Residual Need for Early Orthodontic Treatment and Orthodontic Treatment Experience among 13- to 14-Year-Old School Children in Kuwait

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Key Words

Residual orthodontic treatment need · Early orthodontic treatment, experience

Abstract

Objective: Our purpose was to determine the residual need for early orthodontic treatment and the parameters associated with orthodontic treatment experience in 13- to 14-year-old school children in Kuwait. **Subjects and Methods:** A total of 788 boys and 795 girls, representing about 6.7% of the target population, were selected according to cluster sampling methods. Information on nationality, family income and orthodontic treatment experience was collected through subject and family interviews. The occlusal morphology was recorded in a well-lit classroom or from initial study models of subjects with orthodontic treatment experience. **Results:** Only 6.7% of the 225 subjects with early treatment need, defined as overjet ≥ 6.5 mm, and functional posterior and anterior crossbite on 1 or more teeth, had treatment experience. Residual need for early treatment was present in 13.4% of the subjects. Only 26.8% of the subjects with treatment experience met our criteria for early treatment need. The odds of treatment experience were higher in the subjects attending private schools ($p < 0.05$), in those from fami-

lies with an income of KWD $>2,000$ (USD 6,600; $p < 0.01$) and in subjects meeting the criteria for early treatment need ($p < 0.01$). **Conclusions:** About 15% of each birth cohort of school children in Kuwait need early orthodontic treatment. Less than 10% of those with a need have treatment experience at 13–14 years of age, and about 75% of those with treatment experience at that age do not need early treatment. The predictors for treatment experience at 13–14 years of age are private-school attendance, a high family income and need for early treatment.

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Introduction

Residual orthodontic treatment need is defined as any need that should have been met at an earlier age under ideal conditions [1, 2]. The optimal timing of the majority of comprehensive orthodontic treatments is a 1-phase intervention in the early permanent dentition, thereby avoiding prolonged appliance wear caused merely by the incomplete eruption of premolars and canines, and reducing the potential for patient burnout [3]. At that stage any compensatory increases in the anterior segment of the dental arch have been expressed [4, 5], facilitating an appropriate extraction decision, and enough growth re-

Fig. 1. Profile photos and lateral cephalograms of a patient with severe lip incompetence due to 11 mm OJ prior to treatment (**a** and **b**), and improved lip relationship after 12 months with cervical headgear and functional appliance (**c** and **d**). Note the traumatic injury to the maxillary left central incisor before treatment.

mains for successful results of growth modification strategies [6, 7]. Accordingly, any remaining need in late adolescence that does not merit surgical intervention may be considered residual [1, 2]. Similarly, the prevalence of malocclusions in the early permanent dentition that should have been treated at earlier dental stages to reduce the potential for unfavorable development or irreversible damage may be classified as residual need for early treatment.

The effectiveness of an early Class II treatment phase is well established, resulting in major dentoalveolar changes and relatively minor improvements in the skeletal relationships [8–11]. However, a second treatment phase is typically needed in the early permanent dentition to achieve optimal morphologic results [6, 7]. Comparing the final outcome of matched Class II patient groups who have received 1- or 2-phase treatment in the early perma-

nent dentition, respectively, shows that the additional early phase has no effect [6, 7]. Neither does it reduce the proportion of complex treatments involving extractions or orthognathic surgery [6, 7]. The only difference is a longer treatment time in the 2-phase group, making an early start less efficient and more costly [6, 7]. However, the odds of traumatic injuries to the maxillary incisors in young children are significantly increased if the overjet (OJ) is ≥ 6.5 mm [12–14]. In addition, an OJ of ≥ 7 mm has been associated with school children's reports of being teased [15]. Although inefficient, the early treatment of Class II malocclusion may therefore be justified for preventive reasons in subjects with a large OJ, provided that the aim of the first phase is limited to reducing the OJ to ≤ 6 mm, which may frequently be achieved during a relatively short treatment period through retroclination of the maxillary incisors (fig. 1b, d).

Fig. 2. Study models, tomograms of left temporomandibular joint and facial photos of a patient with unilateral posterior crossbite (a), distraction of left condyle (b) and facial asymmetry (c) in centric occlusion before treatment, and symmetric occlusion (d), normal condylar position (e) and improved facial symmetry (f) in centric occlusion after maxillary expansion.

Unilateral posterior crossbite is one of the most frequent malocclusions in the deciduous and mixed dentitions [16, 17], and is associated with a functional shift in about 80% of the cases [17, 18]. As a result, an asymmetric condylar position has been documented in the maximum intercuspation, with distraction of the non-crossbite-side condyle [19, 20]. Early correction through maxillary expansion will eliminate the occlusal interferences and deviation of the mandible on closure (fig. 2a, d), resulting in a more symmetric condylar position after treatment (fig. 2b, e), and may also improve facial symmetry (fig. 2c, f) [20]. The fact that unilateral posterior crossbite is rarely associated with a functional shift in adults [21] may indicate a potential for adaptive remodeling changes of the temporomandibular joint with age and the development of a skeletal asymmetry [21, 22]. In addition, untreated unilateral crossbite may be associated with an increased risk of temporomandibular disorders [23] and a reduced bite force [24]. Typically, functional posterior crossbite can be corrected in the mixed dentition with maxillary expansion in <4 months, followed by a similar

period of retention [20], with a high chance of posttreatment stability [25]. Early treatment of functional posterior crossbite may therefore not only be effective, but also efficient and preventive.

Patients with anterior crossbite concomitant with a functional anterior shift (fig. 3a) may experience severe attrition of the incisal edges and the incisal aspects of the labial surfaces of the maxillary incisors (fig. 3b). In addition, the anterior displacement of the condyles during function may be a predisposing factor for temporomandibular disorders [26]. Early correction can eliminate the shift during a period of about 8 months through labial expansion of the maxillary incisors [27]. The high success rate of such treatment at the 5-year follow-up [28] may therefore suggest that early treatment of pseudo-class III malocclusion is effective, efficient and preventive.

Kuwait has offered free orthodontic care to its citizens in the last few decades. The prevalence of residual treatment need in this society reflects the effectiveness of the service system to identify malocclusions in time and to provide treatments accordingly. Although a pilot study

Fig. 3. Pretreatment intraoral photos of a patient in centric occlusion (a) and centric relation (b) with abrasion of maxillary incisors.

suggests that the treatment experience among Kuwaiti 8th-grade students is low [29], no information regarding the prevalence and type of early treatment is available. The purpose of this study was therefore to establish the residual need for early orthodontic treatment, defined as $OJ \geq 6.5$ mm, and functional posterior and anterior crossbite on 1 or more teeth, in 13- to 14-year-old school children in Kuwait and to determine variables of significance for the decision to initiate treatment prior to that age.

Subjects and Methods

Subjects

The subjects were selected from 13- to 14-year-old school children in Kuwait according to a stratified cluster sampling method [30], 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. The schools (clusters) from each stratum as well as the classes from each school were randomly se-

lected, 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) of a mean age of 13.24 ± 0.42 years were examined, representing about 6.7% of the target population.

Data Collection

Interviews. Information on nationality and treatment history was recorded prior to the clinical examinations. Nationality was recorded as Kuwaiti, Beidoon or other non-Kuwaiti. Orthodontic treatment experience was recorded as present if active treatment was in progress, or if completion could be confirmed, with either fixed or removable appliances. Space maintenance was not recorded as orthodontic treatment. Information on total family income was collected through phone interviews with the parents and recorded as KWD <500 (USD 1,650), KWD 501–1,000 (USD 1,653–3,300), KWD 1,001–2,000 (USD 3,303–6,600) and KWD $\geq 2,001$ (USD 6,603) per month.

Clinical Examinations. Permission to perform the clinical examinations during school hours was obtained from the Research Department Ministry of Education, Kuwait. A well-lit room was provided by the school principal, and the students were informed about their rights to participate. All interarch parameters were scored with the teeth in maximum intercuspal position, using gloves, mirrors and spatulas. The 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. Functional posterior crossbite was scored as present if a unilateral posterior crossbite was observed on 1 or more teeth in centric occlusion (CO) and a lateral mandibular shift was detected from centric relation (CR) to CO. Similarly, functional anterior crossbite was scored as present if an anterior crossbite was observed on 1 or more incisors in CO and an anterior mandibular shift was detected from CR to CO.

Measurements on Study Models. The subjects with treatment experience were evaluated from initial study models in CO position. OJ was measured as above. A unilateral posterior crossbite was scored as functional in situations with midline deviation and minimal arch asymmetry. An anterior crossbite was scored as functional if the labial and lingual surfaces of the respective incisors were in contact.

Method Error

Two sets of calibrations were performed under conditions identical to the clinical examinations that followed. In the first set each examiner investigated the same 40 subjects. Following comparison of the scores and adjustments of the criteria, another 40 subjects were seen 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 visits. The mean intraclass correlation coefficient between the first and second scores of all the examiners was 0.96 for OJ, 0.80 for posterior crossbite and 0.90 for anterior crossbite. The respective coefficients among the 4 examiners were 0.97, 0.94 and 0.97.

Data Analysis

The number of subjects with treatment experience was calculated for the whole sample as well as by gender, nationality, area and family income. The number of subjects with need for early

Fig. 4. Prevalence of treatment experience by area.

treatment (defined as presence of OJ >6.5 mm, functional posterior and/or anterior crossbite) was calculated. Also, the number of subjects with residual need for early treatment (defined as need for early treatment without treatment experience) was determined. A χ^2 analysis was performed to test the effect of gender, nationality, area, family income and defined the need for early treatment on treatment experience. Finally, stepwise multiple logistic regressions were employed to develop a prediction model for treatment experience. The variables were successively entered into the model if their effects were significant at $p < 0.05$. At each step the variable with the lowest p value was included. Previously entered variables were excluded if their effects were no longer significant ($p > 0.05$) upon inclusion of a new variable. The final model was determined when no remaining variables had a significant effect ($p > 0.05$).

Results

Treatment Experience

Only 4.2% of the 1,583 subjects had treatment experience. While treatment experience was higher ($p < 0.05$) in girls (5.3%) than in boys (3.0%), no difference was detected between the 1,487 Kuwaitis (4.2%) and 96 non-Kuwaitis (3.2%) in the sample ($p > 0.05$). The 180 subjects attending private schools had experienced treatment more often than the 1,403 subjects attending government schools in the 6 different administrative areas ($p < 0.001$, fig. 4). Similarly, treatment experience was higher in the 215 subjects from families of the highest income group

Fig. 5. Prevalence of treatment experience by family income.

than in the 1,368 subjects from families of the remaining income groups ($p < 0.001$, fig. 5).

Early Treatment Need

Initial study models of 10 subjects with treatment experience were not identified, and 1 additional subject was not scored due to human error. Of the remaining

Table 1. Early treatment need in a population-based sample of 1,583 13- to 14-year-old Kuwaiti school children with and without orthodontic treatment experience

	Treatment experience		No treatment experience		Total	
	n	%	n	%	n	%
Early treatment need	15	26.8	210	13.9	225	14.3
No early treatment need	41	73.2	1,306	86.1	1,347	85.7
Total	56	100	1,516	100	1,572	100

11 subjects were not scored, 1 without treatment experience due to human error and 10 with treatment experience due to unsuccessful location of initial study models.

Table 2. Frequency of early treatment need according to category in a population-based sample of 1,583 13- to 14-year-old Kuwaiti residents with and without orthodontic treatment experience

	Treatment experience		No treatment experience		p value
	n	%	n	%	
Posterior crossbite	4	7.1	46	3.0	<0.05
Anterior crossbite	7	12.5	63	4.2	<0.05
Overjet $\pm$ 6.5 mm	4	7.1	101	6.7	>0.05

11 subjects were not scored.

Table 3. Variables with a significant effect on treatment experience in a population-based sample of 1,583 13- to 14-year-old Kuwaiti residents

Variable	Effect ¹	Significance	Odds ratio ²
Area	0.15 (0.08)	p < 0.05	1.16 (1.00–1.35)
Income	0.61 (0.20)	p < 0.01	1.84 (1.25–2.69)
Early treatment need	0.82 (0.32)	p < 0.01	2.27 (1.22–4.23)

¹ The figures in parentheses represent SE.

² The figures in parentheses represent the confidence interval.

1,572 subjects the need for early treatment was identified in 225 (14.3%, table 1). Only 15 (6.7%) of the 225 subjects had treatment experience, resulting in a residual treatment need in 210 (13.4%) of the 1,572 subjects (table 1). Of the 56 subjects with treatment experience a majority, 41 (73.2%), had no need for early treatment. However, the frequency of early treatment need was higher ($p < 0.01$) among the subjects with treatment ex-

perience (26.8%) than among those without (13.9%, table 1). While the frequency of $OJ \geq 6.5$ mm was similar among the subjects with and without treatment experience, functional anterior and posterior crossbite occurred more often in the subjects with treatment experience ($p < 0.05$, table 2).

Predictors of Treatment Experience

The chance of treatment experience was 16% higher for the subjects in the private than for those in the government schools and 84% higher for the subjects from families of the highest income group than for those from the remaining income groups. The odds of treatment experience were 2.27 times higher in the subjects with a presence of 1 or more of the 3 defined categories of early treatment need than for those without early treatment need (table 3).

Discussion

Unfavorable occlusal changes following premature loss of deciduous molars and extraction of first molars may be considered iatrogenic and vary according to the public administration of the preventive and therapeutic dental care programs rather than representing genuine orthodontic problems. We therefore decided to define neither impeded eruption of premolars due to mesial migration of first molars, nor tipping and rotations of molars and premolars into extraction spaces as residual orthodontic treatment need. We were unable to determine whether the early loss of deciduous second molars was due to ectopic eruption of the first molars or to caries. The lack of radiographic examination also precluded a diagnosis of supernumerary or congenitally missing teeth and tooth impactions. However, appropriate early care for the majority of such cases only includes consultation, moni-

Fig. 6. Mandibular occlusal photos before treatment (a), after initial alignment (b) and at the end of treatment (c) of patients with ectopic eruption of tooth No. 32.

toring and occasional surgical intervention. The need for active orthodontic intervention may be limited to subjects with ectopically erupting first molars or incisors (fig. 6) with a minimal potential for self-alignment. Information on the prevalence of different types of dental

anomalies in the Kuwaiti population is limited. However, inferences from other populations [31, 32] suggest that <4% may need early orthodontic intervention for such reasons.

Our finding that <7% of the subjects with a defined need for early treatment had received some orthodontic intervention prior to 13–14 years of age, resulting in a residual need for early treatment of >13% of that age cohort, may be a concern, since orthodontic intervention is part of the public dental care program for Kuwaiti citizens. One obvious reason may be that the current employment of about 20 orthodontists by the Ministry of Health prohibits optimal orthodontic care for every annual birth cohort of >15,000 Kuwaitis, since about 70% have a moderate to severe malocclusion [33]. However, part of the problem may be due to insufficient planning by the health administration and a lack of awareness by the primary dental work force. Orthodontic screening according to well-defined criteria of predetermined age groups during regular examinations in the various dental clinics, followed by information for the parents, may improve the situation.

The overrepresentation of girls among orthodontic patients of this study is similar to a previous report [1]. Of the current orthodontic work force in Kuwait, about 6 are in private practice. Our findings that treatment experience was higher among subjects from families of the highest income level as well as among subjects attending private schools may therefore suggest an association between socioeconomic status and uptake of orthodontic treatment when both free and self-financed orthodontic services are available. While similar findings have been demonstrated in societies with consumer-financed orthodontic health care systems [34], the association is less clear if treatment is available at no cost [35, 36]. In societies with publicly funded orthodontic services other factors, such as the dental visit pattern of subject and mother, general dental health and peer group experiences, may be more important [35, 36]. The exclusion of gender in the final prediction model (table 3) suggests a collinearity between female gender and 1 or more of the 3 remaining independent variables in our sample. Contrary to findings from a recent pilot study [29], we could not demonstrate any difference in treatment rate between public-school students from the urban capital area and the more rural area of Jahra. One reason may be an overrepresentation of Beidoons, who are likely to be of low socioeconomic status, among the students from Jahra in the sample of the pilot study [29].

Only Kuwaiti citizens are eligible under the current regulations for free orthodontic care in the respective government clinics. The remaining population is limited to exploring different self-financed, private treatment options. However, the proportion of Kuwaitis was similar among the students attending private and government schools ($p > 0.05$) as well as among students from families of the highest and the three remaining income groups ($p > 0.05$). An over-representation of Kuwaitis would have reduced the confidence in our finding that private school attendance and high family income are predictors of early treatment experience.

Our data indicate an association between defined need for early treatment and treatment experience in our sample, primarily due to a higher proportion of 1 or more teeth in functional anterior and/or posterior crossbite (table 2). We did not collect information on whether treatment was due to the subject's own initiative, parental concern or referral by the primary dentist. However, the higher proportion of functional anterior crossbite among the treated subjects may reflect a subjective desire for alignment of displaced maxillary inci-

sors, since partial anterior crossbite is typically associated with severe tooth malalignment. Another possibility is the awareness of some general dentists regarding potential functional problems associated with functional shifts.

Conclusions

At least 15% of each birth cohort of Kuwaiti school children need early orthodontic treatment. Less than 10% of such children have treatment experience at 13–14 years of age, and about 75% of those with treatment experience at that age may not have need for early treatment. Predictors for treatment experience at 13–14 years of age are private-school attendance, high family income and need for early treatment.

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