to a standardised scheme, resulting in a standardised and reproducible evaluation of the occlusal situation. In contrast, the orthodontic treatment recommendations of the Swiss cantonal dentists categorises the malocclusion impact according to its oral health impact. The scheme is less rigid and therefore enables a more individual decision. A possible disadvantage, however, might be a higher inter-observer variability.

Unfortunately, the response rate from the initially calculated sample of 558 children was rather low. Probably the strict ethical regulations impeded a wide-range screening. Because the Ethical Committee demanded the presence of one parent at the examination in addition to the oral and written informed consent of each participant plus one parent, working parents may have been deterred from having their child participate in the study. Although the supportive educational authorities had been informed and the study had been announced in the local papers, the final response rate was only at 28%. The low response rate represents a relevant limitation since it bears the risk of selection bias regarding dental health attitude. Although the questionnaire revealed that only 54.8% of the participants' parents perceived orthodontic treatment need in their children, the set-up of the present study (need of active response of the parents) is likely to select for parents with increased dental awareness. Another possible limitation may be the fact that the number of participants was too small to detect seldom malocclusions. The distribution of both genders, however, was almost even, and a systematic bias resulting from gender influences on the presence of certain malocclusal traits are improbable.

The present study is an observational study with cross-sectional design. The findings from the clinical examination were used for determining the sagittal and transversal molar relations, since not all children were sufficiently compliant to enable impression-taking for dental casts. The mixing of data generated from clinical examinations and from dental casts might have caused unnecessary additional bias. Angle class I molar relationship was the most frequent finding in the present study, followed by class II molar relationship and only a small percentage of class III relationships. The variability of mean age and evaluation criteria complicate the comparison with other studies. The values for Angle class I molar relationship found in children of similar age vary between 47.0% (JOSEFSSON ET AL. 2007) and 73.5% (THILANDER ET AL. 2001), for class II molar relationship between 20.8% (THILANDER ET AL. 2001) and 48.8% (JOSEFSSON ET AL. 2007). The frequency for Angle class III molar relationship in literature varies between 2.6% and 5.4% (LAUC 2003). The results from the present study are consistent with these reported values. Overbite and overjet distribution also seem comparable to

values from literature (JOSEFSSON ET AL. 2007; LUX ET AL. 2009). It is, however, surprising that the present study did not find any cases of open bite. The small study sample size might be responsible for the non-appearance of rarer malocclusal traits. The crossbite frequency, on the other hand, was again similar to other reports in literature (HEIKINHEIMO & SALMI 1987; SHALISH ET AL. 2013), although the age of the examined children was different. Perhaps crossbite, once fixated by occlusion, is unlikely to resolve without orthodontic treatment unless the opposing teeth are lost, and therefore might be less dependent on the patient's age.

The investigated population had a higher prevalence of anterior gaps and a lower prevalence of anterior crowding than it is reported from other countries (THILANDER ET AL. 2001; ABU ALHAJJA ET AL. 2005; KAUR ET AL. 2013). A certain extent of anterior spacing represents a normal condition in the mixed dentition. The investigated population was younger than in many other studies researching similar topics, and the premolars were not or not fully erupted in many patients. As long as the second dentition is not established completely, the full extent of alveolar arch dimensions must be evaluated with caution.

The values given for IOTN in literature are heterogeneous: in similar age groups the values for IOTN 1 and 2 vary between 35.1% (SHAW ET AL. 1995) and 48.3% (TAUSCHE ET AL. 2004), the values for IOTN 4 and 5 between 18.1% (PUERTES-FERNANDEZ ET AL. 2011) and 32.7% (SHAW ET AL. 1995). A British study among eleven- to twelve-year old children found a distribution of treatment need which is very similar to the values from the present study (SHAW ET AL. 1995).

The present study could also confirm the previously observed discordance between the parents' perception and the clinical assessment of treatment need (DE OLIVEIRA & SHEIHAM 2003; LIVAS & DELLI 2013). This discordance emphasises the need for generalised orthodontic screening in this age class.

## Conclusion

The malocclusion frequencies and the treatment need assessed in the present study appeared to be comparable to those assessed in other countries. Our data support the opinion that orthodontic screening is meaningful and needed at this stage of dental development (AL NIMRI & RICHARDSON 2000) and that the parental evaluation of the orthodontic treatment need is not always adequate (LIVAS & DELLI 2013). The distribution of public health system funding for orthodontic treatment according to the DHC/IOTN appears appropriate and roughly one-third of the Austrian children in the early mixed dentition stage will be entitled to insurance-covered orthodontic treatment.

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## Ethical Approval

The study has been approved by the local ethics committee (Medical University of Innsbruck, Austria, UM 3830, session 283/4.10).

## Conflict of interest

The authors declare that they have no conflicts of interest.

## Résumé

### Introduction

Les malpositions dentaires peuvent avoir des effets négatifs sur la santé dentaire et l'apparence esthétique. Pour identifier les patients qui profiteront le plus d'un traitement orthodontique, l'index de traitement orthodontique (Index of Orthodontic Treatment Need: IOTN) s'est avéré très utile. Depuis peu aussi en Autriche, les coûts de traitement orthodontique sont pris en charge par la sécurité sociale en cas d'une indication médicale justifiée. Bien qu'il y ait des rapports d'autres pays concernant le besoin de traitement orthodontique, selon l'IOTN, il n'y avait pas de données disponibles en Autriche jusqu'à maintenant. C'était donc le but de cette étude d'enquêter pour la première fois sur la prévalence des malpositions dentaires et sur le besoin de traitement orthodontique en Autriche.

### Matériels et méthodes

Un échantillon stratifié et randomisé de 157 élèves du Tyrol âgés de 8 à 10 ans a été étudié. Tout d'abord, un questionnaire a été rempli pour déterminer le besoin de traitement orthodontique subjectivement indiqué par les parents. Après avoir obtenu l'accord écrit des élèves participants et d'un des parents, un examen clinique orthodontique a été fait, et des empreintes à l'alginate pour la fabrication des modèles en plâtre ont été effectuées. Les relations molaires sagittales d'occlusion selon la classification d'Angle, l'overjet, l'overbite, une occlusion croisée, une occlusion en ciseaux, un encombrement ou espaces entre les dents antérieures ont été notés.

### Résultats

64,3% (95% CI [56.8, 71.8]) des enfants présentaient une occlusion du type classe I d'Angle, 33,1% (95% CI [25.8, 40.5]) avaient une classe II, et 2,5% (95% CI [0.1, 5.0]) une classe III. Une occlusion croisée était présente chez 36,3% (95% CI [28.8, 43.8]) des participants, et 1,9% (95% CI [0.0, 4.1]) avaient une occlusion en ciseaux.

Un encombrement des dents antérieures dans la mâchoire supérieure a été diagnostiqué chez 22,3% (95% CI [15.8, 28.8]), et 38,9% (95% CI [31.2, 46.5]) avaient des espaces entre les dents antérieures dans la mâchoire supérieure. Dans la mâchoire inférieure, un encombrement des dents antérieures a été diagnostiqué chez 31,8% (95% CI [24.6, 39.1]), et seulement 17,2% (95% CI [11.3, 23.1]) avaient des espaces entre les dents antérieures dans la mâchoire inférieure.

30,6% (95% CI [23.4, 37.8]) des enfants avaient un besoin de traitement orthodontique pour des raisons médicales (IOTN 4 et 5). Il n'y avait pas de concordance entre l'opinion des parents et l'évaluation objective en regard du besoin de traitement orthodontique.

### Discussion

Le groupe d'âge étudié était en état de denture mixte, ce qui est une phase de très grande importance du point de vue orthodontique. En comparaison avec d'autres études, les pré-

valences de malocclusions paraissaient comparables. Aussi, le besoin de traitement identifié selon les critères IOTN est en concordance avec la littérature internationale. Les dates présentées soutiennent la recommandation pour le dépistage orthodontique, notamment parce qu'il a été montré de nouveau que le besoin de traitement orthodontique perçu par les parents de façon subjective ne correspondait qu'assez mal au besoin constaté de façon objective. La décision de rendre la prise en charge des coûts de traitement orthodontique dépendante du degré de malocclusion selon la classification IOTN apparaît raisonnable, et environ un tiers des élèves en denture mixte auront droit à cette prise en charge.

## Zusammenfassung

### Einleitung

Zahnfehlstellungen können sich negativ auf die Zahngesundheit und das ästhetische Erscheinungsbild auswirken. Um diejenigen Patienten zu identifizieren, die am meisten von einer kieferorthopädischen Behandlung profitieren, hat sich die Anwendung des Index of Orthodontic Treatment Need (IOTN) bewährt. Neuerdings werden die Kosten für eine kieferorthopädische Behandlung auch in Österreich vom Gesundheitssystem übernommen, wenn ein medizinisch begründeter Behandlungsbedarf vorliegt. Obwohl aus anderen Ländern Berichte zum kieferorthopädischen Behandlungsbedarf gemäss IOTN vorliegen, gab es für Österreich bislang keine Daten. Ziel dieser Studie war es, erstmals Daten über die Prävalenz verschiedener Zahnfehlstellungen und des kieferorthopädischen Behandlungsbedarfes gemäss IOTN bei Schulkindern in Österreich zu erheben.

### Material und Methoden

Eine randomisierte, geschichtete Stichprobe von 157 Tiroler Schulkindern im Alter von 8 bis 10 Jahren wurde untersucht. Zunächst wurde ein Fragebogen ausgefüllt, in dem der subjektiv empfundene Behandlungsbedarf der Eltern ermittelt wurde. Nach Erlangen des schriftlichen Informed Consent der Probanden sowie jeweils eines anwesenden Elternteils erfolgte eine klinisch-kieferorthopädische Untersuchung, und zuletzt wurden Alginateabformungen für die Herstellung von Gipsmodellen angefertigt. Dokumentiert wurden die sagittale Molarenrelation nach Angle, Overjet, Overbite, Kreuz- oder Scherenbiss und anteriores Crowding oder Lückenstand.

### Ergebnisse

64,3% (95% CI [56.8, 71.8]) der Kinder hatten eine Angle-Klasse-I-Verzahnung, 33,1% (95% CI [25.8, 40.5]) hatten eine Angle-Klasse-II-Verzahnung und 2,5% (95% CI [0.1, 5.0]) eine Angle-Klasse-III-Relation. Ein Kreuzbiss lag bei 36,3% (95% CI [28.8, 43.8]) der Probanden vor, und 1,9% (95% CI [0.0, 4.1]) der Kinder hatten einen Scherenbiss.

Im Oberkiefer hatten 22,3% (95% CI [15.8, 28.8]) der Kinder einen anterioren Engstand, 38,9% (95% CI [31.2, 46.5]) zeigten anteriore Lückenbildung. Im Unterkiefer hatten 31,8% (95% CI [24.6, 39.1]) der Kinder anteriores Crowding und nur 17,2% (95% CI [11.3, 23.1]) einen Lückenstand.

30,6% (95% CI [23.4, 37.8]) der Kinder hatten einen kieferorthopädischen Behandlungsbedarf aus medizinischen Gründen (IOTN 4 oder 5). Es wurde keine statistisch signifikante Übereinstimmung zwischen von den Eltern empfundenem und objektiv vorhandenem Behandlungsbedarf gefunden.

## Diskussion

Die untersuchte Altersgruppe befand sich in der Wechselgebissperiode, einer kieferorthopädisch hochrelevanten Entwicklungsphase. Im Vergleich zu anderen Studien scheinen die Prävalenzen der einzelnen Zahnfehlstellungen vergleichbar zu sein. Auch der ermittelte Behandlungsbedarf nach IOTN deckt sich mit der Literatur. Die vorliegenden Daten unterstützen die Empfehlung kieferorthopädischer Screeninguntersuchungen,

besonders da erneut gezeigt werden konnte, dass sich der subjektiv empfundene Behandlungsbedarf der Eltern nur sehr schlecht mit dem medizinischen Behandlungsbedarf deckt. Die Entscheidung, die Kostenübernahme für eine kieferorthopädische Behandlung vom IOTN-Grad abhängig zu machen, erscheint sinnvoll. Ungefähr ein Drittel der Schulkinder im Wechselgebiss wird Anspruch auf diese Kostenübernahme haben.

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