European Journal of Orthodontics 29 (2007) 79–87
doi:10.1093/ejo/cjl054

Malocclusion frequency in Swedish and immigrant adolescents—influence of origin on orthodontic treatment need

Eva Josefsson, Krister Bjerklin and Rune Lindsten
Department of Orthodontics, The Institute for Postgraduate Dental Education, Jönköping, Sweden

SUMMARY Sweden has become increasingly multicultural. In the year 2000, almost 25 per cent of the child and adolescent population was of foreign origin. Such a major change in demographics may lead to altered orthodontic treatment need in the community, with implications for planning appropriate levels of orthodontic resources. The aim of this study was to compare the frequency of malocclusion and orthodontic treatment need in 12- and 13-year olds of Swedish and immigrant background. The subjects, $n = 493$, were stratified into four groups according to family origin: (A) subject and both parents born in Sweden, and subject or at least one parent born in (B) Eastern Europe, (C) Asia, or (D) other countries. Registrations were based on available radiographs, patient records, and a clinical examination. Normative treatment need was based on a number of variables. Treatment need was expressed according to the dental health component (DHC) and aesthetic component (AC) of the Index of Orthodontic Treatment Need (IOTN).

Group A exhibited the greatest space deficiencies and irregularities in the maxillary and mandibular anterior segments and also the greatest overjet. More primary molars had been extracted in groups B and C, with a positive correlation between early extraction of primary molars and retention of permanent successors. Self-assessed orthodontic treatment need, IOTN-AC, was highest in group A. For all four groups, the orthodontist's estimate of treatment need was significantly higher than the subjects' self-assessed need.

This study confirms that, despite the change in demographics, variations in frequencies of malocclusion and treatment need among children of different cultural background are only minor and the overall orthodontic treatment need remains unchanged.

Introduction

In Sweden, orthodontic treatment is provided under the auspices of the public dental services, as part of the comprehensive provision of dental care for children and adolescents up to the age of 19 years. The prevalence of malocclusion in this population is an important determinant in planning appropriate levels of orthodontic services.

During the last two decades, there has been a large influx of refugees and immigrants into Sweden. Data show that in the year 2000 approximately 25 per cent of children and adolescents were of non-Swedish origin (Statistics Sweden, 2001). A demographic change of this magnitude may influence the frequency of malocclusions and orthodontic treatment need, two factors with major implications for planning of orthodontic services.

Occlusal characteristics and the prevalence of occlusal anomalies vary in different populations and ethnic groups, and differences have been found especially with regard to the sagittal relationship of the dental arches and crowding (Kerosuo *et al.*, 1991).

In most countries, the demand for orthodontic treatment is increasing. In this context, the importance of self-perceived orthodontic treatment need should not be underestimated. Several studies have investigated the relationship between normative orthodontic treatment need, measured by a clinician, and the more subjective patient perception of malocclusion (Mandall *et al.*, 2000; Hamdan, 2004) and found that perceived orthodontic treatment need also varies in ethnic groups. In a study of Swedish and immigrant 12- and 13-year olds, on average, 20 per cent had a self-perceived need for treatment. This was more frequent among the Swedish children than those of an immigrant background (Josefsson *et al.*, 2005).

In this context, a distinction needs to be made between the prevalence of malocclusion in a population and treatment need. Despite extensive investigation, there is little conclusive evidence to suggest that the presence of a malocclusion has a major impact on oral health, except for a limited number of gross and conspicuous occlusal traits (Shaw *et al.*, 1991). Thus, factors other than the severity of malocclusion, such as aesthetics, and the impact of the malocclusion on the subject's quality of life must also be considered when assessing treatment need. Such factors are more subjective and less readily measured than the presence and severity of malocclusions and may be influenced by the subject's cultural background and social status.

The Index of Orthodontic Treatment Need (IOTN) has facilitated more objective assessment of treatment need, incorporating both a dental health component (DHC; Brook and Shaw, 1989) and an aesthetic component (AC; Evans and Shaw, 1987). Details of the DHC and representative photographs of the AC have been published (Brook and Shaw, 1989). The validity and reliability of the IOTN have been established (Richmond *et al.*, 1995; Hamdan, 2004).

From a planning perspective, the above issues highlight the importance of epidemiological studies to provide current data concerning the prevalence of different types of malocclusions and the need for orthodontic treatment in the actual population (Thilander *et al.*, 2001). The aim of this study was, therefore, to compare the frequency of malocclusion and orthodontic treatment need in 12- and 13-year olds of Swedish and immigrant backgrounds.

Subjects

The research was approved by the Research Ethics Committee, Faculty of Health Sciences, Linköping University, Sweden.

The study was conducted in two southern Swedish towns, Jönköping and Motala. The initial population sample comprised 553 subjects: all the 12- and 13-year olds (born in 1988 and 1989), from six schools. On the examination days, 37 were absent from school due to illness and 23 declined to participate. The remaining 493 comprised the study group. They were stratified, according to family origins, into four groups:

A. subject and both parents born in Sweden, $n = 263$, and subject or at least one parent born in
B. Eastern Europe (Albania, Bosnia–Herzegovina, Croatia, Hungary, Former Yugoslav Republic of Macedonia, Poland, Romania, Serbia), $n = 64$;
C. Asia (Cambodia, China, Lebanon, India, Iran, Iraq, Pakistan, Syria, Turkey, Vietnam), $n = 118$; or
D. other countries (Africa, America, Western Europe, excluding Scandinavia), $n = 48$.

Both parents were born outside Sweden in 97, 92, and 44 per cent of the subjects from Eastern Europe, Asia, and other countries, respectively. Of the subjects from Eastern Europe with both parents born outside Sweden, in 94 per cent of cases both parents were born in Eastern Europe. In both group C and group D, the corresponding figures were 86 per cent. For eight subjects, both parents were born abroad but in different regions (B, C, and D). They were grouped according to the mother's origin.

Method

The registrations included clinical examination and examination of available radiographs (panoramic and intraoral) and patient records.

An orthodontist (EJ) visited the schools and conducted the clinical examinations in the school nurse's room. A mouth mirror, a ruler, and sliding calliper were used. The examination comprised an extraoral inspection including the soft tissues and an intraoral inspection of the teeth and occlusion. The subject was also classified according to the DHC and AC of the IOTN (Brook and Shaw, 1989).

The AC was estimated both by the examiner and the subject. Each subject was instructed to study his/her anterior teeth in a mirror and then to indicate which photograph of the IOTN-AC scale most closely matched the aesthetic appearance of his/her own teeth.

For subjects undergoing treatment with fixed or functional appliances ($n = 25$ and $n = 14$, respectively), registrations were made on pre-treatment study models. These records were analysed and assessed at the general dental and orthodontic clinics, by one author (EJ). No IOTN-AC classification was made for these subjects. For the 30 subjects who had previously undergone treatment with functional appliances, the assessments were made after completion of treatment. With respect to orthodontic treatment with other types of appliance, mainly space maintainers, lingual arch appliances, and expansion plates, 42 had previously undergone treatment and 22 were currently undergoing treatment. The existing conditions were registered in these subjects, but the soft tissue registrations were excluded in those with ongoing treatment.

To determine the normative treatment need, a number of variables were registered (Table 1). The IOTN-DHC classification was made on completion of all registrations.

Reliability test

To test reliability, twenty-five 12-year olds and twenty-five 13-year olds, selected at random, were re-examined after an interval of 4 weeks under the same conditions. Reliability was analysed by weighted kappa statistics. Variables with good and very good reliability (values 0.61–1.0) were retained for inclusion in the final study, and also two variables with moderate reliability ('rotation' and 'IOTN-AC subject' with kappa values of 0.55 and 0.54, respectively). The variables excluded were 'short upper lip' and 'midline deviation'. The initial registrations were used in the study.

Statistical methods

Differences between groups were tested for significance using the non-parametric methods, chi-square, Mann–Whitney *U*, and Kruskal–Wallis and, when applicable, the parametric method analysis of variance.

Results

The overall results showed the closest intergroup similarity between group A (Swedish) and group D (other countries).

Table 1 The variables registered to determine normative treatment need.

Occlusion
- Sagittal occlusion: intermaxillary relationship of first permanent molars and canines to the nearest half cusp width. An overriding assessment of the sagittal occlusion was made for each subject and was then classified to one of three groups: 1 = Class I, 2 = Class II, 3 = Class III.
- Anterior crossbite of one to four teeth. When the incisal edge of maxillary incisors occluded lingually to the incisal edge of the corresponding mandibular tooth.
- Posterior crossbite: registered when the buccal cusps of the maxillary premolars and/or molars occluded lingually to the buccal cusps of the mandibular antagonists.
  - I: one or two pairs of teeth, uni- or bilateral
  - II: at least three pairs of teeth, uni- or bilateral
- A scissor bite: registered when any of the maxillary premolars or molars totally bite to the buccal surface of the mandibular antagonist teeth.
  - I: one or two pairs of teeth, uni- or bilateral
  - II: at least three pairs of teeth, uni- or bilateral
- Deep bite with gingival contact: registered if present palatal to the maxillary incisors or buccal to the mandibular incisors.
- RP-IP difference: was registered when there was a difference greater than 1 mm between RP (retruded contact position) and IP (intercuspal contact position).
- Overjet: the distance from the most labial point of the incisal edge of the maxillary incisors to the most labial surface of the corresponding mandibular incisor. Measured to the nearest half millimetre, parallel to the occlusal plane.
- Overbite: measured vertically from the incisal edge of the most inferior maxillary incisor to the incisal edge of the corresponding mandibular incisor. Measured to the nearest half millimetre.

Alignment anomalies
- Inclination of incisors: discrepancy from normal inclination, a clinical assessment.
- Rotation of maxillary incisors: >15°.
- Tipping of maxillary incisors: for each maxillary incisor when there was a deviation from normal inclination, in any direction (mesial, distal, buccal, or palatal). A clinical assessment.

Anterior available space and contact point displacement
- Available space in the anterior segment: measured with a sliding calliper, the rectilinear distance from the mesial surface of the right canine to the mesial surface of the left canine, to the nearest half millimetre. The width of the permanent teeth was also measured with a sliding calliper to the nearest half millimetre. In those subjects where the permanent canine was unerupted, the distal surface of the lateral incisor was used for measurement, or the mesial surface of the primary canine if it was in normal position. These measurements were made in both arches.
- Contact point displacement: measured between the normal contact points in a bucco-lingual direction to the nearest millimetre. The highest value for each jaw was registered.

Soft tissue
- Lip closure: normal or strained.

Teeth and eruption anomalies
- Hypodontia: absence of a permanent tooth on the radiographs and no recorded history of extraction. The registration did not include second and third molars.
- Supernumerary teeth. (This figure is less valid because the supernumerary teeth may have been extracted earlier.)
- Tooth retention: when tooth eruption was impeded by crowding, displacement, the presence of supernumerary teeth, or pathological causes or if the normal time for eruption was greatly exceeded compared with the subject's dental stage.
- Ectopic eruption: impeded eruption of a tooth due to displacement. A tooth was classified as ectopic if the path of eruption was considered to deviate from normal. The teeth most frequently involved were the maxillary canines and mandibular second premolars.

Extractions and proximal grinding
- Extracted primary molars, canines, and permanent teeth: age and number.
- Proximal grinding of primary molars and canines: age and number.

Orthodontic consultation and orthodontic treatment
- Subject's age at first orthodontic consultation.
- Referral to specialist orthodontist: yes/no.
- Ongoing orthodontic treatment: yes/no.
- Treatment with functional or other appliances: yes/no.

The subjects' self-assessed orthodontic treatment need, expressed as IOTN-AC, was highest in group A. For all four groups, the orthodontist's estimates of treatment need significantly exceeded the subjects' self-assessments.

Occlusion

The Asian subjects (group C) had the lowest frequency of Angle Class II malocclusions, 36.2 per cent. Eastern European and Asian subjects (groups B and C) had the highest frequency of Angle Class III malocclusions, 10.9 and 9.2 per cent, respectively (Table 2). With respect to frequency of sagittal occlusion, crossbite, a scissor bite, and difference between retruded contact position and intercuspal contact position, there were no significant intergroup differences. Deep bite with gingival contact varied between 19.5 and 35.4 per cent. Subjects from groups A and D showed the highest frequency of proclined maxillary incisors, 22.8 and 22.9 per cent, respectively. There were, however, no significant intergroup differences with respect to either deep bite with gingival contact or proclination or retroclination of the maxillary and mandibular incisors.

The mean value for overjet in group A was 4.1 mm, in group D 4.3 mm, and 3.9 and 3.6 mm in groups B and C, respectively (Table 3). The Swedish students (group A) showed a greater overjet than the Asian students (group C), $P = 0.003$. The mean value for overbite did not differ among the groups.

Table 2 Distribution of subjects with respect to sagittal, transverse and vertical relationship, RP-IP difference, difference between retruded contact position and intercuspal contact position, inclination of incisors, and rotation and tipping of maxillary incisors.

Variables	Groups								P
	A		B		C		D		
	n	%	*n*	%	*n*	%	*n*	%	
Occlusion									
Sagittal occlusion									
Class I relationship	124	47.0	27	42.2	64	54.6	23	47.9	ns
Class II relationship	128	48.8	30	46.9	43	36.2	23	47.9	ns
Class III relationship	11	4.2	7	10.9	11	9.2	2	4.2	ns
Anterior crossbite	30	11.4	5	7.8	15	12.7	7	14.6	ns
Posterior crossbite									
One or two pairs of teeth on one side or bilateral	31	11.8	9	14.1	12	10.2	4	8.3	ns
At least three pairs of teeth on one side or bilateral	16	6.1	3	4.7	5	4.2	2	4.2	ns
Scissor bite									
One or two pairs of teeth on one side or bilateral	3	1.1	1	1.6	1	3.4	1	2.1	ns
At least three pairs of teeth on one side or bilateral	1	0.4	0	0	0	0	0	0	ns
Deep bite with gingival contact	69	26.2	17	26.6	23	19.5	17	35.4	ns
RP-IP difference	20	7.6	2	3.1	10	8.5	3	6.3	ns
Alignment anomalies									
Proclined maxillary incisors	60	22.8	12	18.8	19	16	11	22.9	ns
Proclined mandibular incisors	13	4.9	5	7.8	3	2.5	6	12.5	ns
Retroclined maxillary incisors	25	9.5	6	9.5	12	10.1	8	16.7	ns
Retroclined mandibular incisors	47	17.9	9	14.3	13	10.9	7	14.6	ns
Rotated any maxillary incisor >15°	29	11.0	1	1.6	10	8.5	3	6.3	A≠B*
Tipping of maxillary central incisors	17	6.5	6	9.4	6	5.1	3	6.3	ns
Tipping of maxillary lateral incisors	71	27.0	6	9.4	15	12.7	10	20.8	A≠B, C**

A, Swedish; B, Eastern European; C, Asian; D, others.
$^{*}P < 0.05$; $^{**}P < 0.01$; ns, not significant. ≠ denotes difference.

Table 3 Mean value (mm) and standard deviations (SD) of overjet, overbite, available space in the anterior part of the maxilla and the mandible, and contact point displacement.

Variables	Groups								P
	A (n = 263)		B (n = 64)		C (n = 118)		D (n = 48)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Overjet	4.1	2.2	3.9	2.4	3.6	2.0	4.3	2.9	A≠C**
Overbite	3.7	1.9	3.8	1.6	3.5	1.6	3.7	2.0	ns
Anterior available space									
Maxilla	−2.1	2.4	−1.2	1.9	−1.2	2.7	−1.9	2.4	A≠B**, A≠C*
Mandible	−1.2	1.8	−0.7	1.4	−0.9	2.0	−1.2	2.1	A≠B*
Contact point displacement									
Maxilla	2.1	2.4	1.4	1.9	1.6	2.7	1.7	2.4	A≠B, C**
Mandible	1.7	1.3	1.5	1.2	1.5	1.3	1.8	1.2	ns

A, Swedish; B, Eastern European; C, Asian; D, others. $^{*}P < 0.05$; $^{**}P < 0.01$; ns, not significant. ≠ denotes difference.

Alignment anomalies

Swedish subjects exhibited a higher number of rotated maxillary incisors, 11 per cent, than the subjects in group B (Eastern Europe), 1.6 per cent (Table 2). Overall, rotation was more frequent for lateral than for central incisors. Tipping of the maxillary central incisors did not differ among the four groups. Tipping of maxillary lateral incisors was more frequent in group A than in groups B and C.

Midline deviation was measured to the nearest millimetre. This variable was excluded because of low reliability.

Anterior available space and contact point displacement

All groups showed a space deficiency in the anterior segments of both jaws (Table 3). In group A, lack of space in the maxillary anterior segment was 2.1 mm, which was significantly different from groups B and C. In the mandible, the difference in anterior available space was less among the groups, with a significant difference between groups A and B, $P = 0.046$ (Table 3).

The mean value for contact point displacement in the maxilla was greater in the Swedish subjects (2.1 mm) than in the Eastern European (1.4 mm) and Asian subjects (1.6 mm). The contact point displacement in the mandible did not differ significantly among the groups.

Soft tissue

The frequency of strained lip closure did not differ significantly, ranging from 9.8 per cent in group C to 17.4 per cent in group D. The corresponding values for the Swedish and the Eastern European groups were 16.7 and 14.5 per cent, respectively.

The variable, short upper lip, was excluded because of low reliability.

Teeth and eruption anomalies

Tooth retention was found in 8.6 per cent in group A, 16.4 per cent in group B, 9.4 per cent in group C, and 2.1 per cent in group D. There was a significant difference ($P < 0.05$) between groups B and D. For the remaining variables under this heading, no significant differences were found among the groups.

The Eastern European group (B) showed a frequency of hypodontia of 9.8 per cent. The corresponding values in groups A, C, and D were 5.5, 6.0, and 8.5 per cent, respectively. The frequency of supernumerary teeth varied between 0 per cent for group D and 1.6 per cent for groups A and B. The frequency of ectopic eruption was 5.9 per cent for the Swedish group and 3.3, 3.4, and 2.1 per cent, respectively, in groups B, C, and D.

Extractions and proximal grinding

Swedish subjects (A) had the lowest frequency of extracted primary molars before 7.5 years of age, and also the total number of extractions during childhood and adolescence, significantly less than for Eastern European (B) and Asian (C) subjects (Table 4). Compared with groups B and D, the Asian subjects (C) had undergone significantly more extractions of primary molars before 7.5 years of age (Table 4). With respect to extraction of primary canines, there were no intergroup differences.

Although the number of extracted permanent molars was very low overall, the extraction frequency of first permanent molars was higher in subjects with an immigrant background than in the Swedes ($P = 0.04$).

A positive correlation was found between extraction of any primary molar before 7.5 years of age and retention of the permanent successor ($P = 0.016$). The correlation was even stronger for early extraction of two or more primary molars ($P = 0.002$). The number of proximal ground primary teeth varied between 2.5 and 8.3 per cent for canines and between 12.5 and 22.5 per cent for primary molars. There were no differences among the groups.

Orthodontic care and orthodontic treatment

Forty-six per cent of all subjects had, at some time during their childhood, an orthodontic consultation. In the Swedish subjects, the mean age for this consultation was 9.5 years, on average 7–8 months earlier than for the other subjects (groups B, C, and D), $P = 0.016$.

Table 4 Frequency of subjects with extracted primary and permanent teeth.

Variables	Groups								*P*
	A		B		C		D		
	n	%	*n*	%	*n*	%	*n*	%	
Extraction of any primary molar before 7.5 years	17	6.5	18	28.1	32	27.1	6	12.5	A≠B, C***, C≠B, D*
Extraction of two or more primary molars before 7.5 years	7	2.7	12	18.8	19	16.1	3	6.3	A≠B, C***
Extraction of any primary molar, independent of age	78	29.6	29	45.3	63	53.4	19	39.6	A≠C***, A≠B*
Extraction of two or more primary molars, independent of age	37	14.1	19	29.7	41	34.7	11	22.9	A≠C***, A≠B**
Extraction of any primary canine	42	15.9	6	9.4	17	14.4	6	12.5	ns
Extraction of one or more first permanent molars	1	0.4	3	4.7	2	1.7	2	4.2	A≠B, D*
Extraction of one or more premolars	15	5.7	4	6.2	9	7.6	5	10.4	ns
Extraction of one or more incisors	1	0.4	0	0	2	1.7	1	2.1	ns

A, Swedish; B, Eastern European; C, Asian; D, others. $*P < 0.05$; $**P < 0.01$; $***P < 0.001$; ns, not significant. ≠ denotes difference.

There were no intergroup differences in the number of subjects referred to an orthodontist, n = 57, or with any ongoing treatment, n = 61.

Index of Orthodontic Treatment Need

Table 5 shows the treatment need according to the DHC of the IOTN. In 37.0 per cent of all subjects, a 'real treatment need' (grades 4 and 5) was registered: 35.5 per cent had 'little or no treatment need' (grades 1 and 2), while 'borderline need' (grade 3) was registered in 27.5 per cent. There were no significant intergroup differences.

The orthodontist's assessment of the IOTN-AC (Table 6) showed no significant intergroup differences (P = 0.084). However, the mean value of the orthodontist's assessment was significantly higher than the subject's self-assessment (P = 0.000). The self-assessed treatment need (IOTN-AC) was highest in group A and differed significantly from groups B (P = 0.027) and C (P = 0.000; Table 6). Similarly, the orthodontist's IOTN-AC assessment varied according to the group and, although not statistically significant, the value for group A was higher than for groups B and C (Table 6).

Discussion

The present investigation compared the frequency of malocclusions and orthodontic treatment need in adolescents of Swedish and immigrant backgrounds. The subjects were 12–13 years of age at registration. This age group was chosen because by this age the subjects would be in a late mixed dentition or permanent dentition stage, but major orthodontic treatment would not have commenced.

In groups B (Eastern European) and C (Asian), both parents of the subjects were born outside Sweden in 97 and 92 per cent of cases, respectively. Thus, with respect to origin, very few subjects in these groups had a Swedish parent, whereas in group D (other countries) the Swedish influence was greater: 56 per cent of subjects had one Swedish-born parent.

The cities in the present investigation both have areas of mixed socio-economic structure and a high proportion of immigrants and refugees. The immigrant frequency, (i.e. the child or at least one parent born outside Sweden) is approximately 40 per cent, which greatly exceeds the national average of 24 per cent (Statistics Sweden, 2001).

In the present study, the subjects were not investigated according to gender for the following reasons. Firstly, earlier studies have shown little or no gender-based differences with respect to normative treatment need (Helm, 1968; Thilander and Myrberg, 1973; Mi *et al.*, 2003), although there are some exceptions, such as a study by Ingervall *et al.* (1972), reporting higher treatment need in boys. Secondly, because of the composition of the sample, some gender-based groups would have been too small for statistical analysis.

Previous dental treatment constitutes a source of error in epidemiological malocclusion studies. Väkiparta *et al.* (2005) found that early orthodontic intervention may contribute to a reduction in treatment need between 8 and 12 years of age. Most of the subjects of the present study had participated in the children's public dental health care programme from the age of 3 years, and for these children, comprehensive treatment records were available. Thus interceptive treatment may have resulted in a reduction in the frequency of anomalies. As the frequency of earlier or ongoing orthodontic treatment was similar for all four groups in the present study, it is assumed that earlier orthodontic treatment or extraction of teeth did not influence the results, concerning the differences between the groups.

Most of the variability in the frequency of malocclusions reported in the literature is probably attributable to differences in the subjective criteria for the recorded items (Helm, 1968). Comparison of such results is therefore

Table 5 Number and frequency of subjects in the five different grade groups (A, Swedish; B, Eastern European; C, Asian; D, others), according to the dental component of the Index of Orthodontic Treatment Need (IOTN-DHC), related to culture group, A–D.

Group (n)	IOTN-DHC (1–5)									
	1		2		3		4		5	
	n	%	n	%	n	%	n	%	n	%
A (253)	23	9.1	64	25.3	66	26.1	66	26.1	34	13.4
B (60)	8	13.3	15	25	13	21.7	14	23.3	10	16.7
C (116)	13	11.2	32	27.6	33	28.5	28	24.1	10	8.6
D (47)	8	17	6	12.8	19	40.4	10	21.3	4	8.5
Total (476)	52	10.9	117	24.6	131	27.5	118	24.8	58	12.2
P	ns	ns	ns	ns	ns					

ns, not significant.

Table 6 Mean values and ranges of the the aesthetic component of the Index of Orthodontic Treatment Need (IOTN-AC), estimated by orthodontist and subjects in the four culture groups.

Group (n)	IOTN-AC (orthodontist)		IOTN-AC (subject)		P
	Mean	Range	Mean	Range	
A (245)	3.87	1–10	2.57	1–10	***
B (62)	3.35	1–8	2.10	1–4	***
C (109)	3.20	1–9	2.06	1–9	***
D (44)	3.90	1–10	2.40	1–6	***
P	ns		A≠B*, A≠C***		

A, Swedish; B, Eastern European; C, Asian; D, others. *$P < 0.05$; ***$P < 0.001$; ns, not significant. ≠ denotes difference.

usually unreliable. However, comparisons within one particular study, for instance, between the frequencies for the four groups in the present investigation, are more reliable.

The reported frequency of a Class II malocclusion in 11- to 15-year olds ranges from 7.9 (Garner and Butt, 1985) to 27 (Egermark-Eriksson, 1982) per cent. In the latter study, this frequency was for 11-year olds, and was much lower than the corresponding frequency of 48 per cent with a Class II malocclusion in the Swedish group in the present investigation. In a Finnish study of children at the onset of the mixed dentition period (4.0–7.8 years), a Class II canine relationship was found in 52.4 per cent (Keski-Nisula *et al.*, 2003). The results of most investigations are not comparable because of varying assessments and definitions of malocclusion (Helm, 1968).

The mean frequencies for anterior and posterior crossbites were 11.6 and 16.6 per cent, respectively. The corresponding values reported by Thilander and Myrberg (1973) were similar: 11.1 and 10.7 per cent, respectively. Thilander *et al.* (2001) found a lower frequency of posterior crossbites, 4.6 per cent, in a study of Colombian children.

The variables 'overbite' and 'deep bite with gingival contact' may vary over time because many subjects were in the mixed dentition stage. Egermark-Eriksson (1982) reported a mean overjet of 4.0 mm and an overbite of 3.8 mm. The results in the present study were similar: 4.1 and 3.7 mm, respectively.

The frequency of hypodontia among the Swedish subjects in the present study was 5.5 per cent, which is comparable with that reported by Grahnén (1956) and Thilander and Myrberg (1973) of 6.1 per cent. The immigrant subjects had a higher frequency of hypodontia but the differences were not statistically significant. Thilander *et al.* (2001) reported a lower frequency, 3.2 per cent, in Colombian children.

The overall mean value for tooth retention was 9.5 per cent, and for Swedish students 8.8 per cent. In comparison, Thilander and Myrberg (1973) reported a frequency of 5.4 per cent, and Ingervall *et al.* (1972) 16 per cent for tooth retention. In the present study, the Eastern Europe subjects showed a higher frequency of tooth retention, probably due to early extraction of the primary molars (Table 4), as confirmed by the correlation analysis.

In this study, the mean value for anterior space condition was negative. One explanation may be the method of measurement, i.e. rectilinear. Another factor may be the stage of occlusal development. Thilander and Myrberg (1973) found that crowding was the most common occlusal anomaly recorded. The space deficiency in the maxillary anterior segment was greater in the Swedish sample. A Swedish study by Hosseini *et al.* (1999) found higher intra-arch crowding in immigrant than in Swedish children. Kerosuo *et al.* (1991) also found a higher frequency of crowding and distal occlusion and lower frequency of anterior open bite in Finnish children and adolescents than in an age-matched Tanzanian sample. Such findings may reflect the influence of hereditary and environmental factors on children of different ethnic groups.

Compared with groups B and C, there were significantly fewer primary molar extractions in the Swedish group. This may reflect a low caries frequency in the Swedish group. An improvement in caries frequency has been shown in a Scandinavian cohort during the past few decades and this has also had a positive effect on dental arch length (Lindsten *et al.*, 2000, 2002a). However, despite this improvement in dental health, the orthodontic treatment need, in terms of IOTN-DHC, has not improved: there is still a high frequency of treatment need in the Swedish group, with 39.5 per cent classified as grades 4 and 5.

Crowding is, of course, only one condition requiring orthodontic treatment. In this context, it should be noted that studies on Scandinavian children have shown a trend towards a reduction in the difference between the transverse dimensions of the maxilla and mandible. Thus, the risk of developing a posterior crossbite is greater today than a few decades ago (Lindsten *et al.*, 2001) and also over a much longer time perspective (Lindsten *et al.*, 2002b), which affects treatment need. In the present study, there was no significant difference between the groups with respect to posterior crossbite.

Most of the subjects in this investigation were in the late mixed dentition period. Although the IOTN was constructed primarily for use in the permanent dentition, it is the most frequently applied instrument for measuring treatment need (Tausche *et al.*, 2004). In the present study, the normative need in grades 4 and 5 was 37 per cent. This finding may be viewed in the context of treatment need assessed in the following studies. In 12- to 14-year-old Jordanian schoolchildren, Abu Alhaija *et al.* (2004) reported IOTN severity grades 4 and 5 in 34 per cent. Helm (1968) found a malocclusion frequency of 79 per cent in Danish children, and in a study of Swedish children, Ingervall *et al.* (1972) reported that 75 per cent were in need of some form of orthodontic treatment. This would correspond roughly with IOTN-DHC grades 2–5, which in the present study comprised 89.1 per cent. In a study of the mixed dentition in German children, Tausche *et al.* (2004) found high and very high treatment need (DHC 4 and 5) in 26.2 per cent, borderline need in 25.2 per cent, and no treatment need in 48.3 per cent. Thilander *et al.* (2001) found a malocclusion frequency of 88 per cent in Colombian children and adolescents. In a study of immigrant 9-year olds in Sweden, Hosseini *et al.* (1999) applied the Swedish National Board Index of treatment need, which has a severity grading of 1–4. The overall orthodontic treatment need was 89 per cent with 68 per cent in grades 2–4. These studies not only provide a global perspective of high orthodontic treatment need but also confirm a persistently high orthodontic treatment need over the past 30 years.

Analysis of registrations of the AC of the IOTN should be interpreted with some caution. It has shortcomings, e.g. the lack of photographs showing hypodontia, anterior spacing, and a Class II division 2 dentition. There is always some uncertainty in assessing photographs of different types of malocclusion in order to identify one which corresponds to one's own dental appearance. Kok *et al.* (2004) suggested that concern about a malocclusion is not closely related to the severity of the malocclusion in terms of aesthetics as measured by the IOTN-AC. This index is constructed for Caucasians, and Dawjee *et al.* (2002) suggested that the 10 photographs should be complemented with photographs of subjects from other ethnic backgrounds. In the present study, the value for IOTN-AC should probably be higher because this variable was not registered in subjects currently undergoing treatment with fixed or functional appliances.

The orthodontist's ratings for treatment need in the present study exceeded self-assessments by the subjects. This has also been reported in other studies (Shaw *et al.*, 1975; Prahl-Andersen *et al.*, 1979; Birkeland *et al.*, 1996; Mandall *et al.*, 2001). The Swedish subjects (group A) had a higher IOTN-AC than groups B and C. This reflects a greater treatment need and desire for treatment in group A. The greater treatment need was supported by the IOTN-AC orthodontist scores, although these differences were not significant. The subjects' ratings were lower than those of the examiner. Similarly, Hamdan (2004) found moderate agreement in patient AC scores, with kappa scores of 0.40.

This study has shown that perceptions of orthodontic treatment need are influenced by factors other than measurements of normative orthodontic treatment need and perception of aesthetics. Even patients who are aware of a malocclusion do not consider the need for treatment to be as high as the orthodontist (Espeland and Stenvik, 1991; Mandall *et al.*, 2000). Factors that may contribute to this phenomenon are age, social class, economic considerations, individual perceptions of psychosocial benefits, and attitude to orthodontic appliance therapy (Birkeland *et al.*, 1996; Josefsson *et al.*, 2005). Care, however, must be taken not to generalize these findings.

Conclusion

For a few of the variables measured, there was a difference between the Swedish group (group A) and groups B and C (Eastern European and Asian groups). The Swedish group exhibited the greatest space deficiency and irregularity in both the maxillary and mandibular anterior segments and greater overjet, but of small clinical significance. The frequency of extraction of primary molars was higher in groups B and C. There was a positive correlation between early extraction of primary molars before 7.5 years of age and retention of permanent successors.

The orthodontic treatment need, IOTN-DHC grades 4 and 5, ranged from 30 to 40 per cent. In all groups, the orthodontist's estimate of treatment need, expressed as IOTN-AC, was significantly higher than self-assessment by the subjects. The highest score (IOTN-AC subject) was found in the Swedish group (group A, 2.57; group B, 2.10; and groups C and D, 2.06 and 2.40, respectively).

Despite demographic changes due to immigration, no major change in the prevalence of malocclusions and orthodontic treatment need was found.

Address for correspondence

Dr Eva Josefsson
Department of Orthodontics
The Institute for Postgraduate Dental Education
Box 1030
SE-551 11 Jönköping
Sweden
E-mail: eva.m.josefsson@lj.se

Acknowledgement

This study was supported by Public Dental Health, Östergötland County Council, and Health Research Council in the south-east of Sweden. Our thanks to statistician Birgit Ljungquist, PhD, for help with the statistical analysis.

References

Abu Alhaija E S J, Al-Nimri K S, Al-Khateeb S N 2004 Orthodontic treatment need and demand in 12- to 14-year-old north Jordanian school children. European Journal of Orthodontics 26: 261–263

Birkeland K, Bøe O E, Wisth P J 1996 Orthodontic concern among 11-year-old children and their parents compared with orthodontic treatment need assessed by index of orthodontic treatment need. American Journal of Orthodontics and Dentofacial Orthopedics 110: 197–205

Brook P H, Shaw W C 1989 The development of an index of orthodontic treatment priority. European Journal of Orthodontics 11: 309–320

Dawjee S M, Ackerman A, Shaw W C 2002 An aesthetic component of the IOTN for black subjects. Journal of the South African Dental Association 57: 258–263

Egermark-Eriksson I 1982 Malocclusion and some functional recordings of the masticatory system in Swedish schoolchildren. Swedish Dental Journal 6: 9–20

Espeland L V, Stenvik A 1991 Orthodontically treated young adults: awareness of their own dental arrangement. European Journal of Orthodontics 13: 7–14

Evans R, Shaw W 1987 Preliminary evaluation of an illustrated scale for rating dental attractiveness. European Journal of Orthodontics 9: 314–318

Garner L D, Butt M H 1985 Malocclusion in black Americans and Nyeri Kenyans. The Angle Orthodontist 55: 139–146

Grahnén H 1956 Hypodontia in the permanent dentition. A clinical and genetical investigation. Odontologisk Revy 7 (Supplement 3) p 28–39

Hamdan A M 2004 The relationship between patient, parent and clinician perceived need and normative orthodontic treatment need. European Journal of Orthodontics 26: 265–271

Helm S 1968 Malocclusion in Danish children with adolescent dentition: an epidemiologic study. American Journal of Orthodontics 54: 352–366

Hosseini K R, Dahlström M, Huggare J 1999 Malocclusion and the need for orthodontic treatment in 9-year-old immigrant children in Stockholm, Sweden. Swedish Dental Journal 23: 209–216

Ingervall B, Seeman L, Thilander B 1972 Frequency of malocclusion and need of orthodontic treatment in 10-year old children in Gothenburg. Swedish Dental Journal 65: 7–21

Josefsson E, Bjerklin K, Halling A 2005 Self-perceived orthodontic treatment need and culturally related differences among adolescents in Sweden. European Journal of Orthodontics 27: 140–147

Kerosuo H, Laine T, Nyyssonen V, Honkala E 1991 Occlusal characteristics in groups of Tanzanian and Finnish urban schoolchildren. The Angle Orthodontist 61: 49–56

Keski-Nisula K, Letho R, Lusa V, Keski-Nisula L, Varrela J 2003 Occurrence of malocclusion and need of orthodontic treatment in early mixed dentition. American Journal of Orthodontics and Dentofacial Orthopedics 124: 631–638

Kok Y V, Mageson P, Harradine N W, Spred A J 2004 Comparing a quality of life measure and the aesthetic component of the Index of Orthodontic Treatment Need (IOTN) in assessing orthodontic treatment need and concern. Journal of Orthodontics 31: 312–318

Lindsten R, Ögaard B, Larsson E 2000 Difference in dental lateral arch length between 9-year-olds born in the 1960s and 1980s. American Journal of Orthodontics and Dentofacial Orthopedics 117: 663–668

Lindsten R, Ögaard B, Larsson E 2001 Transversal dental arch dimensions in 9-year-old children born in the 1960s and 1980s. American Journal of Orthodontics and Dentofacial Orthopedics 120: 576–584

Lindsten R, Ögaard B, Larsson E 2002a Dental arch space and permanent tooth size in the mixed dentition of a skeletal sample from the 14th to the 19th centuries and 3 contemporary samples. American Journal of Orthodontics and Dentofacial Orthopedics 122: 48–58

Lindsten R, Ögaard B, Larsson E, Bjerklin K 2002b Transverse dental and dental arch depth dimensions in the mixed dentition in a skeletal sample from the 14th to the 19th century and Norwegian children and Norwegian Sami children of today. The Angle Orthodontist 72: 439–448

Mandall N A, McCord J F, Blinkhorn A S, Worthington H V, O'Brien K D 2000 Perceived aesthetic impact of malocclusion and oral self-perceptions in 14-15-year-old Asian and Caucasian children in Greater Manchester. European Journal of Orthodontics 22: 175–183

Mandall N A, Wright J, Conroy F M, O'Brien K D 2001 The relationship between normative orthodontic treatment need and measures of consumer perception. Community Dental Health 18: 3–6

Mi C B, Fan X L, Tian Y, Peang L, Guo H 2003 The prevalence of orthodontic treatment need in Urumqi Han's adolescents. Shanghai Kou Qiang Yi Xue 12: 11–13

Prahl-Andersen B, Boersma H, Van der Linden F P G M, Moore A W 1979 Perceptions of dentofacial morphology by lay persons, general dentists, and orthodontists. Journal of the American Dental Association 98: 209–212

Richmond S *et al.* 1995 Calibration of dentists in the use of occlusal indices. Community Dentistry and Oral Epidemiology 23: 173–176

Shaw W C, Lewis H G, Robertson N R E 1975 Perception of malocclusion. British Dental Journal 138: 211–216

Shaw W C, O'Brien K D, Richmond S, Brook P 1991 Quality control in orthodontics: risk/benefit considerations. British Dental Journal 170: 33–37

Statistics Sweden 2001 Statistisk årsbok för Sverige. Publikationstjänsten, Stockholm

Tausche E, Luck O, Harzer W 2004 Prevalence of malocclusions in the early mixed dentition and orthodontic treatment need. European Journal of Orthodontics 26: 237–244

Thilander B, Myrberg N 1973 The prevalence of malocclusion in Swedish schoolchildren. Scandinavian Journal of Dental Research 81: 12–20

Thilander B, Pena L, Infante C, Parada S S, Mayorga C 2001 Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogota, Colombia. An epidemiological study related to different stages of dental development. European Journal of Orthodontics 23: 153–167

Väkiparta M K, Kerosuo H M, Nyström M E, Heikinheimo K A 2005 Orthodontic treatment need from eight to 12 years of age in an early treatment oriented public health care system: a prospective study. The Angle Orthodontist 75: 344–349