Orthodontic Treatment Need in Adolescent Kuwaitis: Prevalence, Severity and Manpower Requirements

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Key Words

Orthodontic treatment need · Index of Orthodontic Treatment Need · Epidemiology

Abstract

Objective: Our purpose was to determine the orthodontic treatment need in adolescent Kuwaitis, adjusting for treatment experience and acquired need due to mesial migration or loss of the first molars, and to assess the orthodontic manpower requirements. **Subjects and Methods:** A population-based sample of 753 boys and 728 girls, representing about 7% of all 13- to 14-year-old Kuwaitis, was examined in a classroom setting. Orthodontic treatment need was graded according to the Dental Health Component (DHC) and the Aesthetic Component (AC) of the Index of Orthodontic Treatment Need (IOTN). Subjects with treatment experience were scored on initial study models. The DHC and AC grades were categorized in 3 groups and aggregated to 3 IOTN groups according to the highest DHC or AC group. Group 1 was labeled as 'no need', 2 as 'moderate need', and 3 as 'definite need for orthodontic treatment'. **Results:** According to the IOTN, 31.1% of the subjects demonstrated a definite need and 40.2% no need for treatment. Excluding DHC group 3 categories attributed to mesial migration and/or loss of first molars, definite need was reduced to 23.9%. Definite treatment need was more prevalent when estimated according to the DHC than according to the AC, while moderate and no

need were more prevalent according to the AC ($p < 0.001$). No gender differences were detected ($p > 0.05$). **Conclusions:** About 30% of adolescent Kuwaitis have definite need for orthodontic treatment. The prevalence may be reduced towards 25%, provided loss or mesial migration of the first molars can be prevented. About 50–60 orthodontists are needed to meet the severe need in adolescent Kuwaitis.

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Introduction

Detailed morphologic descriptions of occlusal deviations allow racial comparisons of the prevalence of malocclusion [1] as well as an evaluation of population changes regarding occlusal morphology over time [2]. Accurate information on the prevalence of various occlusal traits may also be needed when planning of certain orthodontic services involves targeting specific types of malocclusion at specific ages [3]. However, the esthetic impairment of certain deviating dental characteristics may be associated with various levels of psychosocial disadvantage [4]. The need for orthodontic treatment may therefore be better estimated if the combined, overall severity of the observed occlusal deviations is scored according to the scale of an index that also takes the psychosocial effects of the malocclusion into account.

Table 1. Proposed hierarchical scale of occlusal anomalies for assessment of orthodontic treatment need according to the DHC of the IOTN

<i>Grade 5 (definite treatment need)</i>		<i>Grade 3 (moderate treatment need)</i>	
5.i	Impeded eruption of teeth (except for third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause	3.a	Increased overjet greater than 3.5 mm but less than or equal to 6 mm with incompetent lips
5.h	Extensive hypodontia with restorative implications (more than 1 tooth missing in any quadrant) requiring preresorative orthodontics	3.b	Reverse overjet greater than 1 mm but less than or equal to 3.5 mm
5.a	Increased overjet greater than 9 mm	3.c	Anterior or posterior crossbites with a discrepancy of more than 1 mm but less than or equal to 2 mm between retruded contact position and intercuspal position
5.m	Reverse overjet greater than 3.5 mm with reported masticatory and speech difficulties	3.d	Contact point displacements greater than 2 mm but less than or equal to 4 mm
5.p	Defects of cleft lip and palate and other craniofacial anomalies	3.e	Lateral or anterior open bite greater than 2 mm but less than or equal to 4 mm
5.s	Submerged deciduous teeth	3.f	Deep overbite complete on gingival or palatal tissues but no trauma
<i>Grade 4 (definite treatment need)</i>		<i>Grade 2 (minimal treatment need)</i>	
4.h	Less extensive hypodontia requiring preresorative orthodontics or orthodontic space closure to obviate the need for a prosthesis	2.a	Increased overjet greater than 3.5 mm but less than or equal to 6 mm with competent lips
4.a	Increased overjet greater than 6 mm but less than or equal to 9 mm	2.b	Reverse overjet greater than 3.5 mm but less than or equal to 1 mm
4.b	Reverse overjet greater than 3.5 mm with no masticatory or speech difficulties	2.c	Anterior or posterior crossbite with a discrepancy of less than or equal to 1 mm between retruded contact position and intercuspal position
4.m	Reverse overjet greater than 1 mm but less than 3.5 mm with recorded masticatory and speech difficulties	2.d	Contact point displacements greater than 1 mm but less than or equal to 2 mm
4.c	Anterior or posterior crossbite with a discrepancy of more than 2 mm between retruded contact position and intercuspal position	2.e	Anterior or posterior open bite greater than 1 mm but less than or equal to 2 mm
4.l	Posterior lingual crossbite with no functional occlusal contact in 1 or both buccal segments	2.f	Increased overbite greater than or equal to 3.5 mm without gingival contact
4.d	Severe contact point displacements greater than 4 mm	2.g	Prenormal or postnormal occlusions with no other anomalies (includes up to half a unit of discrepancy)
4.e	Extreme lateral or anterior open bite greater than 4 mm	<i>Grade 1 (no treatment need)</i>	
4.f	Increased and complete overbite with gingival or palatal trauma	1	Extremely minor malocclusion including contact point displacements of less than 1 mm
4.t	Partially erupted teeth, tipped and impacted against adjacent teeth		
4.x	Presence of supernumerary teeth		

The orthodontic profession has established several indices for objective assessment of treatment need [5–8]. Some allocate weighting factors to occlusal traits to arrive at an overall figure representing a score of severity and, by inference, treatment priority [5]. Others rank the severity of the malocclusion according to an established list of conditions or traits in categories thought to denote increasing need for treatment [6–8]. The purpose has been to establish a screening tool for determining access to publicly funded orthodontic services. The Index of Orthodontic Treatment Need (IOTN) ranks the malocclusion according to the perceived significance of various occlusal deviations for dental health and psychosocial

wellbeing [7]. The Dental Health Component (DHC) of the IOTN is based on the recommendations of the Swedish Medical Board [6], and is supposed to reflect current evidence for adverse effects of malocclusion and benefits of orthodontic correction through placement of occlusal traits thought to be of functional significance in 5 grades according to severity, with clear cutoff points between the grades (table 1). The majority of the measurements is qualitative and recorded by use of a specially designed ruler (fig. 1). The Aesthetic Component (AC) is a proposed scale of 10 intraoral color photographs (fig. 2), developed to illustrate ascending levels of esthetic impairment [9]. The IOTN has been validated against a cross-

Fig. 1. Proposed ruler for assessment of orthodontic treatment need according to the DHC of the IOTN. i = Incompetent lip; c = competent lip; CLP = cleft lip and palate; OB = overbite; G = gingival; P = palatal; Dev. = deviation; interdig = interdigitation.

0	3	4	5	5 Defect of CLP 5 Noneruption of teeth 5 Extensive hypodontia 4 Less extensive hypodontia 4 Crossbite >2 mm discrepancy 4 Scissors bite 4 OB with G + P trauma	3 OB with no G + P trauma 3 Crossbite 1–2 mm discrepancy 2 OB > — 2 Dev. from full interdig 2 Crossbite <1 mm discrepancy	DISPLACEMENT OPEN BITE V 4 3 2 1
2	i	2	c			
3			4			
4			ms - 5			

IOTN © VICTORIA UNIVERSITY OF MANCHESTER

section of professional opinion and has been proven reliable within as well as between examiners [7, 10, 11]. As a consequence, the IOTN is widely used for epidemiologic purposes as well [7, 12–18].

There is agreement that the objective need for orthodontic treatment is higher when determined according to dental health criteria than according to esthetic criteria [7, 12, 14, 16–18]. The obvious explanation is that several dental health criteria qualifying for DHC grades 4 and 5, such as impeded or partial eruption of posterior teeth, submerged deciduous molars, missing posterior teeth, some types of transverse discrepancies, and some types of tooth impaction (table 1), have minimal esthetic impact. Overjet larger than 6 mm and overbite with palatal impingement (table 1) may also be assigned AC grades less than 8, provided the incisors are well aligned (fig. 2).

No gender differences have been detected in normative orthodontic treatment need [17]. However, the combined prevalence of DHC grades 4 and 5 has been found to be less than 20% in Nigerian adolescents [18], to vary closely around 30% in white European and Jordanian adolescents [7, 12, 13, 15, 16], to be about 40% in Turkish and Senegalese adolescents [17], and to approach 50% in Malaysian adolescents [14]. These findings may suggest racial differences in treatment need. Another possibility is population differences in acquired need caused by adverse effects of premature extraction of deciduous molars. About 10% of the Malaysian adolescents had DHC grade 5 due to impeded tooth eruption [14], which may very well be a consequence of mesial molar migration. Although some studies have reported on the prevalence of the various initiating occlusal features for each DHC grade [14, 15, 17], very few attempts have been made at analyzing the effect of mesial migration and loss of the first molars on the need for orthodontic treatment. The reported population differences may also be attributed to variations in treatment rate. Very few studies have examined initial study models of subjects with treatment experience [7]. Exclusion [12] as well as inclusion based on current occlusal examination of subjects with treatment experience will underestimate the need [13].

Fig. 2. Proposed scale of 10 intraoral color photographs for assessment of orthodontic treatment need according to the AC of the IOTN. 1–5 = No treatment; 6–10 = treatment.

Dental health may be defined not only as absence of dental disease, but also as the ability to smile and interact without embarrassment [19]. Individual differences in tolerance level for deviations in tooth alignment may therefore explain why about 10% of adolescent orthodontic patients have minimal normative need, while about 50% of those with definite need remain untreated [20]. Older studies conclude that females [21] and subjects from families of higher socioeconomic status [22] are overrepresented among adolescent orthodontic patients. However, such inequalities are rarely present in more recent studies [20, 23], possibly due to improved availability and financing of the orthodontic services. Indeed, a

recent, well-designed and controlled study failed to detect any predictive effect of sociodental measures and gender on treatment uptake, provided the available orthodontic services were sufficient [20]. Planning of orthodontic manpower requirements in publicly funded healthcare systems should therefore be based on the prevalence of treatment need according to objective criteria.

The purpose of our study was to determine the prevalence and severity of normative orthodontic treatment need among adolescent Kuwaitis, adjusting for treatment experience and acquired need due mesial migration or loss of the first molars, and to calculate the necessary manpower requirements to meet the need.

Subjects and Methods

Subjects

The subjects were selected from 13- to 14-year-old school children in Kuwait following approval by the Ethics Committee of the Faculty of Dentistry, Kuwait University. A stratified cluster sampling method was utilized [24], defining the students in the government schools of each of the 6 administrative areas of Kuwait as 6 different strata, and the students of private schools as the 7th stratum. The schools (clusters) from each stratum as well as the classes from each school were randomly selected, and the number of students to be examined from each stratum was estimated according to proportions. A total of 1,583 subjects (788 boys and 795 girls) with a mean age of 13.24 ± 0.42 years were examined, representing about 7% of the target population. Subjects without Kuwaiti nationality ($n = 96$) and Kuwaitis with treatment experience without availability of initial study models ($n = 6$) were not included in the statistical analyses. Hence, data from 1,481 subjects (753 boys and 728 girls) were analyzed.

Data Collection

Permission was obtained from the Research Department of the Kuwaiti Ministry of Education to perform the examinations during school hours. A well-lit room was provided by the school principal, and the students were informed about their rights to participate.

Interviews

Information on nationality and treatment history was recorded prior to the clinical examinations by a trained assistant and verified through phone interviews with the parents. Orthodontic treatment experience was recorded as present if active treatment was in progress or if completion could be confirmed, either with fixed or removable appliances. Space maintenance was not recorded as orthodontic treatment.

Clinical Examinations

The clinical examinations were performed by 4 calibrated orthodontists using gloves, mirrors and spatulas. Treatment need was graded according to the morphologic criteria of the DHC and the esthetic criteria of the AC of the IOTN [7]. The DHC was graded in 5 categories, with grade 1 indicating no need and grade

5 the most definite need, using the IOTN ruler (fig. 1), and following the proposed hierarchical scale when identifying the worst occlusal feature (table 1) [7]. The AC was graded in 10 categories, with grade 1 indicating no need and grade 10 the most definite need, with reference to the proposed scale of 10 intraoral color photographs showing different levels of dental attractiveness (fig. 2) [7]. Mesial tipping and/or rotation of maxillary first molars, and mesial tipping of mandibular first molars concomitant with reduced space mesial to the first molar in question was scored as mesial migration. Missing first molars were also recorded. The proposed dental cast protocol for use in the absence of clinical information [7] was followed when examining study models of subjects with orthodontic treatment experience.

Method Error

Two sets of calibrations were performed under conditions identical to the clinical examinations to follow. At the first set, each examiner evaluated the same 40 subjects. Following a comparison of the scores and adjustments of the criteria, another 40 subjects were examined twice about 2 weeks apart by all 4 examiners. Intra- and interclass correlation analyses were performed between the first and second scores for each examiner as well as among the 4 scores of the examiners at each of the 2 examinations. The mean intraclass correlation coefficient between the first and second scores of all examiners was 0.87 for the DHC, 0.90 for the AC, and ranged from 0.75 to 0.99 for the scores of the 4 first molars. The respective coefficients among the 4 examiners were 0.86, 0.74, and ranged from 0.92 to 0.99.

Data Analysis

The DHC grades were categorized into 3 groups, with group 1 comprising grades 1 and 2, group 2 comprising grade 3, and group 3 comprising grades 4 and 5. The AC grades were similarly categorized, with grades 1–4 constituting group 1, grades 5–7 constituting group 2, and grades 8–10 constituting group 3. The IOTN was categorized as group 1 if both DHC and AC groups were 1, as 2 if either or both DHC and AC groups were 2 and none was 3, and as 3 if either or both DHC and AC groups were 3. IOTN group 1 was labeled as 'no need', group 2 as 'moderate need', and group 3 as 'definite need for orthodontic treatment' [7]. The individual DHC and AC groups were labeled accordingly. Descriptive statistics were made regarding the prevalence of DHC, AC and IOTN groups 1–3 as well as for the distribution of the initiating occlusal feature for each DHC grade. χ^2 tests were applied to test the differences. Finally, the number of subjects with mesial migration and/or loss of first molars was calculated. In this subgroup, the number of subjects with DHC grade 5.i or 4.t, with DHC grade 5.h or 4.h, and with DHC grade 4.d (table 1) was calculated.

Results

Treatment Need

A total of 31.1% of the subjects presented with definite need, while 40.2% had no need for treatment according to IOTN (table 2). The vast majority of the occlusal features initiating DHC grade 5 were impeded eruption (77.4%) and overjet of >9 mm (17.4%), while the majority

Table 2. Frequency of treatment need according to the DHC, AC and the combined DHC and AC (IOTN) in a population-based sample of 13- to 14-year-old Kuwaiti students (n = 1,481)

	No need		Moderate need		Definite need	
	n	%	n	%	n	%
DHC	732	49.4	316	21.3	433	29.3
AC	856	57.8	434	29.3	191	12.9
IOTN	595	40.2	425	28.7	461	31.1

No differences were detected among governorates or between genders ($p > 0.05$).

Table 3. Distribution of DHC grades according to initiating occlusal feature in a population-based sample of 13- to 14-year-old Kuwaiti students (n = 1,481)

DHC grade	Percent of DHC grade	Percent of sample
5.i	77.4	6.0
5.h	3.5	0.3
5.a	17.4	1.3
5.m	0.9	0.1
5.p	0.9	0.1
Subtotal		7.8
4.h	11.9	2.6
4.a	22.0	4.7
4.b	0.3	0.1
4.m	1.3	0.3
4.c	8.8	1.9
4.d	49.4	10.6
4.e	2.5	0.5
4.t	3.1	0.7
4.x	0.6	0.1
Subtotal		21.5
3.a	12.0	2.6
3.b	1.9	0.4
3.c	5.1	1.1
3.d	77.2	16.5
3.e	2.5	0.5
3.f	0.6	0.1
3.f	0.6	0.1
Subtotal		21.3
2.a	31.9	13.7
2.b	0.2	0.1
2.c	20.1	8.6
2.d	28.8	12.4
2.e	0.5	0.2
2.f	6.3	2.7
2.g	12.1	5.2
Subtotal		42.9
1	100.0	6.5

of the worst occlusal features associated with DHC grade 4 were need for preprosthetic orthodontics (11.9%), overjet of >6 but <9 mm (22.0%), and a contact point discrepancy of >4 mm (49.4%). Almost 90% of the qualifiers for DHC grade 3 were overjet and contact point discrepancy (table 3).

Definite treatment need was more frequent when estimated according to the DHC than according to the AC, while moderate and no need for treatment were more frequent according to the AC ($p < 0.001$) (table 2). As a result, the frequency of definite need was similar according to the IOTN and DHC, and the frequency of moderate need similar according to the IOTN and AC ($p > 0.05$). The frequency of no need was lower according to the IOTN than according to both the DHC and AC ($p < 0.001$). The DHC, AC and IOTN groups were similar across genders and governorates ($p > 0.05$).

Effect of Mesial Migration and/or Loss of First Molars

A total of 180 subjects demonstrated mesial migration and/or loss of 1 or more first molars. Of those subjects, 59 (32.8%) had DHC grade 5.i or 4.t, 24 (13.3%) DHC grade 5.h or 4.h, and 24 (13.3%) DHC grade 4.d. The combined 107 subjects represented 24.7% of the subjects in DHC group 3 and 23.2% of the subjects in IOTN group 3. Hence, 23.9% of the subjects were categorized as IOTN group 3 without DHC grades that could be attributed to mesial migration and/or loss of first molars.

Manpower Requirements

A population prevalence of about 30% of IOTN group 3 (table 2) suggests that about 6,000 of each birth cohort of about 20,000 Kuwaitis will have a definite need for orthodontic treatment. The figure may be reduced to about 25% or about 5,000, provided mesial migration and loss of first molars can be prevented. With an averaged capacity per orthodontic care provider to accept 100 new cases per year, the Ministry of Health must therefore employ 50–60 orthodontists to meet the definite need for orthodontic treatment at adolescence. The number must be increased to about 120 to meet also the moderate need for orthodontic treatment (table 1).

Discussion

Few epidemiologic studies have calculated the composite IOTN group, but our finding that about 30% of adolescent Kuwaitis have definite orthodontic treatment need according to the IOTN is similar to findings in a

population in the UK [12] with similar access to free primary dental care. Definite treatment need according to the morphologic criteria of the DHC component alone will necessarily be slightly lower since subjects with definite esthetic need and no morphologic need are excluded (table 2). Definite need according to the DHC was similar in this adolescent Arab population to what has been reported in other Arab populations [15, 16] and in European populations [7, 12, 13] with access to primary dental care.

In keeping with studies that have tested for effects of gender [17], we could not detect any gender differences in morphologic treatment need. Very few previous studies have accounted for treatment experience when estimating treatment need [7]. Our careful sampling procedures, combined with the fact that only 6 of the subjects with treatment experience were eliminated due to lack of initial study models, are likely indicators that our findings are valid representations of orthodontic treatment need in adolescent Kuwaitis.

We could confirm previous findings [12, 14, 15, 17] that a high proportion of DHC grades 4 and 5 are due to impeded and partial tooth eruption and a contact point discrepancy larger than 4 mm (table 3). Such deviations are not likely to have any esthetic impact, provided the discrepancies are limited to the posterior segments. We could also confirm that increased overjet ranging from 6 to 9 mm, which may not represent an esthetic problem provided the maxillary incisors are aligned, is a major reason for DHC grade 4 [14, 15, 17] (table 3). It may therefore not be unexpected that we could support studies concluding that definite treatment need is higher when judged according to morphologic criteria as opposed to when only esthetic criteria are considered [7, 12, 14, 16–18].

It is well established that premature loss of deciduous molars is associated with mesial migration of the first molars unless the extraction space is maintained [25]. The consequence is likely to be impeded or ectopic eruption of the last erupting tooth in the affected quadrant. Inferences from existing knowledge on normal dental eruption sequence suggest that the tooth most likely affected will be the second premolar in the mandible and either the second premolar or canine in the maxilla. Impeded eruption is scored as 5.i and partial eruption with impaction against adjacent teeth as 4.t. Since eruption disturbances override other morphologic criteria, a portion of the 6% with DHC grade 5.i could otherwise qualify for DHC grade 4 or 5 due to overjet larger than 6 mm (table 3). A portion of the 0.7% with DHC grade 4.t could

similarly qualify for DHC grade 4 due to overjet ranging from 6 to 9 mm (table 3). However, those among the 10.6% with DHC grade 4.d (table 3) due to ectopic premolar or canine eruption as a consequence of mesial molar migration would not qualify for DHC grade 4 unless similar contact point discrepancies were present for regular reasons as well.

It is also well established that first molar loss in the mixed or early permanent dentition is associated with migration of adjacent teeth and supraeruption of opposing teeth. The consequence may be a need for preresortative orthodontic treatment or orthodontic space closure to stabilize the occlusion. A portion of the 2.9% of the adolescents in our sample with DHC grades 5.h and 4.h (table 3) may be in that category. However, for the reasons discussed above, some of those subjects might have qualified for DHC grade 4 or 5 due to increased overjet.

A total of 107 subjects, or about 7% of our total sample, were scored according to DHC grades that in theory could be attributed to adverse effects of premature tooth losses. However, inferences from previous findings on the prevalence of malocclusion among Kuwaitis [1] suggest that about 7% of the 83 of those subjects with DHC grades 5.i, 4.t, 5.h or 4.h would qualify for definite treatment need due to increased overjet. The number of the 24 of those subjects that would qualify for DHC grade 4.d for reasons not contributing to mesial molar migration can only be speculated upon. However, it may be reasonable to assume that the definite need for orthodontic treatment in adolescent Kuwaitis may be reduced downwards to about 25%, provided extractions of first permanent molars and premature extractions of deciduous molars can be avoided.

Conclusions

Societies offering free orthodontic care have an obligation to ensure that the resources are fairly distributed, giving priority to subjects with definite treatment need according to well-defined, objective criteria [13, 20]. A population prevalence of about 30% (table 1) indicates that about 6,000 of each birth cohort of about 20,000 Kuwaitis will have a definite need for orthodontic treatment. However, the figure may be reduced towards 25% or about 5,000 of each birth cohort, provided acquired need due to mesial migration and loss of the first molars can be prevented. With an averaged capacity per care provider to accept 100 new cases annually, the Ministry of

Health in Kuwait must therefore employ 50–60 orthodontists to meet the definite need for orthodontic treatment at the appropriate age. The number must be increased to about 120 if the political aim is also to meet the moderate need for orthodontic treatment.

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