Prevalence and Severity of Malocclusion in Adolescent Kuwaitis

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Key Words

Malocclusion · Prevalence · Adolescents · Kuwaitis

Abstract

Objectives: Our aim was to evaluate prevalence and severity of malocclusion in an adolescent Kuwaiti population. **Subjects and Methods:** Using a stratified cluster sampling method and excluding non-Kuwaitis, subjects with mesial migration and/or loss of first molars, and subjects with orthodontic treatment experience without availability of initial study models, we examined 1,299 Kuwaitis (674 boys and 625 girls) of mean age 13.2 ± 0.4 years in a regular well lit classroom. We scored molar and canine relationship, overjet, overbite, anterior and posterior cross bite as well as spacing and irregularity of the incisors using gloves, mirrors, rulers, and spatulas.

Results: Fourteen, 15, and 71% met the criteria for almost ideal, mild, and moderate to severe malocclusion, respectively. Of the 86% with malocclusion, occurrence of class 1, half step class 2, full step class 2, half step class 3, and full step class 3 was 57.8, 24.9, 6.3, 8.8, and 2.2% for the first molars, and 36.1, 50.0, 6.2, 5.4, and 2.3% for the canines, respectively. Incisor malalignment was the most prevalent malocclusion trait (73.2%). Overjet ≥ 9.5 mm occurred in less than 1.5%, open bite in less than 3.5%, deep bite with gingival contact in less than 2.0%, complete posterior cross bite in less than 1.5%, and complete anterior crossbite in less than 2.0%. Median diastema was present in about 2/3 of the cases with maxil-

lary anterior spacing as opposed to only about 1/3 of those with mandibular spacing. **Conclusion:** Our findings suggest that more than 70% of young adolescent Kuwaitis have moderate to severe malocclusion, with incisor malalignment as the most prevalent malocclusion trait.

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Introduction

Prevalence of occlusal deviations according to different types of indices may provide useful information on treatment need [1–4] as well as on residual treatment need at an age where orthodontic treatment normally should have been rendered [5]. However, treatment need indices do not provide accurate information regarding prevalence of specific malocclusion traits. For example, due to the hierarchy of the Index of Orthodontic Treatment Need [6], a large overjet (OJ) will not be scored in cases with tooth impactions or impeded eruption. Similarly, neither overbite (OB) nor amount of contact displacement will be scored in subjects with a large OJ [6]. Accurate information on prevalence of different occlusal traits may be needed when planning of orthodontic services involves targeting specific types of malocclusion.

It is well established that molar relationship [7–9] as well as prevalence of lateral crossbite [7, 8], open bite [7] and malalignment in the anterior segment [7] may change during the transition from mixed to early permanent den-

tition. Inferences from craniofacial growth studies [10] also suggest changes in anteroposterior and vertical relationships during the period from adolescence to early adulthood. Results from studies examining patients of a wide age range [11–17] may therefore not allow inferences to specific age groups. Another problem is inability to accurately adjust for any effect of previous treatment when older age groups are included [18, 19]. Although some samples have been of sufficient size [3, 7, 17–22], most studies have selected subjects from schools in a limited geographic area [3, 17–21]. Few studies have evaluated homogeneous population-based samples of age comparable to start of one-phase orthodontic treatment [7, 23].

Most studies [3, 7, 17–23] have evaluated molar relationship only in three categories similar to Angle's definition [24]. Rounding the molar relation to the nearest full cusp category will minimize the ability to differentiate between mild and more severe anteroposterior discrepancies. Hardly any attempts have been made at scoring canine relationship. Such information may be more relevant for the severity of the case since the aim of everyday clinical practice is to achieve a perfect class 1 canine relationship, with the accompanying molar relationship being a consequence of the extraction alternative. Lack of clearly defined criteria in previous attempts at estimating transverse and vertical discrepancies and arch perimeter problems [3, 7, 15, 19, 21] makes valid interpretations of such deviations difficult.

Information on prevalence of malocclusion in Arab populations is limited [3]. Therefore the purpose of our study was to examine a large population-based sample of adolescent Kuwaitis in the early permanent dentition to provide an accurate description of prevalence and severity of the different types of occlusal deviation.

Subjects and Methods

Sample

Following approval by the Ethics Committee of the Faculty of Dentistry, Kuwait University, a sample of 13- to 14-year-old 8th grade school children in Kuwait was selected according to a stratified cluster sampling method [25]. The students in the public schools of each of the 6 administrative areas were divided as 6 different strata and the students in the different private schools as the 7th stratum. The number of students to be examined from each stratum was estimated according to proportions, following random sampling procedures when selecting the schools (clusters) from each stratum as well as when selecting students from each school. Subjects without Kuwaiti nationality ($n = 96$), Kuwaitis with a history of treatment without availability of initial study models ($n = 8$), and Kuwaitis scored for mesial migration and/or loss of one or more first

molars ($n = 180$) were excluded. The final sample consisted of 1,299 Kuwaitis (674 boys of mean age 13.3 ± 0.4 years and 625 girls of mean age 13.2 ± 0.4 years), representing 6.7% of that age stratum in the population. In this sample 1,244 subjects were examined clinically, while 55 were examined from pretreatment study models.

Test of proportions did not detect any differences in frequency of class 1, 2 and 3 molar relationship between the subjects without mesial migration or loss of first molars and those with unilateral migration and/or loss of first molars when judged on the normal side ($p > 0.05$).

Examinations

Permission was obtained from the Research Department of the Kuwaiti Ministry of Education to perform the clinical examinations during school hours. Each school principal provided a well-lit room for examination, and the students were informed about their rights to participate in the study. All interarch parameters were scored with the teeth in maximum intercuspal position using gloves, mirrors, rulers, and spatulas. Molar relationship was scored subjectively in five half cusp units as class 1, half step class 2, full step class 2, half step class 3 and full step class 3. Angle's definitions were used to score full step class 1, 2, and 3 [26]. Half step class 2 and 3 were scored if the mesial aspect of the maxillary first molar was flush with the mesial aspect or the disto-buccal groove of the mandibular first molar, respectively. Between-category relationships were recorded according to the closest category, and scored as the respective half step class 2 or 3 when in doubt. Similar criteria were used for scoring of canine relationship, with full step class 2 and 3 denoting occlusion of the maxillary canine cusp at the mesial aspect of mandibular canine and distal aspect of the mandibular first premolar, respectively. Mesial molar migration was scored in cases of tipping and/or rotation combined with lack of space for the premolars. OJ was measured to the nearest half millimeter as the distance parallel to the occlusal plane from the incisal edge of the most labial maxillary central incisor to the most labial mandibular central incisor using a ruler. OB was scored subjectively as open, edge-to-edge, overlap $< 1/3$, overlap $1/3$ – $2/3$, overlap $2/3$ – $3/3$, overlap $> 3/3$, and presence of gingival contact. Interdental spaces judged subjectively as larger than 0.5 mm in the maxillary and mandibular anterior segments were scored as median diastema with no other spaces, median diastema with other spaces, and no median diastema but other spaces. Irregularity of the maxillary and mandibular anterior teeth was evaluated subjectively according to the sum of the labio-lingual contact point displacements of adjacent teeth in each of the 5 interdental areas and scored as no irregularity, irregularity ≤ 3.5 mm, irregularity > 3.5 mm and < 6.5 mm, and irregularity ≥ 6.5 mm [27]. Presence of any posterior cross bite was scored as unilateral or bilateral on one tooth, more than one tooth, or involving the whole segment. Any anterior cross bite was scored as present on one incisor, two or three incisors, or all four incisors. The occlusion was scored as almost ideal provided intercuspation and posterior tooth alignment was judged perfect with no transverse discrepancies, no detectable lateral shift, anterior shift < 2 mm, $1.0 \text{ mm} < \text{OJ} \leq 3.5 \text{ mm}$, $0 < \text{OB} < 2/3$, arch length excess < 2 mm in either arch, and anterior tooth irregularity ≤ 3.5 mm in either arch. A total of four examiners performed the clinical examinations, each of which examined about 25 subjects one day per week for 16 weeks. Only one examiner evaluated the pretreatment study models for those in or with a history of orthodontic treatment.

Method Error

Two sets of calibrations were performed under conditions identical to the clinical examinations that followed. At the first set each examiner examined the same 40 subjects. Following comparison of the scores and adjustments of the criteria, another 40 subjects were examined twice about 2 weeks apart by all four examiners. Intra- and inter-class correlation analyses were performed prior to all clinical examinations and calculated between the first and second scores for each examiner as well as among the four scores of the examiners at each of the two examinations. The mean intra-class correlation coefficient between the first and second scores of all examiners was 0.80, ranging from 0.78 to 0.97. The mean inter-class correlation coefficient among the four examiners was 0.89, ranging from 0.77 to 0.98. The acceptable error margins allowed us to proceed.

Data Analyses

Malocclusion was counted as present if the occlusion was not scored as almost ideal. Malocclusions with bilateral scores were categorized as class 1 with bilateral class 1 molar relationship; as half step class 2 with bilateral half step class 2 molar relationship or half step class 2 on one side and as class 1 on the other; as full step class 2 with bilateral full step class 2 molar relationship or full step class 2 on one side and half step class 2 or class 1 on the other; as half step class 3 with bilateral half step class 3 molar relationship or half step class 3 on one side and class 1, half step class 2, or full step class 2 on the other, and as full step class 3 with bilateral full step class 3 or full step class 3 on one side and half step class 3, class 1, half step class 2, or full step class 2 on the other. Malocclusions with unilateral scores were categorized according to the recorded molar relationship. Canine relationship was categorized in five groups using criteria similar to those for molar relationship. Number and percent of subjects with almost ideal occlusion as well as with presence of each of the five molar and canine malocclusion categories was calculated. In addition, descriptive statistics were performed regarding OJ, frequency of OB categories, frequency of posterior and anterior cross bites, and frequency of anterior spacing and tooth irregularity in either arch. χ^2 analyses were performed to test the gender differences.

Mild malocclusion was defined as class 1 and half step class 2 or 3 malocclusions with the following limitations: $1.0 \text{ mm} \leq \text{OJ} \leq 6.0 \text{ mm}$, $0 < \text{OB} < 2/3$, no median diastema, anterior tooth irregularity $\leq 3.5 \text{ mm}$ in either arch, and no posterior or anterior cross bites. Number and percent of subjects with mild malocclusion were calculated. All remaining malocclusions were categorized as moderate to severe. χ^2 analyses were performed to test the gender differences.

Results

Prevalence of Malocclusion

Only 178 (13.7%) were judged to have almost ideal occlusion. Of the remaining 1,121 (86.3%) subjects with malocclusion, data for molar relationship were collected from 1,119 subjects (table 1) and from 1,081 subjects for canine relationship (table 2). While the most prevalent

Table 1. Prevalence of molar relationships expressed in five half step categories in subjects judged to have malocclusion without mesial migration or loss of first molars (n = 1,119)

Molar relation	Prevalence
Class 1 malocclusion	57.8%
Half step class 2 malocclusion	24.9%
Full step class 2 malocclusion	6.3%
Half step class 3 malocclusion	8.8%
Full step class 3 malocclusion	2.2%

Table 2. Prevalence of canine relationships expressed in five half step categories in subjects judged to have malocclusion without mesial migration or loss of first molars (n = 1,081)

Canine relation	Prevalence
Class 1 canine	36.1%
Half step class 2 canine	50.0%
Full step class 2 canine	6.2%
Half step class 3 canine	5.4%
Full step class 3 canine	2.3%

molar relationship in the malocclusion subsample was class 1 (57.8%) (table 1), the most prevalent canine relationship was half step class 2 (50.0%) (table 2). Full step class 2 as well as half and full step class 3 were rare, and occurred with about similar frequency in both molar and canine areas (tables 1 and 2). No gender differences were detected ($p > 0.05$).

The mean OJ was $3.5 \pm 2.0 \text{ mm}$ ranging from -6.0 to 12.0 mm . Negative OJ and extreme OJ $\geq 9.5 \text{ mm}$ were rarely observed (table 3). Prevalence of open bite and deep bite malocclusions were found to be 7.9 and 22.0%, respectively (table 3). A total of 25.2% had posterior cross bite ranging from unilateral involving one or several teeth to bilateral and complete, and 20.8% of the sample had malocclusion with anterior cross bite (table 3). Median diastema was present in about 2/3 of the 29.3% judged to have maxillary anterior spacing as opposed to only in about 1/3 of the 13.5% with mandibular spacing (table 3). Severe irregularity of more than 6.5 mm was equally prevalent (about 10%) in both arches (table 3). All prevalences were similar in boys and girls ($p > 0.05$).

Table 3. Frequency according to categories of severity of other malocclusion traits in 1,121 subjects judged to have malocclusion without mesial migration or loss of first molars

	%	n
OJ		
Negative to 0.0 mm	4.0	45
Positive to 3.5 mm	53.2	596
4.0–6.0 mm	35.0	392
6.5–9.0 mm	6.4	72
>9.0 mm	1.4	16
OB		
Open bite	3.4	38
Edge to edge	4.5	50
2/3–3/3 overlap	20.3	228
>3/3 overlap with gingival contact	1.7	19
Posterior cross bite		
Unilateral < complete segment	17.0	191
Unilateral complete segment	1.9	21
Bilateral < complete segment	5.0	56
Bilateral complete segment	1.3	15
Anterior cross bite		
One incisor	12.1	136
Two incisors	7.1	80
Complete segment	1.6	18
Spacing in maxillary anterior segment		
Median diastema with no other spaces	6.9	77
Median diastema with other spaces	13.0	146
No median diastema but other spaces	9.4	105
Spacing in mandibular anterior segment		
Median diastema with no other spaces	0.8	0
Median diastema with other spaces	4.2	47
No median diastema but other spaces	8.5	95
Irregularity in maxillary anterior segment		
<3.5 mm	42.9	481
3.5–6.5 mm	16.2	182
>6.5 mm	10.4	117
Irregularity in mandibular anterior segment		
<3.5 mm	47.3	530
3.5–6.5 mm	17.7	198
>6.5 mm	8.2	92

Severity of Malocclusion

Of the 1,119 subjects with malocclusion with presence of scores for molar relationship, 191 (17.1%) subjects (approximately 15% when including the 178 with almost ideal occlusion) were judged to have mild malocclusion, with 10.8% classified as having mild class 1, 4.5% classified as having mild half step class 2, and 1.8% as having mild half step class 3. Accordingly, 928 (82.9%; approximately 72% when including the 178 with almost ideal occlusion) were considered to have moderate to severe malocclusion. All prevalences were similar in boys and girls ($p > 0.05$).

Discussion

The high malocclusion prevalence of 86.3% in this study is similar to that reported from Colombia [7]. Other studies have shown slightly lower prevalence figures in American Caucasians [18], Africans [17], African-Americans [20], and European Caucasians [15, 19]. While these discrepancies could reflect ethnic differences, our strict criteria for almost ideal occlusion may have contributed to a relative overrepresentation of subjects with malocclusion. Lack of similarly-defined criteria in previous studies [15, 18–20] makes direct comparisons difficult. Another explanation could be that the differences in prevalence are due to human evolutionary development and the effect of increased out-breeding, both of which may contribute to an increase in prevalence of malocclusion in modern societies [26]. Since the previous studies were conducted several decades ago [15, 18–20], a current evaluation of the different populations may be merited.

We did not score prevalence of ideal occlusion according to Angle's criteria for morphologic, esthetic and functional optimum, which may only occur in about 3% of the population [18, 20]. Very few attempts have been made at defining criteria for almost ideal occlusion [7]. Our finding of 14% with ideal occlusion similar to that of Thilander et al. [7] and 15% with mild occlusion of this study indicate that orthodontic treatment may be justified in more than 71% of this age group for various morphologic reasons.

Prevalence of class 2 malocclusion has typically been reported according to Angle's three original classes [24]. Accordingly, cases with molar relationship closer to half step than full step class 2 would be scored as class 2 in the previous studies and not as half step class 2, partly explaining our finding of about 6% prevalence of class 2 malocclusion (table 1) as opposed to 12–24% in previous studies [3, 7, 15, 18–22]. Similarly, we found that only slightly more than 2% have full step class 3 malocclusion as opposed to 4–9% reported in other studies [7, 15, 18–22]. However, it should be stressed that our figures represent the proportions of full class 2 and 3 in the subsample with malocclusion that allowed scoring of molar relationship. Previous studies [7, 15, 18–22] have not always been clear in this respect.

Our report on the prevalence of different types of canine relationships may be considered of greater clinical significance than molar relationship and provide more relevant information on the severity of the case since the aim of everyday clinical practice is to achieve a perfect class 1 canine relationship. The accompanying molar re-

lationship is merely a consequence of the extraction alternative. Our findings indicate that while full step class 2 and 3 malocclusions are equally prevalent in the molar and canine areas, half step class 2 may be twice as frequent in the canine area (tables 1 and 2). A shift from class 1 to half step class 2 canine relationship may occur in situations with distal eruption of the lower permanent canines following early loss of the primary canines. If so, emphasis at preventing aggravation of malocclusion caused by early loss of mandibular deciduous canines may be warranted.

In this study the 25% prevalence of posterior cross bite malocclusion is higher than what was reported in previous studies [3, 15, 19, 21], possibly due to inclusion of single-tooth deviations in our findings. Similar to a previous study [7], we found complete unilateral and bilateral cross bite only in 1.9 and 1.3%, respectively. We could confirm that deep bite occurs considerably more frequently than open bite [7, 15, 19], with proportion similar to what has been found in a previous population-based study [7]. We could also report that complete OB or deep bite with gingival contact occurs very rarely (table 3). Our findings also confirm that negative OJ [3, 7] and OJ larger than 6.0 mm [15, 21] are rare. Furthermore, we suggest that extremely large OJ of more than 9.0 mm may occur in less than 1.5% of the Kuwaiti population.

We found a higher prevalence of spacing in the maxillary (29.3%) and mandibular (13.5%) anterior segments than what has previously been reported [3, 7, 15–22]. One reason could be that we recorded prevalence of any space larger than 0.5 mm, while most others used Björk's criteria [28], reporting spaces only if larger than 2 mm [3, 7, 15–22]. Since we were able to report on predilection sites of the spacing, we also suggest that a median diastema is involved in more than 2/3 of the cases with maxillary spacing, while the majority of mandibular anterior spacing appears in other interdental areas (table 3). We could confirm previous findings [3, 7, 15, 19, 26] that malalignment is the most prevalent malocclusion trait, occurring in about 70% in either arch (table 3). However, it should be stressed that our findings reflect prevalence of incisor irregularity [27] rather than actual arch length deficiency, as reported in most studies [3, 7, 15, 19, 21]. This difference in methodology could in part explain the slightly higher figures in our sample compared to what has previously been reported, despite the fact that subjects with irregularity in the posterior segment due to mesial molar migration were excluded from our analyses. Such cases may have been included in studies using total arch length deficiency as a measure of malalignment [3, 7, 15, 19, 21].

Few previous studies have made efforts similar to ours at ensuring that their sample represents the population [7, 15]. We also avoided biases due to underrepresentation of malocclusions, since only 8 of the 63 subjects with treatment experience had to be excluded due to inability to locate initial study models. Finally, the statistical analyses demonstrated that our measures to avoid bias due to effects of untreated caries by eliminating subjects with mesial migration and loss of the first molars did not influence the prevalence of the different categories of molar relationship. Moreover, we ensured that our sample was homogeneous with respect to ethnic background by excluding non-Kuwaiti subjects. All our findings may therefore serve as a reference when planning orthodontic services in Kuwait and when comparing prevalence of different types of malocclusion traits between Kuwaitis and other ethnic groups. Some of our findings regarding malocclusion traits may be considered non-race specific, such as prevalence of almost ideal, mild and more severe malocclusion, of molar and canine relations in five half cusp categories, and of predilection sites for spacing, and therefore allow valid inferences to most populations.

Conclusions

Our findings in adolescent Kuwaitis suggest that 14% have almost ideal occlusion with an additional 15% demonstrating mild malocclusion, indicating that orthodontic treatment may be justified in the remaining 71% of each young adolescent age cohort for morphologic reasons. The most prevalent malocclusion trait was malalignment of the incisors. OJ larger than 9.0 mm, open bite, and deep bite with gingival contact are rare, as are complete anterior and posterior cross bite. Median diastema was present in about 2/3 of the cases with maxillary anterior spacing as opposed to only about 1/3 of those with mandibular spacing.

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