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 amnesic 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 from 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 dental authorities (Björk 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 (Ethikkom­ission 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 graduation.

Result
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 (DHIC/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, χ²(1, N = 95) = 2.603, p = .11.

### Table I  Detailed listing of sagittal molar relations

<table>
<thead>
<tr>
<th>Feature</th>
<th>Frequency [%]</th>
<th>95% CI [%]</th>
<th>registered as</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>42.7</td>
<td>[34.9, 50.4]</td>
<td>Angle Class I</td>
</tr>
<tr>
<td>II 1⁄4 cusp width</td>
<td>19.7</td>
<td>[13.5, 26.0]</td>
<td>Angle Class I</td>
</tr>
<tr>
<td>II 1⁄2 cusp width</td>
<td>24.8</td>
<td>[18.1, 31.6]</td>
<td>Angle Class II</td>
</tr>
<tr>
<td>II 3⁄4 cusp width</td>
<td>2.5</td>
<td>[0.1, 5.0]</td>
<td>Angle Class II</td>
</tr>
<tr>
<td>II 1 cusp width</td>
<td>5.7</td>
<td>[2.1, 9.4]</td>
<td>Angle Class II</td>
</tr>
<tr>
<td>III 1⁄4 cusp width</td>
<td>1.9</td>
<td>[0.0, 4.1]</td>
<td>Angle Class I</td>
</tr>
<tr>
<td>III 1⁄2 cusp width</td>
<td>1.9</td>
<td>[0.0, 4.1]</td>
<td>Angle Class III</td>
</tr>
<tr>
<td>III 1 cusp width</td>
<td>0.6</td>
<td>[0.0, 1.9]</td>
<td>Angle Class III</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1  Overjet distribution
Tab. II Distribution of DHC/IOTN grades

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

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 is 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 complicates 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., 2003), for class II molar relationship between 20.8% (Thilander et al., 2003) 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 is reported from other countries (Thilander et al., 2001; Abu Alhaja 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% (Puertas-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 emphasizes 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.

Acknowledgements

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Source of Funding

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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 superieure. 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 prévalences 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 prendre 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

Material und Methoden

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 Scherenzahn.

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]) des Kinder anteriore 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

References